

力量发展集团有限公司

**分三期建设年产 300 万吨焦炭（一期
100 万吨）热回收焦炉及配套余热利
用项目**

**Kinetic Development Group Limited
3.0MTPA Heat Recovery Coke Oven with
Supporting Waste Heat Utilization
System Project (to be Built in 3 Phases,
1.0 MTPA for the First Phase)**

可行性研究

Feasibility Study Report

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目 录

CONTENT

1	总说明 General Information	1
1.1	项目名称 Name of Project.....	1
1.2	项目主办单位及负责人 Project Employer and Person in Charge	1
1.3	参加编制技术方案的单位名称和主要技术负责人 Name List of the Company Participating in the Preparation of the Technical Plan and the Main Technical Leader	1
1.4	编制依据 Basis of Design	2
1.5	编制原则 Design Philosophy.....	2
1.6	技术方案的概况、结论与建议 Overview, Conclusions and Suggestions of the Technical Scheme	3
2	项目提出的背景 Background of Project	25
2.1	企业现状 Enterprise Status.....	25
2.2	项目的由来 Project Origin	25
2.3	项目建设的有利条件 Favorable Conditions for Project Construction	26
3	产品方案及原料、动力供应 Product Plan, Raw Materials and Power Supply.....	29
3.1	规模及产品方案 Capacity and Production Scheme.....	29
3.2	产品产量 Product Output	29
3.3	产品质量 Product Quality	29
3.4	原料供应 Raw Material Supply.....	30
4	厂址及建设条件 Site and Construction Conditions.....	32
4.1	厂址概况 Overview of the Site	32
4.2	厂址的自然条件 Natural Conditions of the Site	32
4.3	外部主要建设条件(原料、耗材、运输等)分析 Analysis of Main External Construction Conditions (raw materials, consumables, transportation, etc.) Analysis	32
5	技术方案 Technical Proposal	34
5.1	备煤系统 Coal Preparation System.....	34

5.2	炼焦系统 Coking System	40
5.3	焦处理系统 Coke Treatment System	67
5.4	余热利用设施 Waste Heat Utilization Facilities	70
5.5	烟气脱硫系统 De-sulfuration System	107
5.6	化验室 Laboratory	115
5.7	总图运输 General Drawing Transportation	120
5.8	给排水 Water Supply & Drainage	125
5.9	通风、除尘 Ventilation, Dust Removal	140
5.10	电气 Electrical	153
5.11	电信 Telecommunications	175
5.12	仪表 Instrumentation	177
5.13	生产过程基础级控制 Basic Level Control of Production Process	188
5.14	建筑与结构 Architecture and Structure	200
6	环境保护 Environmental protection	210
6.1	设计依据及采用标准 Design Basis and Applicable Standards	210
6.2	建设地区环境现状 Current Environmental Situation in the Construction Area	211
6.3	工程概述 Engineering Overview	212
6.4	主要污染源、污染物、控制措施及符合的标准 Main Pollution Sources, Pollutants, Control Measures, and Compliance Standards	217
6.5	绿化措施 Greening Measures	226
6.6	环境管理机构及环境监测机构 Environmental Management Agencies and environmental Monitoring Agencies	227
6.7	投资估算 Investment Estimation	228
6.8	建议 Proposal	228
7	劳动安全 Work Safety	230
7.1	编制依据及采用的主要标准 Compilation Basis and Main Standards	230
7.2	建设地区存在的自然危害因素及主要防范措施 Natural Hazard Factors and Main Prevention Measures in the Construction Area	232

7.3	生产过程中主要危害因素及主要防范措施 Main Hazard Factors and Prevention Measures in the Production Process	236
7.4	劳动安全机构设置 Establishment of Work Safety Institutions	248
7.5	投资估算 Investment Estimation	249
7.6	预期达到的效果 Expected Result	249
7.7	建议 Proposal	250
8	职业卫生 Occupational Health	251
8.1	编制依据及采用的规范 Compilation Basis and Adopted Specifications 251	
8.2	建设地区存在的自然危害因素及防范措施 Natural Hazards and Prevention Measures in Construction Areas	253
8.3	生产过程中主要职业病危害因素及防范措施 Main Occupational Hazards and Prevention Measures during the Production Process	254
8.4	其他防范措施 Other Preventive Measures.....	261
8.5	职业卫生机构 Occupational Health Organization.....	263
8.6	投资估算 Investment Estimation	264
8.7	预期达到的效果 Expected Results.....	264
8.8	建议 Proposal	265
9	消防 Firefighting.....	266
9.1	编制依据及采用的规范 Compiled Basis and Specifications	266
9.2	工程的火灾危险性分析 Fire Hazard Analysis of the Project	267
9.3	消防站的依托 Reliance on Fire Stations	270
9.4	消防设计的初步方案 Preliminary Plan for Fire Fighting	270
9.5	投资估算 Investment Estimation	280
9.6	预期达到的效果 The Expected Result	280
9.7	建议 Proposal	280
10	节能 Energy-saving.....	282
10.1	节能编制依据 Basis of Energy-saving.....	282
10.2	能源构成 Energy Mix	283
10.3	能耗计算 Energy consumption calculation.....	283

10.4	节能分析 Energy-saving analyss	286
10.5	节能措施 Energy-saving measures.....	286
10.6	节能结论 Energy-saving conclusion	293
11	职工定员及技术经济指标 Employee quota and technical and economic indicators	294
11.1	职工定员 Staff Quota	294
11.2	技术经济指标 Technical and Economic Indicators	299
12	附图（见附件）Attached Figures (See attachment)	315
13	财评附表（见附件）Financial Evaluation Appendix (See attachment)	316

1 总说明 General Information

1.1 项目名称 Name of Project

力量发展集团有限公司分三期建设年产 300 万吨焦炭（一期 100 万吨）热回收焦炉及配套余热利用项目。

Kinetic Development Group Limited is planing to build a heat recovery coke ovens with an annual output of 3.0 million tons of coke in three phases (1.0 million tons in the first phase) and supported waste heat utilization projects.

1.2 项目主办单位及负责人 Project Employer and Person in Charge

项目主办单位：

Project Employer:

企业法人：

Legal Representative of
the Company:

项目负责人：

Project Leader

1.3 参加编制技术方案的单位名称和主要技术负责人 Name List of the Company Participating in the Preparation of the Technical Plan and the Main Technical Leader

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Director of Project Management Department:	Li Fuquan

设计经理:

韩克明

Design Manager:

Han Keming

1.4 编制依据 Basis of Design

- a) 力量发展集团有限公司提供的有关设计参照及资料；Reference for Basic Design Supplied by Kinetic Development Group Limited;
- b) 南非有关的法律、法规及规程、标准等。The relevant laws, regulations, rules and standards of the Republic of South Africa.

1.5 编制原则 Design Philosophy

- a) 本项目的设计在“实用、安全、可靠、先进、低成本”的原则下，尽可能减少占地、节省投资，保证满足目前生产建设；The design of the project is based on the principle of "practical, safety, reliable, advanced and low cost" so as to reduce the land area and save investment to satisfy the current production and construction demands as far as possible;
- b) 采用先进可靠的工艺技术和稳定可靠的设备材料，以确保焦电厂长期、安全、稳定地连续生产；Adopt advanced and reliable process technology and stable, reliable equipment and materials to ensure long-term, safety and stable continuous production of the coking plant;
- c) 工程自动化控制水平遵循经济、实用、有效、有利于产品质量控制和安全生产、性价比高的原则，不片面追求高、精、尖配置；The engineering automation control level follows the principles of economy, practicality, effectiveness, producing benefits to product quality control and safe production, and achievement of high economy value. The design will not partially pursue high-grade, precision and advanced configuration;
- d) 对“三废”排放量的控制满足当地有关法律法规的要求；The control of the emissions of "three wastes" shall meet the requirements of relevant local laws and regulations;
- e) 在工艺流程和设备选择方面，采用先进的节能降耗技术，减少对水、电、蒸汽等动力的消耗，以达到国家有关节能规定的要求；In the process and equipment selection, adopting advanced energy-saving and consumption reduction technologies, reducing the consumption of

water, electricity, steam and other power, in order to meet the requirements of the relevant national energy-saving regulations;

- f) 对各装置、厂房和设施采取优化设计，最大限度地减少用地面积。

Optimize the design of devices, plant and facilities to minimize the use of land.

1.6 技术方案的概况、结论与建议 Overview, Conclusions and Suggestions of the Technical Scheme

1.6.1 概况 Overview

1.6.1.1 设计规模 Designed Capacity

根据总体规划，并考虑工程的供水、供电等情况，项目建设地点位于南非 MC Mining 所在的 Makhado 地区，拟采用换热热回收焦炉，分三期建设年产焦炭 300 万吨，一期 100 万吨，二期 100 万吨，三期 100 万吨。

According to the overall plan and considering the water and power supply of the project, the construction site of the project is located in the Makhado area of South Africa. It is proposed to adopt heat exchange and heat recovery coke oven, and the total annual output of coke will be 3.0 million tons that to be built in three phases, 1.0 million tons in the first phase, 1.0 million tons in the second phase and 1.0 million tons in the third phase.

1.6.1.2 建设内容 Construction Content

分三期建设年产 300 万吨焦炭热回收焦炉及配套设施，统一规划，分步实施。一期建设年产 100 万吨焦炭 4×25 孔热回收焦炉及配套余热发电设施、生产管理、生活福利设施和化验室，系统采用空冷，焦炭干熄为主，湿熄备用；二期建设年产 100 万吨焦炭 4×25 孔热回收焦炉及配套余热发电设施，焦炭干熄为主，湿熄备用；三期建设年产 100 万吨焦炭 4×25 孔热回收焦炉及配套余热发电设施，焦炭干熄为主，湿熄备用。

The heat recovery coke oven with an annual output of 3.0 million tons of coke and supporting facilities will be built in three phases, with consistent planning and step-by-step implementations. The first phase of the construction of 1.0MTPA will be 4×25 ovens heat recovery coke ovens and supported by waste heat power generation facilities, production management, welfare facilities and laboratories, the system adopts air cooling, coke dry quenching,

wet quenching as stand by; The second phase of the construction of 1.0 MTPA will be of 4×25 ovens of heat recovery coke ovens and supported by waste heat power generation facilities, coke dry quenching, wet quenching as stand by; The third phase will build a 4×25 ovens heat recovery coke oven battery with an annual output of 1.0 million tons of coke and supported by waste heat power generation facilities, and coke dry quenching, wet quenching as stand by .

建设内容：Construction Content:

备煤车间：露天煤场、预粉碎机室、配煤仓、粉碎机室、煤塔顶以及相应的带式输送机通廊和转运站组成。

Coal preparation workshop: coal storage yard, Pre-pulverizer room 、Coal blending bunker 、pulverizer room, top of coal tower and the corresponding belt conveyor corridor and transfer station.

炼焦车间：热回收焦炉、煤塔、熄焦塔、粉焦沉淀池、干熄焦装置、迁车台、焦罐检修站、焦台、转运站、焦皮带机通廊、筛焦楼、贮焦场等组成。

Coke workshop: type heat recovery and recuperative stamping coke ovens, coal tower, coke quenching tower, powder coke sedimentation tank, dry quenching coke device, transfer platform, coke bucket overhauling station, coke platform, transfer station, coke belt machine corridor, coke screening building, storage field etc.

辅助生产设施：汽轮发电站（含除氧给水泵站及发电电气室）、空冷岛、除盐水处理站、压缩空气氮气站、液氮气化站、消防给水泵站、132kV 开闭站、车间变电所、装煤除尘地面站、出焦除尘地面站、烟气脱硫装置、干熄焦电气室、干熄焦排焦除尘地面站、循环水泵站、机修间、备品备件库、汽车衡等组成。

Auxiliary production facilities: Steam turbine power station (including deoxygenated water supply pump station and power generation electrical room), air cooling island, desalination station, compressed air nitrogen station, liquid nitrogen gasification station, fire water supply pump station, 132kV switching station, workshop substation, coke oven loading and discharging dust removal ground Station, coke oven pusher dedusting ground station, Flue gas desulphurization unit, dry quenching integrated electric room, coke oven discharge dust removal ground station, flue gas dust removal ground station,

coke oven loading and pushing coke dust removal ground station, dry quenching environmental dust removal ground station, Circulating water pumping station, machine repair room, spare parts warehouse, truck scale, etc.

生产管理和生活福利设施: 综合办公楼、浴室、值班宿舍、中心化验室。

Production management and living welfare facilities: comprehensive office building, bathroom, shift dormitory, central laboratory.

1.6.1.3 原料来源及产品销售 Raw Material Sources and Product Sales

1.6.1.3.1 原料来源 Raw Material Sources

本项目生产所需日处理炼焦煤料约 13152t (含水分~10%), 年处理煤量约 480 万 t (含水分~10%), 炼焦用煤主要产自南非国内, 采用汽车运输。

The daily demand of coking coal for the production of this project is about 13152t (containing moisture ~10%), and the annual coal treated is about 4.8 million tons (containing moisture ~10%). The coking coal is mainly produced in South Africa and transported by Trucks.

1.6.1.3.2 产品及销售方向 Product and Sales

a) 焦炭 Coke

本项目的主要产品是焦炭, 炼焦煤加工成焦炭, 作为炼铁的燃料, 销往南非国内。

The main product of the project is metallurgical coke, which will be sold domestically in South Africa as the fuel for iron making.

b) 电 Electricity

本项目产生的高温烟气通过余热发电系统生产的电除厂区自用外, 剩余部分供周围其他企业及并网外送。

Except for the self consumption of the plant, the rest of the electricity generated by the high temperature flue gas in the waste heat power generation system will be transmitted to the outside grid and supplied to neighbourhood.

1.6.1.4 工艺方案 Process Scheme

该项目组成包括备煤、炼焦、焦处理、余热发电及配套的公用辅助设施。

The project consists of coal preparation, coke making, coke treatment, waste heat power generation and supporting public auxiliary facilities.

备煤系统: 采用配煤炼焦, 工艺过程简单、设备较少、操作方便。煤场的炼焦煤经粉碎后由皮带送至焦炉煤塔。

Coal preparation system: Coal blending is adopted for coking process, which is simple with less equipment, convenient operation. The coking coal in the coal yard is crushed and sent to the coal tower of the coke ovens by belt.

炼焦系统：分三期建设 3×4×25 孔热回收焦炉，年产干全焦 300 万 t，配套 3 座煤塔、2 套湿熄焦、2 座焦台、3 套干熄焦。

Coking system: The 3×4×25 ovens heat recovery coke oven battery is built in three phases, with an annual output of 3.0 million tons of dry total coke, with 3 coal towers, 2 sets of wet quenching coke systems, 2 sets of coke tables and 3 sets of coke dry quenching systems.

焦处理系统：焦处理系统是将干熄或湿熄后的焦炭进行输送，并按要求筛分成不同粒级，经皮带送至焦场。

Coke treatment system: The coke treatment system is used for transporting the coke after dry quenching or wet quenching, and screening it into different grain grades according to the requirements, and sending it to the coke field by belt.

余热发电：焦炉产生的高温烟气经余热锅炉换热后，经烟囱排入大气；锅炉产生的蒸汽进入汽轮发电机发电。

Waste heat power generation: the high temperature flue gas produced by coke oven is discharged into the atmosphere through the stack after heat exchange by the waste heat boiler; The steam produced by the boiler goes into the turbo-generator to generate electricity.

1.6.1.5 主要技术经济指标 Main Technical and Economic Index

表 1-1 一期主要经济技术指标表
Table 1-1 Main Economic and Technical Indicators of the First Phase

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
1	装置能力 Unit capability			
1.1	焦炭产量 Coke production	10 ⁴ t/a	100	
1.2	焦炉炉型 Coke oven type		热回收焦炉 heat recovery coke oven	
1.3	焦炉孔数 Number of coke oven ovens	孔 ovens	4×25	
1.4	干法熄焦装置能力 Capacity of dry	t/h	1×140	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	quenching device			
1.5	干法熄焦锅炉 (P=13.8MPa,t=570°C)	t/h	1×63	最大 73 Maximum 73
1.6	焦炉烟气余热锅炉 Coke oven flue gas coke oven waste heat recovery boiler (P=13.8MPa,t=570°C)	t/h	2×152	
1.7	汽轮发电站 Steam turbine power station (P1=13.2MPa (绝), t1=566°C)	MW	2×65	
2	产品产量 Product output			
2.1	干全焦 Dry total focus	t/a	1065742	
2.2	焦炭(干基) Coke (dry basis)	t/a	1030724	
	>30mm	t/a	979188	
	<30mm	t/a	51536	
2.3	沉淀池粉焦(干基) Sedimentation tank powder coke (dry basis)	t/a	745	
2.4	干熄焦粉焦 Dry quenching powder coke	t/a	24024	
2.5	发电量 Power generation	10 ³ kWh/a	1027600	
	其中: 外供 Among them: external supply	10 ³ kWh/a	929300	
3	原材料消耗量 Raw material consumption			
3.1	炼焦用洗精煤(干) Clean coal for coking (dry)	t/a	1440144	
3.2	磷酸三钠 Trisodium Phosphate	t/a	7.763	
3.3	PH 调节剂 PH regulator	t/a	48.26	
3.5	复合药剂 complex reagent	t/a	5.28	
3.6	氧化杀菌灭藻剂 Oxidative fungicide and algacide	t/a	0.17	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
3.7	非氧化杀菌灭藻剂 Non oxidizing bactericidal and algicidal agents	t/a	0.05	
3.11	盐酸: HCL (30%) Hydrochloric acid: HCL (30%)	t/a	0.208	
3.8	烧碱: NaOH (40%) Caustic soda: NaOH (40%)	t/a	2.025	
3.11	絮凝剂 Flocculant	t/a	3.67	
3.8	杀菌剂 bactericide	t/a	6.716	
3.9	还原剂 reducing agent	t/a	1.113	
3.10	阻垢剂 Scale inhibitor	t/a	1.113	
3.12	反渗透膜 Reverse osmosis membrane	万元/a 10000 yuan(CNY)/a	14	
3.13	超滤膜 ultrafiltration membrane	万元/a 10000 yuan(CNY)/a	6	
3.14	反渗透保安过滤膜 Reverse osmosis security filter membrane	万元/a 10000 yuan(CNY)/a	1.2	
3.15	超滤膜保安过滤膜 Ultrafiltration membrane security filter membrane	万元/a 10000 yuan(CNY)/a	0.6	
3.16	焦炭烧损 Burn Loss	t/a	10248	
3.17	生石灰 Raw Lime	t/a	7464	
4	动力消耗 Power consumption			
4.1	水 Water			
	生产用水 Production water	10 ³ m ³ /a	1237.74	
	焦炉循环水 Coke oven recirculating cooling water	m ³ /h	39	自供 Self supply
	汽轮发电循环水 Recirculating cooling water for steam turbine power generation	m ³ /h	45	自供 Self supply
	空氮站循环水 Compressed air		2374	自供 Self supply

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	nitrogen station circulating water			
	生活用水 Domestic water	m ³ /d	19.58	
4.2	电 Electricity			
	有功功率 Active power	kW	17874	
	视在功率 Apparent power	kVA	19428	
	年耗电量 Annual power consumption	10 ³ kWh/a	98300	自供 Self supply
4.3	蒸汽 Steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	4	开工用 Starting work
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	0.2	焦炉用 Used for coke oven
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	8	脱硫用 For desulfurization purposes
4.5	压缩空气 compressed air	m ³ /min	15.33	新建空压站供 Supplied by New Built Air Compression Station
4.6	净化压缩空气 Purified compressed air	m ³ /min	77.1	新建空压站供 Supplied by New Built Air Compression Station
4.7	除尘用 Use for dust remove	m ³ /min	13.5	新建空压站供 Supplied by New Built Air Compression Station
4.8	仪表用净化空气 Purified air for instruments	m ³ /min	3.5	新建空压站供 Supplied by New Built Air Compression Station
4.8	干熄焦烘炉用天然气 Natural gas for Coke Dry Quenching Furnace Drying	10 ³ m ³ /a	132	一年用 10 天（以 热值约 36420kJ/Nm ³ 计 算） 10 days per year (calculated based on a calorific value of approximately

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
				36420kJ/Nm3)
4.9	除盐水 Desalinated water	t/h	26.55	新建除盐水处理站供 Supplied by New Built Desalination Station
5	投资 Investment			
5.1	建设投资 Construction investment	万元 10 ⁴ yuan (CNY)	154099.02	
5.2	建设期利息 Interest during construction period	万元 10 ⁴ yuan(CNY)	9275.53	
5.3	流动资金 Working capital	万元 10 ⁴ yuan(CNY)	11437.30	
6	财务预测指标 Financial Prediction indicators			
6.1	营业收入 Operating income	万元(CNY)/a 10 ⁴ yuan(CNY)/a	298421.95	达产年 Production year
6.3	增值税 value added tax	万元/a 10 ⁴ yuan(CNY)/a	17887.48	达产年 Production year
6.4	原料费用 Raw material costs	万元/a 10 ⁴ yuan(CNY)/a	161001.05	达产年 Production year
6.5	动力费用 Power cost	万元/a 10 ⁴ yuan(CNY)/a	283.53	达产年 Production year
6.6	总成本费用 Total cost expenses	万元/a 10 ⁴ yuan(CNY)/a	176507.42	经营期平均 Average operating period
6.7	利润总额 Total profit	万元/a 10 ⁴ yuan(CNY)/a	101290.12	经营期平均 Average operating period
6.8	所得税 Income tax	万元/a 10 ⁴ yuan(CNY)/a	33425.74	经营期平均 Average operating period
6.9	税后利润 After tax profit	万元/a 10 ⁴ yuan(CNY)/a	67864.38	经营期平均 Average operating period
6.10	项目投资财务内部收益率（税前） Project investment financial internal rate of return (BEFORE tax)	%	58.59	
6.11	项目投资财务内部收益率（税后） Financial internal rate of return on project	%	42.46	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	investment (AFTER tax)			
6.12	资本金财务内部收益率 Capital Financial Internal Rate of Return	%	59.57	
6.13	项目投资回收期（税前） Project investment payback period (BEFORE tax)	年 Years	3.19	含建设期 Including construction period
6.14	项目投资回收期（税后） Project investment payback period (AFTER tax)	年 Years	3.82	含建设期 Including construction period
6.15	资本金投资回收期 Capital investment payback period	年 Years	4.06	含建设期 Including construction period
6.16	项目投资净现值（ic=12%，税前） Net present value of project investment (ic=12%, BEFORE tax)	万元 10 ⁴ yuan	551063.17	
6.17	项目投资净现值（ic=12%，税后） Net present value of project investment (ic=12%, AFTER tax)	万元 10 ⁴ yuan	341710.59	
6.18	资本金净现值(ic=12%) Net present value of capital (ic=12%)	万元 10 ⁴ yuan	1391219.83	
6.19	总投资收益率 Total investment return rate	%	58.88	
6.20	项目资本金净利润率 Net profit margin of project capital	%	102.49	
7	其他指标 Other indicators			
7.1	职工定员 Employee quota	人 Person	358	
	其中：生产人员 Among them: Production personnel	人 Person	315	
	管理和服务人员 Management and service personnel	人 Person	43	
7.2	总图及运输 Overall plan and transportation			
7.2.1	工程用地面积 Engineering land area	m ²	428700	一期用地面积 Phase I land area

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
7.2.2	道路工程 Road engineering	m ²	66350	全部三期道路 All three phases of roads
7.2.3	绿化用地率 Green land utilization rate	%	15	
7.2.4	绿化用地面积 Green land area	m ²	64305	全部三期绿化 All three phases of greening

表 1-2 二期主要经济技术指标表

Table 1-2 Technical and Economic Indicators for Phase II

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
1	装置能力 Unit capability			
1.1	焦炭产量 Coke production	10 ⁴ t/a	100	
1.2	焦炉炉型 Coke oven type		热回收焦炉 heat recovery coke oven	
1.3	焦炉孔数 Number of coke oven	孔 ovens	4×25	
1.4	干法熄焦装置能力 Capacity of dry quenching device	t/h	1×140	
1.5	干法熄焦锅炉 (P=13.8MPa,t=570℃)	t/h	1×63	最大 73 Maximum 73
1.6	焦炉烟气余热锅炉 Coke Oven flue gas coke oven waste heat recovery boiler (P=13.8MPa,t=570℃)	t/h	2×152	
1.7	汽轮发电站 Steam turbine power station (P1=13.2MPa (绝), t1=566℃)	MW	2×65	
2	产品产量 Product output			
2.1	干全焦 Dry total COKE	t/a	1065742	
2.2	焦炭（干基） Coke (dry basis)	t/a	1030724	
	>30mm	t/a	979188	
	<30mm	t/a	51536	
2.3	沉淀池粉焦（干基） Sedimentation tank	t/a	745	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	powder coke (dry basis)			
2.4	干熄焦粉焦 Dry quenching powder coke	t/a	24024	
2.5	发电量 Power generation	10 ³ kWh/a	1027600	
	其中：外供 Among them: external supply	10 ³ kWh/a	929300	
3	原材料消耗量 Raw material consumption			
3.1	炼焦用洗精煤(干) Clean coal for coking (dry)	t/a	1440144	
3.2	磷酸三钠 Trisodium Phosphate	t/a	7.763	
3.3	PH 调节剂 PH regulator	t/a	48.26	
3.5	复合药剂 Complex reagent	t/a	5.28	
3.6	氧化杀菌灭藻剂 Oxidative fungicide and algacide	t/a	0.17	
3.7	非氧化杀菌灭藻剂 Non oxidizing bactericidal and algicidal agents	t/a	0.05	
3.11	盐酸： HCL（30%） Hydrochloric acid: HCL（30%）	t/a	0.208	
3.8	烧碱： NaOH（40%） Caustic soda: NaOH（40%）	t/a	2.025	
3.11	絮凝剂 Flocculant	t/a	3.67	
3.8	杀菌剂 Bactericide	t/a	6.716	
3.9	还原剂 Reducing agent	t/a	1.113	
3.10	阻垢剂 Scale inhibitor	t/a	1.113	
3.12	反渗透膜 Reverse osmosis membrane	万元/a 10000 yuan(CNY)/a	14	
3.13	超滤膜 Ultrafiltration membrane	万元/a 10000 yuan(CNY)/a	6	
3.14	反渗透保安过滤膜 Reverse osmosis	万元/a 10000	1.2	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	security filter membrane	yuan(CNY)/a		
3.15	超滤膜保安过滤膜 Ultrafiltration membrane security filter membrane	万元/a 10000 yuan(CNY)/a	0.6	
3.16	焦炭烧损 Burn Loss	t/a	10248	
3.17	生石灰 Raw Lime	t/a	7464	
4	动力消耗 Power consumption			
4.1	水 Water			
	生产用水 Production water	10 ³ m ³ /a	1237.74	
	焦炉循环水 Coke oven recirculating cooling water	m ³ /h	39	自供 Self supply
	汽轮发电循环水 Recirculating cooling water for steam turbine power generation	m ³ /h	45	自供 Self supply
	空氮站循环水 Compressed air nitrogen station circulating water		2374	自供 Self supply
	生活用水 Domestic water	m ³ /d	19.58	
4.2	电 Electricity			
	有功功率 Active power	kW	13007	
	视在功率 Apparent power	kVA	14138	
	年耗电量 Annual power consumption	10 ³ kWh/a	71539	自供 Self supply
4.3	蒸汽 Steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	4	开工用 Starting work
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	0.2	焦炉用 Used for coke oven
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	8	脱硫用 For desulfurization purposes
4.5	压缩空气 Compressed air	m ³ /min	15.33	新建空压站供 Supplied by New Built Air

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
				Compression Station
4.6	净化压缩空气 Purified compressed air	m ³ /min	54.1	新建空压站供 Supplied by New Built Air Compression Station
4.7	除尘用 Use for dust remove	m ³ /min	13	新建空压站供 Supplied by New Built Air Compression Station
4.8	仪表用净化空气 Purified air for instruments	m ³ /min	3.5	新建空压站供 Supplied by New Built Air Compression Station
4.8	干熄焦烘炉用天然气 Natural gas for dry quenching oven	10 ³ m ³ /a	132	一年用 10 天（以热值约 36420kJ/Nm ³ 计算） 10 days per year (calculated based on a calorific value of approximately 36420kJ/Nm ³)
4.9	除盐水 Desalinated water	t/h	26.55	新建除盐水处理站供 Supplied by New Built Desalination Station
5	投资 Investment			
5.1	建设投资 Construction investment	万元 10 ⁴ yuan (CNY)	127263.29	
5.2	建设期利息 Interest during construction period	万元 10 ⁴ yuan (CNY)	7660.24	
5.3	流动资金 Working capital	万元 10 ⁴ yuan (CNY)	10804.14	
6	财务预测指标 Financial forecast indicators			
6.1	营业收入 Operating income	万元/a 10 ⁴ yuan(CNY)/a	299813.52	达产年 Production year
6.3	增值税 value added tax	万元/a 10 ⁴ yuan(CNY)/a	18070.33	达产年 Production year
6.4	原料费用 Raw material costs	万元/a 10 ⁴ yuan(CNY)/a	161001.05	达产年 Production year

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
6.5	动力费用 Power cost	万元/a 10 ⁴ yuan(CNY)/a	273.29	达产年 Production year
6.6	总成本费用 Total cost expenses	万元/a 10 ⁴ yuan(CNY)/a	173206.15	经营期平均 Average operating period
6.7	利润总额 Total profit	万元/a 10 ⁴ yuan(CNY)/a	105788.33	经营期平均 Average operating period
6.8	所得税 Income tax	万元/a 10 ⁴ yuan(CNY)/a	34910.15	经营期平均 Average operating period
6.9	税后利润 After tax profit	万元/a 10 ⁴ yuan(CNY)/a	70878.18	经营期平均 Average operating period
6.10	项目投资财务内部收益率（税前） Project investment financial internal rate of return (BEFORE tax)	%	70.82	
6.11	项目投资财务内部收益率（税后） Financial internal rate of return on project investment (AFTER tax)	%	51.13	
6.12	资本金财务内部收益率 Capital Financial Internal Rate of Return	%	74.41	
6.13	项目投资回收期（税前） Project investment payback period (BEFORE tax)	年 Years	2.91	含建设期 Including construction period
6.14	项目投资回收期（税后） Project investment payback period (AFTER tax)	年 Years	3.44	含建设期 Including construction period
6.15	资本金投资回收期 Capital investment payback period	年 Years	3.46	含建设期 Including construction period
6.16	项目投资净现值（ic=12%，税前） Net present value of project investment (ic=12%, BEFORE tax)	万元 10 ⁴ yuan	592461.07	
6.17	项目投资净现值（ic=12%，税后） Net present value of project investment (ic=12%, AFTER tax)	万元 10 ⁴ yuan	373938.12	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
6.18	资本金净现值(ic=12%) Net present value of capital (ic=12%)	万元 10 ⁴ yuan	1453002.6 8	
6.19	总投资收益率 Total investment return rate	%	73.50	
6.20	项目资本金净利润率 Net profit margin of project capital	%	128.34	
7	其他指标 Other indicators			
7.1	职工定员 Employee quota	人 Person	256	
	其中：生产人员 Among them: Production personnel	人 Person	225	
	管理和服务人员 Management and service personnel	人 Person	31	
7.2	总图及运输 Overall plan and transportation			
7.2.1	工程用地面积 Project land area	m ²	87480	二期用地面积 Phase II land area

表 1-3 三期技术经济指标表

Table 1-3 Technical and Economic Indicators for Phase III

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
1	装置能力 Unit capability			
1.1	焦炭产量 Coke production	10 ⁴ t/a	100	
1.2	焦炉炉型 Coke oven type		热回收焦炉 heat recovery coke oven	
1.3	焦炉孔数 Number of coke oven	孔 ovens	4×25	
1.4	干法熄焦装置能力 Capacity of dry quenching device	t/h	1×140	
1.5	干法熄焦锅炉 (P=13.8MPa,t=570℃)	t/h	1×63	最大 73 Maximum 73
1.6	焦炉烟气余热锅炉 Coke oven flue gas coke oven waste heat recovery boiler (P=13.8MPa,t=570℃)	t/h	2×152	
1.7	汽轮发电站	MW	2×65	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	Steam turbine power station (P1=13.2MPa (绝), t1=566°C)			
2	产品产量 Product output			
2.1	干全焦 Dry total focus	t/a	1065742	
2.2	焦炭(干基) Coke (dry basis)	t/a	1030724	
	>30mm	t/a	979188	
	<30mm	t/a	51536	
2.3	沉淀池粉焦(干基) Sedimentation tank powder coke (dry basis)	t/a	745	
2.4	干熄焦粉焦 Dry quenching powder coke	t/a	24024	
2.5	发电量 Power generation	10 ³ kWh/a	1027600	
	其中: 外供 Among them: external supply	10 ³ kWh/a	929300	
3	原材料消耗量 Raw material consumption			
3.1	炼焦用洗精煤(干) Clean coal for coking (dry)	t/a	1440144	
3.2	磷酸三钠 Trisodium Phosphate	t/a	7.763	
3.3	PH 调节剂 PH regulator	t/a	48.26	
3.5	复合药剂 complex reagent	t/a	5.28	
3.6	氧化杀菌灭藻剂 Oxidative fungicide and algacide	t/a	0.17	
3.7	非氧化杀菌灭藻剂 Non oxidizing bactericidal and algicidal agents	t/a	0.05	
3.11	盐酸: HCl(30%) Hydrochloric acid: HCl(30%)	t/a	0.208	
3.8	烧碱: NaOH(40%) Caustic soda: NaOH(40%)	t/a	2.025	
3.11	絮凝剂 Flocculant	t/a	3.67	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
3.8	杀菌剂 bactericide	t/a	6.716	
3.9	还原剂 reducing agent	t/a	1.113	
3.10	阻垢剂 Scale inhibitor	t/a	1.113	
3.12	反渗透膜 Reverse osmosis membrane	万元/a 10000 yuan(CNY)/a	14	
3.13	超滤膜 Ultrafiltration membrane	万元/a 10000 yuan(CNY)/a	6	
3.14	反渗透保安过滤膜 Reverse osmosis security filter membrane	万元/a 10000 yuan(CNY)/a	1.2	
3.15	超滤膜保安过滤膜 Ultrafiltration membrane security filter membrane	万元/a 10000 yuan(CNY)/a	0.6	
3.16	焦炭烧损 Burn Loss	t/a	10248	
3.17	生石灰 Raw Lime	t/a	7464	
4	动力消耗 Power consumption			
4.1	水 Water			
	生产用水 Production water	10 ³ m ³ /a	1237.74	
	焦炉循环水 Coke oven recirculating cooling water	m ³ /h	39	自供 Self supply
	汽轮发电循环水 Recirculating cooling water for steam turbine power generation	m ³ /h	45	自供 Self supply
	空氮站循环水 Compressed air nitrogen station circulating water		2374	自供 Self supply
	生活用水 Domestic water	m ³ /d	19.58	
4.2	电 Electricity			
	有功功率 Active power	kW	12038	
	视在功率 Apparent power	kVA	13084	
	年耗电量 Annual power consumption	10 ³ kWh/a	66207	自供 Self supply

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
4.3	蒸汽 Steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/a	4	开工用 Starting work
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	0.2	焦炉用 Used for coke oven
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	8	脱硫用 For desulfurization purposes
4.5	压缩空气 Compressed air	m ³ /min	15.33	新建空压站供 Supplied by New Built Air Compression Station
4.6	净化压缩空气 Purifying compressed air	m ³ /min	48.1	新建空压站供 Supplied by New Built Air Compression Station
4.7	除尘用 Use for dust remove	m ³ /min	12	新建空压站供 Supplied by New Built Air Compression Station
4.8	仪表用净化空气 Purified air for instruments	m ³ /min	3.5	新建空压站供 Supplied by New Built Air Compression Station
4.8	干熄焦烘炉用天然气 Natural gas for dry quenching oven	10 ³ m ³ /a	132	一年用 10 天（以热值约 36420kJ/Nm ³ 计算） 10 days per year (calculated based on a calorific value of approximately 36420kJ/Nm ³)
4.9	除盐水 Desalinated water	t/h	26.55	新建除盐水处理站供 Supplied by New Built Desalination Station
5	投资 Investment			
5.1	建设投资 Construction investment	万元 10 ⁴ yuan (CNY)	75003.45	
5.2	建设期利息 Interest during construction period	万元 10 ⁴ yuan (CNY)	9275.53	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
5.3	流动资金 Working capital	万元 10 ⁴ yuan(CNY)	11437.30	
6	财务预测指标 Financial forecast indicators			
6.1	营业收入 Operating income	万元/a 10 ⁴ yuan(CNY)/a	121855.03	达产年 Production year
6.2	增值税 Value added tax	万元/a 10 ⁴ yuan(CNY)/a	8713.90	达产年 Production year
6.3	原料费用 Raw material costs	万元/a 10 ⁴ yuan(CNY)/a	54932.90	达产年 Production year
6.4	动力费用 Power cost	万元/a 10 ⁴ yuan/a	115.56	达产年 Production year
6.5	总成本费用 Total cost expenses	万元/a 10 ⁴ yuan/a	63368.65	经营期平均 Average operating period
6.6	利润总额 Total profit	万元/a 10 ⁴ yuan(CNY)/a	47602.15	经营期平均 Average operating period
6.7	所得税 Income tax	万元/a 10 ⁴ yuan(CNY)/a	11245.86	经营期平均 Average operating period
6.8	税后利润 After tax profit	万元/a 10 ⁴ yuan(CNY)/a	36356.29	经营期平均 Average operating period
6.9	项目投资财务内部收益率（税前） Project investment financial internal rate of return (BEFORE tax)	%	40.43	
6.10	项目投资财务内部收益率（税后） Financial internal rate of return on project investment (AFTER tax)	%	32.63	
6.11	资本金财务内部收益率 Capital Financial Internal Rate of Return	%	39.79	
6.12	项目投资回收期（税前） Project investment payback period (BEFORE tax)	年 Years	4.09	含建设期 Including construction period
6.13	项目投资回收期（税后） Project investment payback period (AFTER tax)	年 Years	4.66	含建设期 Including construction period
6.14	资本金投资回收期 Capital investment	年 Years	5.06	含建设期 Including

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	payback period			construction period
6.15	项目投资净现值 (ic=12%, 税前) Net present value of project investment (ic=12%, BEFORE tax)	万元 10 ⁴ yuan(CNY)	216864.42	
6.16	项目投资净现值 (ic=12%, 税后) Net present value of project investment (ic=12%, AFTER tax)	万元 10 ⁴ yuan(CNY)	150960.36	
6.17	资本金净现值(ic=12%) Net present value of capital (ic=12%)	万元 10 ⁴ yuan(CNY)	745304.00	
6.18	总投资收益率 Total investment return rate	%	40.07	
6.19	项目资本金净利润率 Net profit margin of project capital	%	68.03	
7	其他指标 Other indicators			
7.1	职工定员 Employee quota	人 Person	260	
	其中：生产人员 Among them: Production personnel	人 Person	229	
	管理和服务人员 Management and service personnel	人 Person	31	
7.2	总图及运输 Overall plan and transportation			
7.2.1	工程用地面积 Project land area	m ²	63820	三期用地面积 Phase III land area

1.6.2 结论 Conclusion

1.6.2.1 工艺技术方案评价 Evaluation of Process Technology Scheme

本项目结合力量发展集团有限公司的实际情况，选择技术先进、经济合理、工艺成熟可靠、性价比高、低能耗、占地面积小、污染小、水重复利用率高的生产工艺，保证各项指标达标排放，同时最大限度地发挥设备的效率、降低投资，使整个工程的投资效益最大化。

Combined with status of Kinetic Development Group Ltd, the production process selected in this project is of advanced technologies, which are matured,

economically reasonable, low energy consumption, small footprints, low pollution and high reuse utilization rate of water, ensuring the various index will meet relevant emission standards while maximally utilizing the equipment so as to control the cost and maximize investment benefits.

1.6.2.2 环境效益及社会效益 Environmental and Social Benefits

- a) 从工艺过程的源头上进行污染物的控制, 焦炉负压操作, 使得炼焦过程实现无烟尘外泄, 不走带化产回收焦炉尾部治理的老路; Pollutants control will be started from the source of the process. Coke Oven operation will be negative pressure so that the coking process can achieve no smoke leakage, not follow the old routine that the chemical recovery coke oven uses for tail treatment;
- b) 没有复杂的煤气净化过程, 不产生有化学污染成份的废水, 解决了废水污染治理难题, 真正实现了清洁生产; There are no complicated gas purification process, and no waste water with chemical pollution components, which solves the problem of waste water pollution control to realizes real clean production;
- c) 采用先进的捣固侧装煤技术, 煤的密实度增加, 生产出来的焦炭强度高; The use of advanced stamp-charging technology will increase density of coal, the intensity of produced coke;
- d) 属于宽炭化室焦炉, 不仅推焦容易, 改善焦炭质量, 延长焦炉寿命, 而且减少焦炉推焦次数, 减少机械磨损, 减少污染, 降低劳动强度; It is a wide carbonizing chamber coke oven, which is not only easy to push coke, improve coke quality, extend the life of coke oven, but also reduce the number of coke oven pushing, reduce mechanical wear, reduce pollution and reduce labor work;
- e) 炼焦生产中产生的煤气全部燃烧, 除焦炉自身加热外, 其余热量全部回收用来发电, 实现了资源的综合利用; All the gas generated in the coking production is burned, except for being used for the coke oven heating, the rest of the heat is recovered for power generation, realizing the comprehensive utilization of resources;
- f) 工艺流程短, 动力消耗少, 操作方便; Short process flow, less power consumption, easy to operate;

- g) 与传统的卧式热回收焦炉比较，具有无焦炭烧损、结焦时间短、炼焦效率高、投资少、占地面积小等优势； Compared with the traditional horizontal heat recovery coke oven, the TYPE COKE OVEN has the advantages characterized as no coke burning loss, short coking time, high coking efficiency, less investment and small footprint;
- h) 本工程采用先进、高效、节能、环保的技术和设备，形成“煤—焦—电”一体化循环经济发展模式。具有良好的经济效益和社会效益。 The project adopts advanced, efficient, energy-saving and environmentally friendly technologies and equipment to form an integrated circular model of economy development that is “coal - coking - electricity”. It is believed that the model will generate good economic and social benefits.

1.6.2.3 结论 Conclusion

综上所述，本项目选用先进、可靠、环保的工艺技术方案，能生产优质的冶金焦炭，产生的高温烟气用来发电。项目的盈利能力及清偿能力均较强，并具有较强的环境效益和社会效益，项目的建设是可行的，也是必要的，因此建议尽快实施。

To sum up, this project uses advanced, reliable and environmentally friendly process technology to produce high-quality metallurgical coke, and the generated high temperature flue gas is used for power generation. The project has strong profitability and solvency, and has good environmental and social benefits. The construction of the project is feasible and necessary, so it is recommended to implement it as soon as possible.

2 项目提出的背景 Background of Project

2.1 企业现状 Enterprise Status

力量发展集团有限公司于 2010 年 7 月在开曼群岛注册成立，2012 年 3 月在香港联交所主板上市，业务覆盖煤炭生产、洗选、装载、运输及煤炭贸易全产业链。

Kinetic Development Group Limited was incorporated in Cayman Island in July 2010. It has been listed on the main board of Hong Kong Stock Exchange in March 2012. The company business cover a full industry chain of coal, including coal mining and production, coal cleaning plant, coal transportation and trade.

2024 年，力量发展在煤炭业务领域迈出了国际化发展的第一步，宣布以增资扩股的方式认购 MC Mining Limited 51% 的股份。认购完成后，将开发及经营位于南非的四个煤矿项目，煤种涵盖动力煤和焦煤，总可采资源量 19.6 亿吨（根据 MC Mining 于截至 2023 年 6 月 30 日止年度之年报数据），资源优质禀赋，有望成为未来业绩增长的主要驱动力之一。

In 2024, the Group took its first step towards international development in the coal sector by announcing the subscription of 51% shares in MC Mining Limited through subscription of new shares of MC Mining. Upon completion of the subscription, the Group will develop and operate four coal mining projects in South Africa, encompassing both thermal and coking coals, with total mineable resources of 1.96 billion tonnes (based on the annual report of MC Mining for the year ended on 30th June 2023). These high-quality resources are positioned to become a key driver of the Group's future performance growth.

2.2 项目的由来 Project Origin

2.2.1 概况 Overview

南非是非洲煤炭资源最丰富的国家之一，探明储量约 98 亿吨，主要分布在姆普马兰加省(Mpumalanga)、林波波省(Limpopo)、夸祖鲁-纳塔尔省(KwaZulu-Natal)和自由州省(Free State)。主要的焦化厂有安赛乐米塔尔南非公司(AMSA)，总产能约 230 万吨，林波波省 Grooteegeluk 煤矿附近配套焦化厂，产能约 60 万吨/年，SASOL 塞昆达(Secunda)煤制油项目副产焦炭，产能约 100 万吨/年。

South Africa is one of Africa's richest countries in coal resources, with

about 9.8 billion tonnes of proven deposit, mainly in the provinces of Mpumalanga, Limpopo, KwaZulu-Natal and Free State. The main coking plants of South Africa are owned by ArcelorMittal South Africa (AMSA), with a total capacity of about 2.3 million tons; another one is a supporting coking plant near the Grooteegeluk coal mine in Limpopo province, with a capacity of about 600,000 tons/year, and the last one is SASOL Secunda coal-to-oil project, the capacity of by-product coke is 1million tons per year.

南非总焦炭年产能约为 400 万吨，而目前需求约 500 万吨，存在缺口。且南非环保法规趋严，要求焦化厂减少硫化物、氮氧化物排放，推动企业升级脱硫设备或转向清洁焦化技术。

South Africa's total annual coke production capacity is approximately 4 million tons, while the current demand is about 5 million tons, resulting in a gap. Moreover, environmental protection regulations in South Africa are becoming increasingly strict, requiring coking plants to reduce emissions of sulfides and nitrogen oxides, and promoting enterprises to upgrade desulfurization equipment or shift to clean coking technologies.项目建设的有利条件 Favorable Conditions for Project Construction

a) 建设条件优越 Excellent construction conditions

南非矿产资源丰富，是世界五大矿产资源国之一，且采矿业是经济支柱产业之一。综合来看，铬矿储量约 2300 亿吨，居世界第一位。目前，南非政府正采取措施，加强吸引国际资金投资矿产开发及深加工，限制原矿出口等，发展本国经济。

South Africa is rich in mineral resources, and is one of the world's five largest mineral resource countries. Mining in South Africa is one of the pillar industries of the economy. Overall, chromium ore reserves of about 230 billion tons, ranking first in the world. At present, the South African government is taking measures to strengthen the attraction of international capital investment in mineral development and deep processing, restricting the export of raw ore, etc., to develop the national economy.

南非拥有现代化交通体系以及非洲最完善的交通运输系统，其运输网络不仅对本国经济发展具有重要作用，也是周边国家经济发展的生命线。南非拥有非洲最长的公路网络，公路网不仅覆盖全国，且与邻国相通，往来十分方便。南非铁

路与津巴布韦、莫桑比克、博茨瓦纳、赞比亚、马拉维等国相接，总里程 3.41 万公里，约占非洲铁路总里程的 35%。南非是世界上海洋运输业较发达的国家之一，拥有非洲最大、设施最完备、最高效的海运网络，其出口 96% 通过海运。

South Africa has a modern transport system and the most complete transport system in Africa, and its transport network not only plays an important role in the economic development of its own country, but also the lifeline of the economic development of neighboring countries. South Africa has the longest road network in Africa, which not only covers the entire country, but also connects with neighboring countries and is very convenient. South African railways connect with South Africa, Mozambique, Botswana, Zambia, Malawi and other countries, with a total mileage of 34,100 kilometers, accounting for about 35% of the total railway mileage in Africa. South Africa is one of the most developed countries in the world with the largest, best equipped and most efficient maritime transport network in Africa, with 96% of its exports going by sea.

南非电力生产主要由南国家电力公司（Eskom）负责，南非 90% 以上的电力供应来自该公司。由于发电设备老化、故障频发和运维不足，Eskom 越来越难以满足国内不断增长的电力需求。

Electricity production in South Africa is mainly the responsibility of the Southern State Electricity Company (Eskom), which supplies more than 90% of South Africa's electricity. Due to aging generation equipment, frequent failures and inadequate operation and maintenance, Eskom is struggling to meet the growing demand for electricity in the country.

非洲是南非贸易政策的战略中心，通过建立南部非洲发展共同体、关税同盟等，进一步加强了南部非洲区域性整合，并与东南非共同市场、东非共同体等签订三方协议，深化东部和南部非洲市场融合。通过参与非洲大陆自贸区建设，南非进一步扩展了同非洲国家内部贸易的联系。。

Africa is the strategic center of South Africa's trade policy. Through the establishment of the Southern African Development Community (SADC) and the Customs Union, the regional integration of Southern Africa has been further strengthened, and tripartite agreements have been signed with the Common Market for Eastern and Southern Africa (COMESA) and the East African

Community (EAC) to deepen market integration in Eastern and Southern Africa. By participating in the construction of the African Continental Free Trade Area, South Africa has further expanded its links with intra-African trade.

主要原料和产品运输可以充分利用当地资源，建厂条件成熟。

The transportation of main raw materials and products can make full use of local resources, and the condition for building factories is mature.

b) 人才优势 Talented Advantage

3 产品方案及原料、动力供应 Product Plan, Raw Materials and Power Supply

3.1 规模及产品方案 Capacity and Production Scheme

根据总体规划,本项目一期、二期和三期的建设总规模为年产焦炭 300 万 t, 采用 3×4×25 孔热回收焦炉。本工程产品主要有焦炭和电。

According to the overall plan, the total construction capacity of the first, second and third phase of the project is 3.0 million tons of coke per year, using 3×4×25 ovens heat exchange and recovery coke oven. The main products of this project are coke and electricity.

3.2 产品产量 Product Output

表 3-1 产品产量表
Table 3-1 Output table

序号 No.	指标名称 Name	单位 Unit	指标 Index	备注 Remarks
1	焦炭 coke	t/a	3197225	
2	电 electricity	10 ³ kWh	3082800	

3.3 产品质量 Product Quality

冶金焦质量指标如下: Metallurgical coke quality indicators are as follows:

表 3-2 冶金焦质量指标表(GB/T 1996-2017)
Table 3-2 Quality specifications of metallurgical coke(GB/T 1996-2017)

指标 Index			等级 Grade	粒度 / mm Granular		
				>40	>25	25-40
灰分 Ad(%)			一级 first 二级 second 三级 third	≤12.00 ≤13.50 ≤15.00		
硫分 St.d(%)			一级 二级 三级	≤0.70 ≤0.90 ≤1.10		
机械 强度 Mechanical Strength	抗碎强度 Anti-crush Strength	M25(%)	一级	≥92.0		
			二级	≥89.0		
			三级	≥85.0		
		M40(%)	一级	≥82.0		
			二级	≥78.0		
			三级	≥74.0		
	耐磨强度 Wear Resistance	M10(%)	一级	≤7.0		
			二级	≤8.5		
			三级	≤10.5		

指标 Index	等级 Grade	粒度 / mm Granular		
		>40	>25	25-40
反应性 CRI(%)	一级	≤30		--
	二级	≤35		
	三级	--		
反应后强度 CSR(%)	一级	≥60		
	二级	≥55		
	三级	--		
挥发分 Vdaf(%)		≤1.8		
水分含量 Mt(%) Water Content	干熄焦 CDQ	≤2.0		
	湿熄焦 coke wet quenching	≤7.0		
焦末含量(%) rate of coke fines		≤5.0		
注：百分号为质量分数。Note: The percentage sign is the quality fraction				

本项目暂按生产二级冶金焦考虑，实际生产时焦炭质量将随炼焦煤的变化而改变。This project considers the production to be of secondary metallurgical coke temporarily, and the quality of coke in actual production will be subject to the quality of coking coal.

3.4 原料供应 Raw Material Supply

本项目分三期建设，总体规模为年产焦炭 300 万 t，主要原料为洗精煤，年需洗精煤约 480 万 t（含水分 10%）。

The project will be constructed in three phases, with an overall annual capacity of 3.0 million tons of coke. The main raw material is washed coal, and the annual demand for washed coal is about 4.8 million tons (containing 10% moisture).

设计对生产冶金焦的装炉煤质量要求如下：

The quality requirements of coal loading for metallurgical coke production are as follows:

水分 Mt	~10%
灰分 Ad	8%~10%
硫分 St.d	0.6%~1.2%
挥发分 V _d	24%~30%
粒度 particle size (<3mm)	~90%
粘结指数 G	55~72

Y(mm)

12~15

4 厂址及建设条件 Site and Construction Conditions

4.1 厂址概况 Overview of the Site

厂址位于南非 MC Mining 所在的 Makhado 地区。Makhado 矿山位于南非林波波省 Louis Trichardt 镇正北约 23 公里处（公路 32 公里），可通过公路进入，公路网络条件良好。

The site will be located in the Makhado region of South Africa where MC Mining is located. The Makhado Mine is located 23 km (32 km by road) directly north of the town of Louis Trichardt in Limpopo Province, South Africa and is accessible by road with a good road network.

4.2 厂址的自然条件 Natural Conditions of the Site

当地气候为半干旱气候，夏季炎热至极热，冬季温暖至凉爽，全年降水最少。该地区在 10 月至 3 月之间为温暖潮湿的夏季，5 月至 8 月之间为凉爽干燥的冬季。4 月和 9 月是过渡月份。最高温度出现在初夏的几个月，温度在 20° C 到 33° C 之间。最低温度在冬季中期，范围在 7° C 到 28° C 之间。冬天通常是温和的，霜冻很少发生。降雨具有很强的季节性，夏季主要以强对流雷暴的形式出现。年平均降雨量在 285 毫米至 622 毫米之间。

The climate is semi-arid, with extremely hot summers and warm to cool winters, with minimal rainfall throughout the year. The region has warm, wet summers between October and March and cool, dry winters between May and August. April and September are transition months. The highest temperatures occur in the early summer months, with temperatures ranging from 20°C to 33°C. The lowest temperatures are in mid-winter, ranging from 7°C to 28°C. Winters are usually mild and frosts rarely occur. Rainfall is highly seasonal and occurs mainly in the form of severe convective thunderstorms in summer. The average annual rainfall is between 285 mm and 622 mm.

4.3 外部主要建设条件（原料、耗材、运输等）分析 Analysis of Main External Construction Conditions (raw materials, consumables, transportation, etc.) Analysis

马卡多项目可通过国家公路网络到达。N1 高速公路从北向南穿过采矿区的西端，由北向南连接 Musina, Louis Trichardt, Polokwane 和约翰内斯堡等城镇。

由砾石铺成的 D745 公路与 N1 高速穿越 Mudimeli 村段连接，东向到 Nzhelele 大坝和 Tshipise。D3678 砾石公路从 D745 公路向东连接到 Makushu 和 Musekwa 村庄，以及 Nzhelele 大坝的南部地区。D1021 碎石路将 N1 高速公路连接到拟议的 Huntleigh 铁路侧线位置。几条砾石轨道提供了通往项目区域不同地点的通道。

The Makhado project is accessible via the national road network. The N1 motorway runs north to south through the western end of the mining area, connecting the towns of Musina, Louis Trichardt, Polokwane and Johannesburg from north to south. The gravel-paved D745 connects with the N1 motorway through Mudimeli Village, heading east to the Nzhelele Dam and Tshipise. The D3678 gravel road runs east from the D745 to the villages of Makushu and Musekwa, as well as to the southern area of the Nzhelele Dam. The D1021 gravel road connects the N1 motorway to the proposed Huntleigh rail siding location. Several gravel tracks provide access to different locations in the project area.

本工程所需用煤由周边煤矿提供，所需用水可由地下水、水库水和处理后的工业用水水源构成。

The coal required for this project will be provided by the surrounding coal mine, and the water required can be composed of groundwater, reservoir water and treated industrial water sources.

本工程新建一座 132kV 升压站，分三期建成。两路 132kV 电源由上级变电所提供，业主负责送至升压站。

A new 132 kV step-up station is built in this project, built in three phases. Two 132kV power sources are provided by the superior substation, and the owner is responsible for delivering them to the booster station.

5 技术方案 Technical Proposal

5.1 备煤系统 Coal Preparation System

5.1.1 概述 Overview

备煤系统是将炼焦用单种煤经粉碎加工成符合焦炉生产要求的装炉煤，本系统是新建捣固换热热回收焦炉配套建设。

The coal preparation system is designed to grind and process single coal into coal charge that meet the specific production requirements for coke ovens. This system is a supporting construction for the new Stamp-charging heat exchange and recovery coke oven plant.

备煤系统分二期建设，二期建设完成可满足 300 万吨焦炉装炉煤要求。

The coal preparation system will be constructed in two phases, and the completion of the second phase can meet the requirements of loading 3 million tons of coke oven coal.

用煤均来自洗煤厂，来煤方式以汽车来煤。

The coal used in the coal preparation system comes from the coal washing plant and supplied by trucks.

5.1.2 工艺流程 Process Flow

由汽车运来的原料煤在贮煤场堆放，当需要炼焦煤时，利用装载机将煤料推入受料槽内，然后经受料槽下电液动颚式闸门卸至带式输送机上，气煤、瘦煤等硬质煤由带式输送机运至预粉碎机室进行初步粉碎处理后进入配煤仓贮存，焦肥煤等易粉碎煤不经过预粉碎可通过带式输送机直接运至配煤仓内贮存。配煤仓内的各单种煤经过特定的比例混合后，由带式输送机运往粉碎机进行混合粉碎到要求细度，直接运往煤塔，并由安装在带式输送机上的固定式电动犁式卸料器卸至煤塔内，供焦炉生产使用。

The raw coal transported by trucks is piled up in the coal storage yard. When coking coal is needed, it will be pushed into the coal pit by the loader and then unloaded onto the belt conveyor through the electro-hydraulic jaw gate under the coal pit. Hard coal such as gas coal and lean coal are transported by belt conveyors to the pre-crusher room for preliminary crushing treatment, and then stored in the coal blending bin. Coal that is easily crushed, such as coke and fat coal, can be directly transported to the coal blending bin for storage

without the need for pre crushing through belt conveyors. After each type of coal in the coal blending bin is mixed in a specific proportion, it is transported by a belt conveyor to the crusher for mixing and crushing to the required fineness. It is directly transported to the coal tower and discharged into the tower through a fixed electric plow unloader installed on the belt conveyor for use in coke oven production.

整个系统工艺过程简单、设备较少、操作方便。

The entire system has a simple process, fewer equipment, and convenient operation.

整个系统由贮煤场、受煤坑、预粉碎机室、配煤槽、粉碎机室、煤塔顶以及相应的带式输送机通廊和转运站组成。

The entire system comprises coal storage yard, coal pit, pre crusher room, coal blending bin, crusher room, coal tower top, as well as the corresponding belt conveyor corridor and transfer stations.

5.1.3 工艺设施及主要设备 Process Facilities and Key Equipment

5.1.3.1 贮煤场 Coal Storage Yard

由汽车运来的原料煤在贮煤场分区域堆放。由装载机进行堆取煤的辅助作业和堆煤场的清底工作。

The raw coal transported by trucks is stacked in different areas of the coal storage yard. Auxiliary operations for coal stacking and bottom cleaning in the coal yard are carried out by loaders

炼焦用煤经过煤场贮存后，能够达到煤质均匀化和脱水的目的，同时还能保证焦炉连续、均衡生产，并稳定焦炭质量。

After the coking coal is stored in the coal yard, it can achieve the purpose of coal quality homogenization and dehydration, and also ensure the continuous and balanced production of coke oven, and stabilize the coke quality.

贮煤场总贮量约为 14 万吨，分两期建设，一期建设贮量约 7 万吨，二期建设贮量约 7 万吨。

The total storage capacity of the coal storage yard is about 140,000 tons, which will be constructed in two phases. The first phase will have a storage capacity of about 70,000 tons, and the second phase will have a storage capacity of about 70,000 tons.

贮煤场内设受煤坑。受煤槽为钢筋混凝土结构，深槽方锥形，内衬压延微晶板，槽口上方设有篦条孔。

The coal pit is arranged in the coal storage yard. The coal receiving trough is a reinforced concrete structure with deep and square conical groove, lined with rolled microcrystal plate, and a grate is arranged above the trough.

当需要炼焦煤时，利用装载机将单种煤推入受料槽内，然后经受料槽下部带式输送机运往粉碎机室进行粉碎处理。

When coking coal is needed, a single type of coal is pushed into the coal pit by the loader, then to be transported to crushing room for crushing by the conveyor belt installed under the trough.

5.1.3.2 预粉碎机室 Pre Crusher Room

为了更好的控制装炉煤的粉碎细度及装炉煤的粒级分配，气煤、瘦煤等难粉碎的硬质煤先一次粉碎后再配煤，使二次粉碎后配合煤的粒度分布更均匀，达到提高焦炭质量的目的。

In order to better control the crushing fineness and particle size distribution of the coal loaded into the furnace, hard coal such as gas coal and lean coal that are difficult to crush are first crushed before coal blending, so that the particle size distribution of the blended coal after secondary crushing is more uniform, achieving the goal of improving the quality of coke.

预粉碎机室设 2 台可逆反击锤式粉碎机，2 台同时使用。

The pre crusher room is equipped with two reversible impact hammer crushers, which are used simultaneously.

由贮煤场运来的气、瘦煤等难粉碎的煤，经除铁装置将煤料中的铁件吸净后进入预粉碎机室进行粉碎，粉碎后的煤经带式输送机送往配煤槽；焦煤、肥煤等不需要预粉碎的煤，可通过一次破碎机室的电液动翻板调整煤料经带式输送机直接送往配煤槽。

The difficult to crush coal such as gas and lean coal transported from the coal yard is absorbed by the iron removal device and enters the pre pulverizer room for pulverization. The pulverized coal is sent to the coal blending bin by belt conveyor; Coking coal, fat coal and other coal that do not require pre crushing can be adjusted by the electro-hydraulic flap in the primary crusher room and directly sent to the coal blending bin through belt conveyor.

在粉碎机室底层还设有检验粉碎细度的设施,按规定制度进行煤的采样检验,根据检验结果及时更换锤头保证装炉煤的细度达到规定要求。

There is also a facility for inspecting the fineness of pulverization at the bottom of the crusher room, sampling and inspecting the coal according to the prescribed system, and replacing the hammer head in time according to the test results to ensure that the fineness of the coal in the oven meets the specified requirements.

5.1.3.3 配煤槽 Coal Blending Bin

配煤槽是把各种牌号的炼焦用煤,根据配煤试验确定的配比进行配合,使配合后的煤料能够炼制出符合质量要求的焦炭,同时达到合理利用煤炭资源,降低生产成本的目的。

The coal blending bin is used to mix various grades of coking coal according to the proportion determined by coal blending experiments, so that the mixed coal can be refined into coke that meets quality requirements, while achieving the goal of reasonable utilization of coal resources and reducing production costs. The coal blending tank is used to mix various grades of coal according to the ratio determined by coal blending tests, so that the blended coal can be refined into coke that meets quality requirements, while achieving the goal of reasonable utilization of coal resources and reducing production costs.

由贮煤场或预粉碎机室运来的单种煤,经顶部卸料小车分别布入 20 个直径 $\phi 10\text{m}$ 双曲线斗嘴的煤槽内。20 个煤槽为双排布置,每个煤槽贮量约 850t,总贮量为 17000t。

The single coal transported from the coal yard or pre crusher room is distributed into 20 coal bin with a diameter of $\phi 10\text{m}$ hyperbolic nozzles by the top unloading trolley. 20 coal bins are arranged in double rows, with each bin storing approximately 850 tons and a total storage capacity of 17,000 tons.

配煤槽口采用等截面收缩率型双曲线斗嘴,对含水分高和泥煤量大的煤,有良好的适应性,操作稳定,可防止煤在仓内棚料,提高配煤的准确性。

The coal blending slot adopts a hyperbolic bucket with equal cross-sectional shrinkage rate, which has good adaptability to coal with high moisture content and large mud coal content. The operation is stable, which can prevent

coal from being trapped in the warehouse and improve the accuracy of coal blending.

配煤槽双曲线斗嘴采用压延微晶板，内衬板面不得有反错台和明显的顺错台。

The hyperbolic nozzle of the coal blending bin is made of rolled microcrystalline board, and the inner lining board surface must not have any reverse or obvious forward or reverse alignment.

配煤槽下部设置自动配煤装置，主要由电液动平板闸门、定量给料带式输送机、电子配料秤控制系统等组成。生产时按照给定值自动控制各单种煤的配量，确保配煤比连续稳定。采用自动配煤装置可以大大提高配煤的准确性和自动化程度，降低工人的劳动强度，提高焦炭质量。配煤槽双曲线部分设有高能破拱助流器，利用压缩空气瞬间释放的能量进行清堵和破拱。

The lower part of the coal blending bin is equipped with an automatic coal blending device, mainly composed of an electro-hydraulic flat gate, a quantitative feeding belt conveyor, an electronic batching scale control system, etc. Automatically control the blending ratio of each individual coal according to the given value during production to ensure continuous and stable blending ratio. The use of automatic coal blending equipment can greatly improve the accuracy and automation level of coal blending, reduce the labor intensity of workers, and improve the quality of coke. The hyperbolic section of the coal blending tank is equipped with a high-energy arch breaking flow aid, which uses the energy released instantly by compressed air to clear blockages and break arches.

5.1.3.4 粉碎机室 Crusher Room

粉碎机室的作用是将配合煤进行粉碎处理，使其粉碎细度（ $<3\text{mm}$ 煤的含量达到 90%以上）达到炼焦生产要求。

The function of the crusher room is to crush the blended coal, so that its crushing fineness (less than 3mm coal content reaches 90% or more) meets the requirements of coking production.

粉碎机室内共设置 3 台可逆反击锤式破碎机；分两期供货，一期设 2 台（1 开 1 备）；二期再设 1 台（2 开 1 备）。

Three reversible impact hammer crushers are installed in the crusher room; supplied by 2 phases, with two units (1 on and 1 standby) in the first phase;

One more unit will be installed in Phase II (2 on and 1 standby).

由配煤槽运来的配合煤，先经除铁装置将煤料中的铁件吸净后，进入可逆反击锤式粉碎机进行混合粉碎；粉碎后的装炉煤，经带式输送机送入煤塔顶。

The blended coal transported from the coal blending bin will have the iron contained removed by the iron removal device, and then enters the reversible impact hammer crusher for mixing and crushing; The pulverized coal loaded into the furnace is transported to the top of the coal tower by belt conveyor.

5.1.3.5 煤塔顶 Coal Tower Top

由粉碎机室运来的装炉煤经安装在带式输送机上的固定式电动犁式卸料器送至煤塔内，供焦炉生产使用。

The coal to be charged from the crusher room is sent to the inside of coal tower by power-driven plough type discharger mounted on belt conveyor for the coke oven production.

5.1.4 其他 Others

- a) 在配煤槽和煤塔顶设有雷达料位计，对各煤槽中煤的料位情况实施监控；

A radar level meter is installed on the top of the coal tower and coal blending bin to monitor the level of coal in each coal tank;

- b) 在配煤槽前和粉碎机室前的带式输送机上各设置 1 台电子皮带秤，计量进出煤量； Install one electronic belt scale on each of the belt conveyors in front of the coal blending bin and the crusher room to measure the amount of coal entering and exiting

- c) 新建带式输送机均按照 DT II (A)型带式输送机手册选型； New belt conveyors are selected in accordance with the DT II(A) belt conveyor manual;

带式输送机能力： Belt conveyor capacity:

配煤槽前 Before the coal blending bin: B=1400mm, Q=1200t/h;

配煤槽后 After the coal blending bin: B=1400mm, Q=1000t/h.

- d) 根据带式输送机的使用情况不同，设有双向拉绳开关、跑偏开关、打滑检测器、纵向撕裂检测器、溜槽堵塞检测器等保护装置，确保系统安全运行； According to the different use conditions of belt conveyor, equipped with two-way pull switch, belt tracking limit, belt slip sensor,

chute block sensor, sensor for belt longitudinal tear and other protection devices to ensure the safe operation of the system;

- e) 带式输送机电机功率大于 45kW 时采用限矩型液力耦合器；When the motor power of belt conveyor is greater than 45kW, the torque limited fluid coupler is adopted;
- f) 备煤系统采用四班制操作，工艺生产过程为 PLC 联锁自动控制。The coal preparation system adopts four-shift operation, and the production process is automatically controlled by PLC interlock.

5.2 炼焦系统 Coking System

5.2.1 概述 Overview

拟在南非分三期建设年产 300 万吨焦炭热回收焦炉项目，配套建设余热发电系统及熄焦系统，熄焦采用干熄焦（湿法熄焦作为备用）。

This project is planned to build coke ovens with annual output of 3 million tons of coke divided into three phases in South Africa. The coke oven uses heat recovery coke oven of meters high coke chamber with coordinated waste heat power generation system and coke quenching system, dry quenching (wet quenching as a backup) is used for quenching coke.

一期建设年产 100 万吨焦炭的 1~4#热回收焦炉（4×25 孔）及配套余热利用设施（带发电）、1#湿熄焦系统，1#干熄焦装置预留。

The phase I of this project includes 1~4# heat recovery coke ovens with annual output of 1 million tons (4×25 ovens), waste heat utilization facilities (with power generation), 1# wet coke quenching system and other supporting facilities, and 1# CDQ is reserved.

二期建设年产 100 万吨焦炭的 5~8#热回收焦炉（4×25 孔）及配套余热利用设施（带发电）、1#、2#干熄焦装置。

The phase II of this project includes 5~8# heat recovery coke oven with an annual output of another 1 million tons (4×25 ovens), waste heat utilization facilities (with power generation), 1# and 2# CDQ.

三期建设年产 100 万吨焦炭的 9~12#热回收焦炉（4×25 孔）及配套余热利用设施（带发电）、3#干熄焦装置、2#湿熄焦系统。

The phase III of this project includes 9~12# heat recovery coke oven with an annual output of another 1 million tons (4×25 ovens), waste heat utilization

facilities (with power generation), 3# CDQ and 2# wet coke quenching system.

5.2.2 炼焦工艺基本参数 Basic Process Parameters for Coke-making

表 5-1 炼焦工艺基本参数表（100 万吨/年）

Table 5-1 Basic process parameters for coke-making (1 million tons/a)

序号 No.	项目名称 Project	单位 Unit	参数 Parameter
1	炉型 Type of oven		热回收焦炉 coke oven with heat transfer
2	焦炉孔数 Number of oven	座×孔 Site×oven	4×25
3	每个炭化室装干煤量（干） Bulk density of charging coal (dry)	t	41.1
4	焦炉周转时间 Gross coking time of coke oven	h	25
5	焦炉年工作日 Annual operating days of coke oven	d	365
6	装炉煤干基挥发分 Volatilization of coal charg (dry)	%	28
7	装炉煤水分 Moisture of coal charg	%	10
8	全焦率 Coke rate	%	74

5.2.3 炼焦工艺流程 Process Flow for Coke-making

由备煤车间送来的能满足炼焦要求的煤装入煤塔。通过摇动给料器将煤装入装煤车的煤箱内，并将煤捣固成煤饼，装煤车按作业计划将煤饼从机侧送入炭化室内。煤饼在炭化室内经过一个结焦周期的高温干馏炼制成焦炭（焦饼中心温度 $1000\pm 50^{\circ}\text{C}$ ）。炭化室内的焦炭成熟后，由推焦机推出。

The qualified coal sent by the coal preparation workshop is charged into the coal tower, and loaded by vibrating feeder before being rammed into the stamped cake. The charging car sends the stamped cake into the coke chamber from the pusher side according to the operation plan. The stamped cake made into coke (the central temperature of the stamped cake is $1000 \pm 50^{\circ}\text{C}$) by high temperature distillation in a coke chamber. The coke in the coke chamber is rolled out by a coke pusher after matured.

当采用干法熄焦时，炭化室内的焦炭成熟后，由推焦机推出，焦炭经拦焦机导入焦罐车中，由电机车牵引至干熄站的提升井架底部。提升机将焦罐提升并送至干熄炉炉顶，通过带钟型布料器的装入装置将焦炭装入干熄炉内。在干熄炉中

焦炭与惰性气体直接进行热交换,焦炭被冷却至 200℃以下,经排焦装置卸到带式输送机上,然后送往筛贮焦系统。

When dry quenching is used, after the coke in the coke chamber is fully matured, it is pushed out by the pusher machine, and the coke is discharged into the coke bucket car through the coke guide machine. The electric locomotive is hauled to the bottom of the lifting derrick at the dry quenching station. The hoist lifts the coke bucket and sends it to the top of the CDQ chamber, and the coke is loaded into the CDQ chamber through the charging device with the distributing bell. In the CDQ chamber, direct heat exchange occurs between the coke and the inert gas. The coke is cooled to less than 200℃, and discharged on the belt conveyor by the coke discharging device, and then sent to coke screening and storage station.

当干熄焦装置检修或事故时,采用备用湿法熄焦,炭化室内成熟的焦炭经拦焦机导入熄焦车内,由电机车牵引至熄焦塔内进行喷水熄焦,熄焦后的焦炭卸至晾焦台上,晾置一定时间后送往筛贮焦工段。

When the CDQ is under maintenance or in case of an accident, the backup wet quenching system is utilized, the mature coke in the coke chamber is then directed into the quenching car by the coke guide machine, the electric locomotive hauls the quenching car with coke into quenching tower for quenching by spraying water at a stationary place, quenched coke is discharged onto coke wharf, after a certain cooling time, the coke is sent to coke screening and storage station.

煤在炭化室高温干馏过程中产生的荒煤气经顶部跨越孔进入燃烧室立火道,处于不同结焦时间炭化室之间的荒煤气通过煤气平衡道分配,使各炭化室的荒煤气量均匀分配。空气经换热室预热后,进入燃烧室与荒煤气分段混合燃烧。所产生的高温烟气下降进入换热室,与空气间接换热,换热后的烟气经烟道进入废气余热锅炉回收烟气余热。当废气余热锅炉检修或故障时,焦炉烟气经烟道通过烟囷排放。

Crude gas produced in the coke chamber during the process of high temperature carbonization enters the combustion chamber fire flue through the crossing holes at the top, and the waste gas between the coke chambers at different coking times is distributed through the gas balancing passages,

making each coke chamber of waste gas evenly distributed. After being preheated by the heat exchange chamber, the air enters the combustion chamber and combusts with the waste gas in stages. The high-temperature flue gas generated drops into the heat exchange chamber, and has indirect heat exchange with air. After heat exchange, flue gas through the flue into the waste gas heat recovery boiler for heat recovery. When the waste gas heat boiler is under maintenance or has failure, the gas will be discharged by the stack through flues.

当 1# (3#、5#) 废气余热锅炉检修或故障时, 1# (5#、9#) 焦炉烟气进入 1# (4#、7#) 烟囱排放, 2# (6#、10#) 焦炉烟气进入 2# (5#、8#) 烟囱排放。

When the 1 # (3 #, 5 #) waste heat boiler is under maintenance or malfunctions, the flue gas from the 1 # (5 #, 9 #) coke oven enters the 1 # (4 #, 7 #) chimney for discharge, and the flue gas from the 2 # (6 #, 10 #) coke oven enters the 2 # (5 #, 8 #) chimney for discharge.

当 2# (4#、6#) 废气余热锅炉检修或故障时, 3# (7#、11#) 焦炉烟气进入 2# (5#、8#) 烟囱排放, 4# (8#、12#) 焦炉烟气进入 3# (6#、9#) 烟囱排放。

When the 2 # (4 #, 6 #) waste heat boiler is under maintenance or malfunctions, the flue gas from the 3 # (7 #, 11 #) coke oven enters the 2 # (5 #, 8 #) chimney for discharge, and the flue gas from the 4 # (8 #, 12 #) coke oven enters the 3 # (6 #, 9 #) chimney for discharge.

5.2.4 炼焦工艺布置 Process Arrangement for Coking

一期和二期建设的 2×4×25 孔热回收焦炉布置在同一条中心线上, 依次为 1~8#焦炉。4×25 孔焦炉组成 1 个炉组, 每两座焦炉对应一台余热锅炉。在炉组中部 (2#和 3#焦炉之间、6#和 7#焦炉之间) 间台的机侧各设一座两跨双曲线斗嘴的煤塔。

The Phase I and Phase II (2×4×25 ovens heat recovery coke ovens) are arranged along the same central axis, sequentially designated as 1# to 8# Coke Oven. Each set of 4×25 ovens coke ovens forms one battery, with every two coke ovens sharing one waste heat boiler. A double-curve hopper coal tower is installed on the pusher side of the intermediate platform between the central coke ovens (between 2# and 3#, between 6# and 7#) of each battery.

三期建设的 4×25 孔热回收焦炉布置在二期焦炉下方，依次为 9~12#焦炉。每两座焦炉对应一台余热锅炉，在炉组中部（10#和 11#焦炉之间）间台的机侧设一座两跨双曲线斗嘴的煤塔。

The Phase III constructed 4×25 ovens heat recovery coke ovens are located downstream of the Phase II coke ovens, sequentially designated as 9# to 12# Coke Ovens. Every two coke ovens share one waste heat boiler, and a double-curve hopper coal tower is set up on the pusher side of the intermediate platform between the central coke ovens (between 9# and 10#) of the battery.

在两座焦炉之间设置锅炉，煤塔间台设置烟囱，4#（8#、9#）焦炉左侧以及 1#（5#、12#）焦炉右侧设置炉端台及烟囱。焦炉两侧设机、焦侧操作台。

A waste heat boiler is installed between each two coke ovens, and a chimney is set up on the coal tower intermediate platform. The end platforms and chimneys are arranged at the left side of 1#, 5# and 9# Coke Ovens and the right side of 4#, 8# and 12# Coke Ovens. Both the pusher side and coke side of the coke ovens are equipped with operating platforms.

炉端台顶层设旋转起重机，二层设有炉门修理站、事故煤槽、推焦杆和托煤板试验更换站、导焦栅维修站、电动葫芦等。煤塔端部设有捣固机更换站，其底层设有粘结机室。

The top floor of coke oven end platform is equipped with a rotary crane. The second floor is arranged some facilities such as a coke oven door repair station, accident coal hopper, a push rod and coal ram testing and replacement station, a guide bar maintenance station, and an electric hoist. A stamping machine replacement station is installed at the end of the coal tower, with a binder preparation room located on its ground floor.

在 4#焦炉、12#焦炉的端台外侧各布置一套湿熄焦系统，在 1#、8#及 9#焦炉端台外侧各布置一套干熄焦装置，三期共建设 2 套湿熄焦系统、3 套干熄焦装置。在 4#焦炉端台外侧、5#焦炉端台外侧及 9#焦炉端台外侧各设置一套迁车台和焦罐检修站。

Each set of wet quenching system is installed outside the end platform of 1# and 12# Coke Ovens, while each set of dry quenching device is arranged

outside the end platform of 4#, 5# and 9# Coke Ovens. Transfer cars and coke bucket maintenance stations are provided at three locations: adjacent to the wet quenching system of 1# Coke Oven, and outside the end platforms of 8# and 9# Coke Ovens.

5.2.5 焦炉炉体 Coke Oven

5.2.5.1 焦炉炉体主要尺寸 Main Dimensions of Coke Oven

表 5-2 焦炉炉体主要尺寸表
Table 5-2 Main dimensions of coke oven

序号 No.	名称 Name	单位 Unit	数量 Quantity	备注 Remarks
1	炭化室总长度 Total length of Coke Chamber	mm	15980	煤饼长度 15110 Stamped cake length
2	炭化室高度 Chamber height	mm	5550	煤饼高度 5440 Stamped cake height
3	炭化室平均宽度 Chamber mean width	mm	554	煤饼宽度 500 Stamped cake width
4	炭化室机侧宽度 Chamber width in ram side	mm	544	
5	炭化室焦侧宽度 Chamber width in coke side	mm	564	
6	炭化室中心距 Oven centres distance	mm	1350	
7	立火道中心距 Center distance of heating flue	mm	512	

5.2.5.2 焦炉炉体结构及特点 Structure and Characteristics of Coke Oven

热回收捣固焦炉的组成：烟道、换热室、斜道区、燃烧室（炭化室）、炉顶区；燃烧特点为自上而下的倒焰分段燃烧方式；带空气预热单元。

The heat-exchange and recovery coke oven includes flues, heat-exchange chambers, connecting ducts, heating walls (coking chambers), and oven top; Combusting characterized as a top-down inverted-flame segmented combustion method; Equipped with air preheating unit.

主要结构特点如下：The main structural features are as follows:

- a) 热回收焦炉采用换热室预热空气。换热室内，空气预热道及烟气排出道为分层结构，空气分别与相邻的烟气进行换热；The recovery coke oven preheats air in heat-exchange chambers. In heat-exchange chambers, the air preheating duct and smoke exhaust duct are arranged in layers

and the air exchanges heat with adjacent flue gas separately;

- b) 换热热回收焦炉全火道加热，火道加热连续、稳定；The coke oven has complete flue heating, which is continuous and stable;
- c) 焦炉的空气道在立火道隔墙中，高向分段供气。保证了焦炉高向加热均匀，减少 NOx 排放量；The air ducts of the coke oven are located in partition wall of flues, supplying gas in high section, ensuring uniform high directional heating of the coke oven and reducing NOx emissions;
- d) 炭化室顶部空间设有荒煤气平衡道，充分保证全炉加热均匀；The top space of the coking chambers is equipped with raw gas balance ducts, which fully ensures uniform heating of the entire coke oven;
- e) 烟道在换热室底部，焦炉基础底板上方，采用四分烟道形式，减少气流系统阻力，利于烟气排出；The flues are located at the bottom of the heat-exchange chambers, above base plate of the coke oven foundation, and adopts a four-part flue form to reduce the system resistance of the flue gas, which facilitates the emissions of flue gas;
- f) 焦炉的主要部位如燃烧室、斜道区、换热室、烟道等均采用硅砖砌筑，其它部位采用粘土砖、缸砖、隔热砖砌筑。The main parts of the coke oven, such as heating walls, connecting ducts, heat-exchange chambers, flues, are all built with silica bricks, while other parts are built with fire clay bricks, clinker bricks, and insulating bricks.

5.2.6 焦炉机械 Coke Oven Machines

5.2.6.1 焦炉机械配置 Configuration of Coke Oven Machines

表 5-3 焦炉机械配置表（一期、三期）
Table 5-3 Configuration of coke oven machines (phases I and III).)

序号 No.	名称 Name	数量 Quantity		备注 Remarks
		操作 Operation	备用 Stanby	
1	装煤车 Charging car	2 台 set	0	左、右型各一台 Left and right type
2	推焦机 Coke pusher	2 台 set	0	左、右型各一台 Left and right type
3	拦焦机 Coke guide	2 台 set	0	
4	捣固机 Stamping machine	2 套 set	0	
5	摇动给料器 Shaking feeder	2 组 set	0	
6	湿法熄焦车 Quenching car	1 台 set	1 台 set	
7	电机车 Electric locomotive	1 台 set	1 台 set	干湿两用 Both wet and dry

注：一期、三期工程车辆配置相同。

Note: Vehicle configuration identical across all phases (I, III).

表 5-4 焦炉机械配置表（二期）
Table 5-4 Configuration of coke oven machines (phases II).)

序号 No.	名称 Name	数量 Quantity		备注 Remarks
		操作 Operation	备用 Stanby	
1	装煤车 Charging car	2 台 set	0	左、右型各一台 Left and right type
2	推焦机 Coke pusher	2 台 set	0	左、右型各一台 Left and right type
3	拦焦机 Coke guide	2 台 set	0	
4	捣固机 Stamping machine	2 套 set	0	
5	摇动给料器 Shaking feeder	2 组 set	0	
6	电机车 Electric locomotive	1 台 set	1 台 set	仅干熄用 Only dry

5.2.6.2 焦炉机械的主要性能及特点 Main Properties and Characteristics of Coke Oven Machinery

本工程选用的焦炉机械主要从提高机械效率，以安全、实用、可靠为原则进行设计和制造。

Coke oven machinery selected in this project are designed and manufactured on the principle of safety, practicality and reliability.

a) 装煤车 Charging car

装煤车工作于焦炉机侧，分左、右型，可以同时于煤塔下工作，用来将捣固机捣实后的煤饼送入炭化室内。装煤车可以收集装煤过程中产生的烟气并将其导入机侧地面站的集尘总管中进行处理。

The charging car operates on the pusher side of the coke oven and is divided into left and right types, which is able to work simultaneously under the coal tower. It is sent to convey the stamped cake (compacted by the stamping machine) into the coke chamber. The charging car can collect the smoke generated during the coal charging and direct it into the dust collection main pipe of the pusher side ground station for treatment.

装煤车主要设有钢结构、走行装置、装煤装置、启闭炉门装置、电气系统、液压系统、润滑系统、气路系统等，并设余煤回收装置、炉门密封装置及炉头烟收集、导出装置（送往除尘地面站集尘总管）。

The charging car is mainly equipped with steel structure, running device, coal loading device, opening and closing oven door device, electrical system, hydraulic system, lubrication system, gas circuit system, etc. It is also equipped with a residual coal recovery device, an oven door sealing device and oven head fume collection and extraction system (connected to the dust collection main pipe of the dedusting ground station).

b) 推焦机 Coke pusher

推焦机工作于焦炉机侧，分左、右型，用来推出炭化室内成熟的焦炭。主要由钢结构、走行装置、启闭炉门装置、推焦装置、炉门清扫装置、炉门框清扫装置、润滑系统、空调系统、气路系统、液压系统及电气系统等组成，并设头尾焦回收处理装置、烟尘收集装置、推焦电流自动显示和记录以及推焦电流过载保护报警装置。

The coke pusher works on the pusher side of the coke oven and is divided into left and right types, which is used to push out mature coke from the coke chamber. It mainly consists of steel structure, running device, opening and closing oven door device, coke pushing device, oven door cleaning device, oven door frame cleaning device, lubrication system, air conditioning system, pneumatic system, hydraulic system, and electrical system. It is also equipped with head and tail coke recycling and processing device, smoke and dust

collection device, pushing current auto-display and recording system with overload protection alarm device.

c) 拦焦机 Coke guide

拦焦机运行在焦炉焦侧的拦焦机轨道上，用于开启和关闭焦侧炉门。推焦时可通过导焦栅将推出的焦炭导入湿熄焦车或焦罐运载车内。拦焦机主要由钢结构、走行装置、启闭炉门装置、炉门及炉框清扫装置、头尾焦回收装置、液压系统和电气系统组成。

The coke guide runs on the track of the coke guide on the coke side for opening and closing the coke side oven door. When pushing coke, the coke can be introduced into the wet quenching car or coke bucket car through the coke guide grid. The coke guide is mainly composed of steel structure, running device, opening and closing oven door device, oven door and frame cleaning device, head and tail coke recovery devices, hydraulic system and electrical system.

d) 固定式捣固机 Stationary stamping machine

捣固机安装在煤塔两侧的轨道上，可将落入煤箱内的煤料捣固成煤饼。捣固机由安全挡装置、导向辊装置、提锤传动装置、停锤装置、捣固锤、机架、集中润滑系统、电控系统及液压系统等组成。捣固机的控制由 PLC 控制，实现煤饼捣固过程自动化，并可以方便切换为手动控制。

The stamping machine is installed on the track on both sides of the coal tower and can stamp the coal material falling into the coal box into stamped cake. The stamping machine is composed of safety stop device, guide roller device, lifting hammer transmission device, stopping hammer device, tamping hammer, frame, centralized lubrication system, electronic control system and hydraulic system. The stamping machine is controlled by PLC to realize the automation of stamping process, and can be easily switched to manual control.

e) 摇动给料器 Shaking feeder

摇动给料器是捣固焦炉上使用的给料机械设备，它担负着在煤塔下给装煤车煤槽给料的任务。

Shaking feeder is used on the stamp-charging coke oven . It feeds the coal car trough under the coal tower.

由传动装置、摇动托板、箱体结构、吊架等组成。主要结构性能：采用可分

批向捣固装煤车的煤槽内给料，也可采用连续薄层给料，配合多锤捣固机捣固煤饼。操作方式为集中操作控制，也可单台独立驱动。

The shaking feeder is composed of a transmission device, a rocking supporting plate, a box structure, a hanger, etc. Main structure performance: feeding in batches for stamping coal car or continuous feeding of thin layer to work with multiple hammer stamping machine. Operation mode for centralized operation control, can also be a single independent drive.

f) 熄焦车 Quenching car

熄焦车是用来承接由推焦机从焦炉中推出的炽热焦炭运至熄焦塔下，将焦炭熄灭，再将焦炭运至焦台自动卸焦的车辆。

Quenching car is used to take the hot coke from the coke oven to the coke quenching tower, to extinguish the coke, and then to transport the coke to the coke wharf to unload the coke automatically.

熄焦车采用定点式接焦，熄焦车为底板固定、侧开车门式，主要由转向架、车底板、车箱及开门机构、制动装置等组成。熄焦车两端部有牵引车钩和缓冲器，并与电机车配合。

The quenching car receives coke at a fix point, the quenching car is arranged with a fixed inclined bottom plate and a side opening door, which is mainly composed of a bogie frame, a car bottom plate, a car trunk, a door opening mechanism, a brake device, etc. The two ends of the quenching car are provided with traction couplers and buffers, and are coordinated with the electric locomotive.

g) 电机车 Electric locomotive

电机车运行在焦炉焦侧的熄焦车轨道上，用于牵引和操纵焦罐车或熄焦车，两端均设有牵引装置。一期、三期的电机车既能满足干熄焦操作要求，也能满足湿熄焦操作要求，二期的电机车仅满足干熄焦要求。

The electric locomotive runs on the quenching car track on the coke side of the coke oven, used for pulling and operating coke tankers or quenching cars, with traction devices at both ends. The electric locomotives of Phase I and Phase III can meet both the requirements of dry quenching and wet quenching operations, while the electric locomotives of Phase II only meet the requirements of dry quenching.

电机车主要由车体、走行装置、制动装置、气路系统、空调系统、电气系统等组成。车体由司机室、机械室、电气室、台车、平台及走梯等组成。在靠炉侧设有电源滑触线器,电机车两端设有缓冲器及机械刚性连杆插销连接方式。运载车的焦罐旋转控制系统、操控箱、摄像头、操作台及供电等满足焦罐车使用要求的设备安装在电机车上。

The electric locomotive is mainly composed of the body, running gear, braking device, pneumatic system, air conditioning system, electrical system, etc. The vehicle body consists of a driver's cab, a mechanical room, an electrical room, a trolley, a platform, and a ladder. There is a power sliding contact wire on the furnace side, and buffers and mechanical steel connecting rod pins are installed at both ends of the electric locomotive for connection. The coke tank rotation control system, control box, camera, operation console, and power supply of the transport vehicle are installed on the electric locomotive to meet the requirements of coke tank truck use.

由于一期项目干熄焦装置为预留,仅使用湿熄焦系统,因此一期项目所配套的电机车可以先按照仅满足湿熄焦使用考虑,并预留干熄焦控制所需位置及接口,待到 1#干熄焦装置投用之前将其改造为干湿两用即可。

Due to the reserved nature of the dry quenching device in the phase I of the project, which only uses a wet quenching system, the electric locomotives provided for the first phase of the project can be initially considered to only meet the needs of wet quenching, and the required positions and interfaces for dry quenching control can be reserved. Before the 1# CDQ is put into use, it can be transformed into a dual-purpose dry and wet vehicle.

5.2.7 工艺装备 Process Equipment

5.2.7.1 护炉铁件 Coke Oven Armour

护炉铁件包括炉柱、纵横拉条、弹簧、炉门、炉门框和保护板等。

The coke oven armour includes buckstays, longitudinal tie rods, cross tie rods, springs, protection plates, coke oven doors, door frames and so on.

炉柱采用大型焊接 H 型钢制作,具有足够的强度和刚度。同时,通过在炉柱高向设置多线小弹簧,使得施加于炉体高向的保护性压力更加均匀。炉柱顶部和底部设置的上、下横拉条,可使焦炉砌体在机、焦侧方向受到足够的保护性压力,从而保持砌体的完好和严密,使其能够长期稳定地工作。

The coke oven column is made of large welded H-shaped steel, which has sufficient strength and rigidity. At the same time, by setting multiple small springs along the height direction of the coke oven column, the protective pressure applied to the coke oven body along the height direction is more uniform. The upper and lower cross tie rods set at the top and bottom of the coke oven column can provide sufficient protective pressure to the coke oven masonry along the pusher and coke side directions, thereby maintaining the integrity and tightness of the masonry and enabling it to work stably for a long time.

大保护板能有效的保护炉头不受损坏，箱形断面的厚炉门框抗变形性能好，机械强度适当，不易断裂。

Large protection plate can effectively protect the coke oven from damage, box-shaped section of the thick coke oven door frame has a good deformation resistance, appropriate mechanical strength, not easy to be fractured.

炉门采用弹性刀边，弹簧门栓、腹板可调、悬挂式空冷炉门。弹性刀边能始终保持一定压力，防止炉门冒烟冒火；炉门、炉框、保护板主要材质选用蠕墨铸铁(RuT350)，它具有耐急冷急热性能好，抗拉、抗弯强度高，铸件寿命长的优点。

The coke oven door is equipped with an elastic knife-edge, spring-loaded door bolts, adjustable webbing, and a suspended air-cooled design. The elastic knife-edge ensures constant pressure is maintained to prevent smoke and flame leakage from the coke oven door. The compacted graphite cast iron (RuT350) is used as the main material of coke oven doors, door frames and protection plates. It has the advantages of good resistance to rapid cooling and heating, high tensile and bending strength, and long casting life.

5.2.7.2 辅助设施 Auxiliary Facilities

焦炉炉端台顶层设旋转起重机，二层设有炉门修理站、推焦杆和托煤板试验更换站、事故煤槽、导焦栅维修站、电动葫芦等。。这些设施方便了生产操作，减轻了工人的劳动强度。

The top floor of coke oven end platform is equipped with a rotary crane. The second floor is arranged some facilities such as a coke oven door repair station, a push rod and coal ram testing and replacement station, accident coal hopper, a guide bar maintenance station, and an electric hoist. These

installations facilitate production operations and reduce the labor intensity of workers.

5.2.8 焦炉环保 Environmental Protection of Coke Oven

5.2.8.1 连续性排放烟尘治理 Continuous Emission Control

换热热回收焦炉生产操作的特点之一是加热系统为负压操作，因此焦炉的孔、盖、炉门、炉体都不往外泄漏烟气。

One of the characteristics of stamping heat exchange and recovery coke oven is that the heating system is operated under negative pressure. Therefore, the ovens, covers, doors, and bodies of the coke oven do not leak smoke to the outside.

因换热热回收焦炉采用了空气分段燃烧和炉内燃烧控制技术，有效地降低了火道温度，无需脱硝处理。

Because the coke oven adopts segmented air combustion and internal combustion control technologies, the temperature of flue is effectively lowered and no denitrification treatment is required.

5.2.8.2 废水和固体废弃物 Water and Solid Waste

换热热回收焦炉煤气在炼焦过程进行燃烧，无化产回收和净化系统，不产生焦化废水；

Crude gas of the coke oven is burned in the coking process without a chemical recovery and purification system, can not produce coking water waste.

5.2.9 湿熄焦系统 Wet Quenching System

本工程一期、三期工程各建设 1 套新型湿法熄焦系统，布置在 4#焦炉及 12#焦炉的端台外部，负责将熄焦车运来的红焦进行熄灭降温。

The Phase I and Phase III construct a new wet quenching system, located outside the end platforms of 1# and 12# Coke Oven, responsible for cooling and extinguishing the red-hot coke transported by the quenching car.

湿熄焦采用定点接焦式熄焦车和新型的熄焦塔。湿法熄焦系统包括熄焦泵房、熄焦塔、熄焦喷洒管、水雾捕集装置、折流板式除尘装置、粉焦沉淀池和清水池、粉焦脱水台和双梁抓斗起重机、高位槽及自动控制系统等。

Wet quenching adopts a fixed-point coke quenching car and a new type of coke quenching tower. The wet coke quenching system includes a coke quenching pump room, coke quenching tower, coke quenching spray pipe,

water mist capture device, baffle dust removal device, powder coke sedimentation tank and clean water tank, powder coke dewatering platform and double beam grab crane, high-level tank and automatic control system.

熄焦塔内设有快速熄焦装置、水雾捕集装置以及折流板式除尘装置，熄焦塔内设置有防焦炭迸溅的挡焦罩。

The quenching tower is equipped with a rapid quenching device, a water mist capture device, and a baffle dust removal device. The quenching tower is also equipped with a coke splash proof cover.

熄焦车到达熄焦塔固定位置后，熄焦系统开始对红热的焦炭进行熄焦，时间控制在 70-90s，熄焦后的焦炭水分低且水分稳定，同时使焦炭的粒度更加均匀，可大大改善焦炭质量。

After the quenching car arrives at the fixed position of the quenching tower, the quenching system begins to extinguish the red hot coke for 70-90 seconds, the moisture content of quenched coke is low and stable, while making the particle size of coke more uniform, which can greatly improve the quality of coke.

当熄焦系统开始工作时，水雾捕集系统提前启动并在熄焦塔内形成一层水雾，熄焦时产生的大量熄焦逸散物在热浮力的作用下急剧上升，在经过水雾捕集系统形成的水雾层时得到冷却，蒸汽中的粉尘颗粒一部分被洗涤下来，其余大部分形成了以粉尘颗粒为内核的冷凝液滴，随蒸汽继续上升。

When the quenching system starts working, the water mist capture system is activated in advance and forms a layer of water mist inside the quenching tower. The large amount of quenching emissions generated during quenching rise sharply under the action of thermal buoyancy and are cooled when passing through the water mist layer formed by the water mist capture system. Part of the dust particles in the steam are washed away, and the rest form condensed droplets with dust particles as the core, which continue to rise with the steam.

在熄焦塔的顶部设有两层折流板式除尘装置。折流板式除尘装置由木架、除尘板组成。经过水雾捕集系统洗涤冷却的蒸汽在熄焦塔内继续上升，冷却后的气体速度有所下降，在通过折流板捕尘格栅缝隙时，以粉尘颗粒为内核的冷凝液滴被静电吸附并通过机械碰撞而沉淀在格栅上，最后被净化的汽体从熄焦塔出口排入大气。除尘装置的除尘片上附着的焦粉颗粒，定期用水喷淋洗涤。

There are two layers of baffle plate dust removal devices at the top of the

quenching tower. The baffle dust removal device consists of a wooden frame and a dust removal plate. The steam that has been washed and cooled by the water mist capture system continues to rise in the quenching tower, and the velocity of the cooled gas decreases. When passing through the gaps of the baffle dust grid, the condensed liquid droplets with dust particles as the core are electrostatically adsorbed and deposited on the grid through mechanical collision. Finally, the purified steam is discharged into the atmosphere from the outlet of the quenching tower. The coke powder particles attached to the dust removal blades of the dust removal device are regularly sprayed and washed with water.

熄焦产生的含有大量污染物的蒸汽在经过水雾洗涤、冷却、重力沉降以及折流板捕集净化后，大大降低了含尘量。

The steam generated by coke quenching, which contains a large amount of pollutants, is greatly reduced in dust content after being washed with water mist, cooled, gravity settled, and purified by baffle plates.

5.2.10 干熄焦工艺系统 CDQ Technology

5.2.10.1 概述 Overview

本工程一期建设 1#湿熄焦系统，预留 1#干熄焦装置用地；二期建设 1#、2#干熄焦装置。正常生产时，1#干熄焦装置与一期新建 1~4#焦炉相配套，2#干熄焦装置与二期新建 5~8#焦炉相配套。

The first phase of this project involves the construction of the 1# wet quenching system, with reserved position for the 1# CDQ. The second phase includes the construction of two sets of 1# and 2# CDQ units. During normal production, the 1# CDQ will be paired with the newly built 1~4# coke ovens in the first phase, while the 2# CDQ will be paired with the newly built 5~8# coke ovens in the second phase.

当 1#干熄焦装置年修或故障时，1~4#焦炉使用 1#湿熄焦系统熄焦；当 2#干熄焦装置年修或故障时，1~4#焦炉使用 1#湿熄焦系统熄焦，5~8#焦炉使用 1#干熄焦装置熄焦。三期建设 2#湿熄焦系统、3#干熄焦装置与三期新建 9~12#焦炉相配套。正常生产时使用 3#干熄焦装置熄焦，当干熄焦装置年修或故障时，采用 2#湿熄焦系统熄焦。

In the event of annual maintenance or failure of the 1# CDQ, 1#~4# coke ovens will utilize the 1# wet quenching system for quenching. If the 2# CDQ undergoes annual maintenance or fails, 1#~4# coke ovens will use the 1# wet quenching system, while 5#~8# coke ovens will switch to the 1# CDQ for quenching. The third phase involves the construction of the 2# wet quenching system and the 3# CDQ, which will be paired with the newly built 9#~12# coke ovens in the third phase. Under normal production conditions, the 3# CDQ will be used. However, in cases of annual maintenance or failure of the 3# CDQ, the 2# wet quenching system will be employed.

本工程 1~3#干熄焦装置的处理能力为 140t/h。

The processing capacity of the 1#~3# CDQ units in this project is 140t/h.

5.2.10.2 干熄焦基本工艺参数 Basic Process Parameters of CDQ

干熄焦基本工艺参数如下：

Basic process parameters of CDQ refers to Table 5–5:

表 5-5 干熄焦基本工艺参数表
Table 5-5 Basic process parameters of CDQ

项目名称 Item Name		主要工艺参数 Parameters
干熄焦配置 Maximum capacity of CDQ device		3×140t/h 干熄焦装置 CDQ unit
每套干熄焦装置额定处理量 Rated capacity of each CDQ device		121.66t/h
焦炭温度 Coke temperature	干熄前 Before CDQ	950~1050℃
	干熄后 After CDQ	≤200℃（保证值，水当量法） (Guarantee value, water equivalent method)
干熄时间 Dry quenching time		~2h
冶金焦炭烧损率 Coke burning loss rate		≤1%
入炉气料比 Gas / coke ratio in the chamber		1280m³/t 焦 coke
循环气体最大流量 Maximum flow capacity of circulating gas		200200m³/h
循环气体正常流量 Rated flow capacity of circulating gas		173975m³/h
循环气体温度 Temperature of	进干熄炉 entering CDQ chamber	~130℃

项目名称 Item Name		主要工艺参数 Parameters
circulating gas	出干熄炉 outing CDQ chamber	880~1000℃
预存室允许最长中断供焦时间 Permitted maximum breaking time of coke charging		1h
干熄焦装置强化操作系数 Intensified operating coefficient of CDQ device		1.1
干熄炉操作制度 Operation system of CDQ		350d/a, 24h/d 连续运转, 15d/a 年修 350d/a, 24 h/d continuous operation, 15d/a annual maintenance 1#和 2#干熄焦不同时检修, 检修时间错开 1# and 2# CDQ are not inspected at the same time, and the inspection time is staggered

5.2.10.3 干熄焦工艺流程 Process of CDQ Technology

装满红焦的焦罐车由电机车牵引至提升井架底部。提升机将焦罐提升并送至干熄炉炉顶，通过带布料器的装入装置将焦炭装入干熄炉内。在干熄炉中焦炭与惰性气体直接进行热交换，焦炭被冷却至 200℃以下，经排焦装置卸到带式输送机上，然后送往焦处理系统。

Coke bucket carriage full of red coke is pulled to the bottom of lifter derrick by the electric locomotive. The crane lift coke bucket to the top of CDQ chamber, and coke will be sent into the CDQ chamber by charging device with distributor. Heat exchange between hot coke and circulating gas will proceed in the CDQ chamber. The coke is cooled to below 200℃, and discharging to belt conveyor by discharging device, then coke will be transported to coke treatment system.

5.2.10.4 干熄焦工艺布置 Process Arrangement of CDQ Technology

干熄焦装置布置在 1#、8#及 9#焦炉端台外侧区域，干熄炉—锅炉中心线垂直于焦炉中心线。干熄焦装置的提升井架横跨在熄焦车轨道上方，提升机直接提升焦罐。

CDQ device is arranged in the outer area of the end of 1# 、8#and 9#coke oven, and the center line of the coke oven -boiler is perpendicular to the center line of the Coke Oven. The hoisting derrick of the coke dry quenching device spans over the track of the coke quenching car, and the crane directly lifts the

coke bucket.

干熄焦装置的干熄炉、一次除尘器、干熄焦锅炉、二次除尘器、循环风机、热管换热器等，均由循环气体管线密闭连通，流程短、设备布置紧凑合理。

The coke dry quenching furnace, primary dust collector, coke dry quenching boiler, secondary dust collector, recirculating fan, heat pipe heat exchanger, etc. of CDQ unit are all closed connected by the circulating gas pipeline, with a short process and compact and reasonable equipment layout.

5.2.10.5 干熄焦工艺的主要设备 Main Equipment of CDQ

表 5-6 干熄焦工艺主要设备表（1×140t/h）
Table 5-6 Main edupment of CDQ （1×140t/h）

序号 No.	名称 Name	单位 Unite	数量 quantity	备注 Remarks
1	运载车 Bucket carriage	台 set	3	2 用 1 备 Two operation with one standby
2	焦罐 Coke bucket	个 set	3	2 用 1 备 Two operation with one standby
3	自动对位装置 Automatic alignment device	套 set	1	
4	提升机 Crane	台 set	1	
5	装入装置 Charging device	套 set	1	
6	装入装置用电动缸 Electric cylinder for charging device	个 set	1	
7	布风装置 Blasting device	套 set	1	
8	排焦装置 Pushing device	套 set	1	含平板闸门、电磁振动给料器、旋转密封阀、双岔溜槽 Including bulkhead gate, magnetic vibration feeder, rotating seal valve and double-fork chute, etc.
9	二次除尘器 Second de-duster	台 set	1	
10	热管换热器 Heat pipe exchanger	台 set	1	
11	循环风机 Circulating fan,	台 set	1	
12	循环风机用电动机 Motor for circulating fan	台 set	1	
13	高温矩形补偿器 High temperature rectangular compensator	个 set	2	
14	客货两用电梯 Elevator	台 set	1	

注：1#、2#、3#干熄焦的设备配置相同。

Note: The configuration of 1 #, 2 #, and 3 # CDQ equipment is the same.

5.2.10.6 干熄焦工艺设备 Dry Quenching Process Equipment

5.2.10.6.1 红焦输送装置 Hot Coke Transportation System

红焦输送系统将炭化室中推出的红焦运送至干熄炉炉顶,并与装入装置相配合,将红焦装入干熄炉内。主要设备包括电机车、焦罐车(运载车及焦罐)、自动对位装置及提升机等。焦罐车采用定点接焦的方式接焦。为缩短电机车的操作周期,一台电机车拖带二台焦罐车。其中电机车是牵引机车,既能满足干法熄焦的作业要求,又能满足湿法熄焦的作业要求。为确保焦罐车在提升井架的准确对位及操作安全,在干熄站的熄焦车轨道外侧设置了一套液压驱动的自动对位装置。提升机在提升井架进行放空焦罐、提满焦罐、平移焦罐等操作,并将红焦装入干熄炉内。

The hot coke transportation system will transport the hot coke from the coke chamber to the top of the CDQ chamber, and cooperate with the charging device to charge the red coke into the CDQ chamber. The main equipment includes electrical locomotive, coke bucket car (carriage and coke bucket), automatic positioning system and crane. Coke bucket adopts the method of fixed point coke connection. In order to shorten the operation cycle of electrical locomotive, one electrical locomotive tows two coke bucket cars. The electric locomotive is a traction locomotive, which can meet the operation requirements of dry quenching and wet quenching. In order to ensure the accurate alignment and safe operation of coke truck in lifting derrick, a set of hydraulically driven automatic alignment device is set on the outside of the quenching car track at the CDQ unit. The crane carries out operations such as emptying coke bucket, filling coke bucket, shifting coke bucket in the lifting derrick, and charging hot coke into the CDQ unit.

a) 焦罐及运载车 Coke bucket and Carriage

运载车运行在焦炉焦侧的熄焦车轨道上,用于在焦炉区域及干熄站之间运送红焦和焦罐。主要由台车框架、车轮组、制动器、焦罐提升导向轨道等组成。

The carriage runs on the quenching car track on the coke side of the coke oven and is used to transport hot coke and coke bucket between the coke oven area and the drying quenching station. It is mainly composed of truck frame, wheel group, brake and coke can lifting guide track.

焦罐主要由焦罐体及摆动的底闸门和吊杆组成。焦罐体由型钢构架和铸铁内

衬板构成。焦罐两侧设有导向辊轮供升降导向，还设有与底闸连动的提吊罐体的吊杆。

The coke bucket is mainly composed of a coke bucket body, a swinging bottom gate and a boom. The coke bucket is composed of a steel frame and cast iron lining. Both sides of the coke can are provided with a guide roller for lifting and guiding, and a derrick for lifting the can body is also provided with a link with the bottom brake.

b) 自动对位装置 Automatic positioning system

为确保焦罐车在干熄站的准确对位及操作安全，在干熄站的熄焦车轨道外设置了一套液压强制驱动自动对位装置。

In order to ensure the accurate alignment and safe operation of coke bucket car in dry quenching station, a set of automatic positioning system driven by hydraulic force is set outside the track of coke quenching car.

自动对位装置主要由对位装置（含夹紧装置、油缸及底座）、液压系统（含液压站、管路及附件）等组成。

Automatic positioning system is mainly composed of alignment device (including clamping device, cylinder and base), hydraulic system (including hydraulic station, pipeline and accessories).

c) 提升机 Crane

提升机运行于地面和干熄炉顶部之间，负责提升和搬运焦罐。

The crane operates between the ground and the top of the CDQ chamber and is responsible for lifting and transporting coke bucket.

提升机是一台二层结构的桥式吊车，设有提升、走行、自动操作与自动对位等功能，由机械和电气两部分组成。机械部分主要由钢结构、提升机构、走行机构、吊具及焦罐盖、润滑装置、维修用电动葫芦及手动葫芦、安全保护装置、电缆拖链等组成。钢结构主要包括提升机主框架（车架）、焦罐导向架、操作室、机械室及平台、走梯等。提升机的电气部分主要由传动系统、检测系统及控制系统组成。其传动系统常采用全数字式矢量型变频传动系统。为连续、安全、稳定地生产，提升机设有完善的检测和联锁控制系统。走行轨道两端设有过行程限位开关和防风锚链等。供电及信号传输电缆通过设在提升机侧面的电缆拖链送至提升机上。为更大程度保证提升系统的安全性，增设提升机钢丝绳卷筒用安全制

动器，提升机提升机构制动器具备制动间隙自动补偿和自动补偿失效报警功能。

The crane is a two-storey structure of the bridge crane, with lifting, running, automatic operation and automatic alignment and other functions, by mechanical and electrical parts. The mechanical part is mainly composed of steel structure, lifting mechanism, running mechanism, lifting gear and coke can cover, lubrication device, maintenance electric hoist and manual hoist, safety protection device, cable drag chain, etc. The steel structure mainly includes the main frame of the hoist (frame), the coke can guide frame, the operation room, the mechanical room and the platform, and the ladder. The electrical part of the hoist is mainly composed of the transmission system, the detection system and the control system. Its transmission system usually adopts full digital vector frequency conversion transmission system. For continuous, safe and stable production, the hoist is equipped with a perfect detection and interlock control system. Both ends of the running track are provided with over travel limit switches and windproof anchor chains. The power supply and signal transmission cables are delivered to the elevator through cable drag chains located on the side of the elevator. In order to ensure the safety of the hoisting system to a greater extent, the safety brake for the rope drum of the hoisting machine is added. The brake of the hoisting mechanism of the hoisting machine has the function of automatic brake gap compensation and automatic compensation failure alarm.

提升机由 PLC 控制，并在干熄焦控制室监控。提升机由 PLC 与其他设备联动，正常操作时，提升机由 PLC 与其他设备联动，车上无司机操作。

The crane is controlled by PLC and monitored in the coke quenching control room. Crane by PLC and other equipment linkage, normal operation, hoist by PLC and other equipment linkage, no driver on the car operation.

d) 干熄炉及壳体 CDQ chamber and CDQ shell

干熄炉为圆形截面的槽体，外壳用钢板制作，内衬耐磨粘土砖及隔热砖等。在干熄炉内，从顶部装入的红热焦炭与从底部鼓入的冷循环气体逆向换热，将焦炭温度从 $1000\pm 50^{\circ}\text{C}$ 降至 200°C 以下。

The CDQ chamber is a tank with circular section, the shell is made of steel plate, and the inner lining is wear-resistant clay brick and heat-insulating brick. In the CDQ chamber, the red hot coke charged from the top exchanges heat in

reverse with the cold circulation gas pumped in from the bottom, and the coke temperature reduces from $1000 \pm 50^{\circ}\text{C}$ to 200°C below.

干熄炉上部为预存室，中间是斜道区，下部为冷却室。干熄炉顶部装料口设置炉顶水封槽，水封槽选用冲压生产工艺产品，内圈增加耐火浇注料。设置在预存室外的环形风道通过各斜道与冷却室相通，环形风道的出口与一次除尘器的进口相连。预存室设有料位检测装置，还设有压力测量装置及放散装置；环形风道设有空气导入装置；冷却室设有温度、压力测量及烘炉孔等。

The upper part of the CDQ chamber is prestoring chamber, the middle is a chute, and the lower part is cooling chamber. The top of the CDQ chamber is equipped with a seal tank of chamber roof. The seal tank of chamber roof is made of stamping production process products, and the inner ring is equipped with refractory castable. The annular air duct arranged outside the prestoring chamber is communicated with the cooling chamber through each ramp, and the outlet of the annular air duct is connected with the inlet of the primary dust collector. The prestoring chamber is provided with a material level detection device, a pressure measuring device and a release device; Annular air duct is provided with an air inlet device; The cooling chamber is equipped with temperature, pressure measurement and coke oven ovens.

e) 布风装置 Gas feeder

布风装置安装在干熄炉底部，将冷循环气体均匀地供入冷却室内，并可使炉内焦炭均匀下落。

The gas feeder is installed at the bottom of the CDQ chamber, and the cold circulating gas is uniformly supplied to the cooling chamber, and the coke in the feeder can be uniformly dropped.

f) 装入装置 Charging device

装入装置采用分体式，安装在干熄炉顶部的平台上，主要由固定式料斗、防尘盖板、炉盖、活动料斗、料斗台车、炉盖台车、传动机构、轨道框架、固定式焦罐支座、导向模板、安全栏杆等组成的。

The charging device adopts a split type and is installed on the platform at the top of the CDQ chamber. It mainly consists of a fixed hopper, dust cover plate, furnace cover, movable hopper, hopper trolley, coke oven cover trolley, transmission mechanism, track frame, fixed coke tank support, guide template,

safety railing, etc.

g) 排焦装置 Coke discharge equipment

排焦装置位于干熄炉的底部，将干熄炉下部已冷却到 200℃ 以下的焦炭连续密闭地排出。它是由平板闸门、电磁振动给料器、补偿器、中间连接溜槽、旋转密封阀、和双岔溜槽等设备组成。

The coke discharge device is located at the bottom of the CDQ chamber, continuously and tightly discharging the coke that has been cooled to below 200℃ in the lower part of the CDQ chamber. It is composed of bulkhead gate, vibration feeder, compensator, intermediate connecting chute, rotary sealing valve, and double-chute hopper and other equipment.

1) 平板闸门 Bulkhead gate

平板闸门安装在干熄炉的底部出口。正常生产时，平板闸门完全打开；在年修或排焦装置需要检修时，关闭平板闸门切断干熄炉底部的焦炭下落。平板闸门的电动头带有行程限位和过力矩保护装置，停电时将平板闸门电动头的转换扳手由电动位置转换到手动位置，采用人工手动操作。

The bulkhead gate is installed at the bottom outlet of the CDQ chamber. During normal production, the bulkhead gate is fully opened; When the annual maintenance or coke discharge device needs maintenance, close the bulkhead gate to cut off the coke falling from the bottom of the CDQ chamber. The electric head of the bulkhead gate is equipped with travel limit and over torque protection devices. When there is a power outage, the conversion wrench of the electric head of the bulkhead gate is switched from the electric position to the manual position, and manual operation is used.

2) 电磁振动给料器 Vibration feeder

电磁振动给料器是焦炭定量排出装置，通过改变励磁电流的大小可以改变焦炭的排出量。电磁振动给料器是由料槽、电磁振动体、减振器、控制器等组成的。电磁振动给料器设有机旁操作、中央控制室手动操作和 PLC 自动控制三种操作方式。

The vibration feeder is a quantitative discharge device for coke, and the discharge amount of coke can be changed by changing the excitation current. The vibration feeder is composed of a material tank, electromagnetic vibration body, shock absorber, controller, etc. The electromagnetic vibration feeder is

equipped with three operation modes: machine side operation, manual operation in the central control room, and PLC automatic control.

3) 旋转密封阀 Rotary sealing valve

旋转密封阀把振动给料器定量排出的焦炭在密闭状态下连续地排出。旋转密封阀正常生产时为正向旋转，但在处理卡料事故时，现场操作盘上设有反向旋转功能（点动操作）。旋转密封阀设有现场单独操作、中央控制室单独操作和中央控制室控制系统连动操作三种操作方式。

The rotary sealing valve continuously discharges the coke quantitatively discharged from the vibration feeder in a sealed state. The rotary sealing valve normally rotates in the forward direction during production, but when dealing with material jamming accidents, the on-site operation panel is equipped with a reverse rotation function (jog operation). The rotary sealing valve has three operation modes: on-site independent operation, central control room independent operation, and central control room control system linkage operation.

4) 双岔溜槽 Double-chute hopper

双岔溜槽是将旋转密封阀排出的焦炭送至带式输送机的设备。

The double-chute hopper is a device that sends the coke discharged by the rotating sealing valve to the belt conveyor.

h) 气体循环装置 Circulating gas transportation system

气体循环设备布置在干熄炉的布风装置（冷循环气体入口）与环形风道（热循环气体出口）之间。主要设备有一次除尘器、二次除尘器、循环风机及热管换热器等。

The equipment of circulating gas transportation system are arranged between the gas feeder (cold circulation gas inlet) and the circular duct (hot circulation gas outlet) of the CDQ chamber. The main equipment include a primary de-duster, a secondary de-duster, a circulating fan, and a heat pipe exchanger.

1) 一次除尘器 Primary de-duster

一次除尘器为重力沉降槽式除尘装置，用于除去循环气体中所含的粗粒焦粉，以降低对于干熄焦锅炉炉管的磨损。一次除尘器主要由壳体、金属支撑构架及内部砌体等构成，外壳由钢板焊制，并设有托砖板。除尘器采用带有挡墙的重力沉降

方式。

The primary de-duster is a gravity settling tank type dust removal device used to remove coarse coke powder contained in the circulating gas, in order to reduce wear on the furnace tubes of the dry quenching boiler. A primary de-duster is mainly composed of a shell, a metal support frame, and internal masonry. The shell is welded with steel plates and equipped with brick support plates. The dust collector adopts a gravity settling method with a retaining wall.

2) 二次除尘器 Secondary de-duster

二次除尘器采用了适合于干熄焦工艺的专用多管旋风分离式除尘器, 以将循环气体中的细粒焦粉进一步分离出来, 使进入循环风机的气体中粉尘含量少, 以降低焦粉对循环风机叶片的磨损, 从而延长循环风机的使用寿命。

The secondary de-duster adopts a specialized multi tube cyclone separation dust collector suitable for the dry quenching process to further separate the fine coke powder in the circulating gas, reducing the dust content in the gas entering the circulating fan and reducing the wear of coke powder on the blades of the circulating fan, thereby extending the service life of the circulating fan.

多管旋风二次除尘器主要由单体旋风器、旋风子(外套筒)固定板、导气管(内套筒)固定板、外壳、下部灰斗及进出口变径管等构成。

The multi tube cyclone secondary de-duster mainly consists of a single cyclone, a cyclone sub (outer sleeve) fixing plate, a guide pipe (inner sleeve) fixing plate, an outer shell, a lower ash hopper, and inlet and outlet variable diameter pipes.

3) 循环风机 Circulating fan

安装在二次除尘器与热管换热器间的循环风机, 把闭路循环的气体加压后源源不断地送入干熄炉内循环使用。循环风机主要由风机本体、电机、入口电动挡板及检测元件等组成。风机本体是由外壳及衬板、转子、轴承等组成的。

The circulating fan installed between the secondary de-duster and the heat pipe exchanger pressurizes the closed-loop circulating gas and continuously sends it into the CDQ chamber for circulation. The circulating fan is mainly composed of the fan body, motor, inlet electric baffle, and detection components. The fan body is composed of an outer shell, lining plate, rotor, bearings, etc.

4) 热管换热器 Heat pipe exchanger

热管换热器安装在循环风机出口至干熄炉入口间的循环气体管路上,用锅炉给水与循环气体进行换热,降低进入干熄炉的循环气体的温度,从而强化干熄炉的换热效果。

The heat pipe exchanger is installed on the circulating gas pipeline between the outlet of the circulating fan and the inlet of the CDQ chamber . It uses boiler feeding water to exchange heat with the circulating gas, reducing the temperature of the circulating gas entering the CDQ chamber and enhancing its heat transfer effect.

i) 客货两用电梯 Passenger and cargo elevator

为方便巡检及检修人员的操作,在干熄炉构架外设置客货两用电梯。

For the convenience of inspection and maintenance personnel, a passenger and cargo elevator is installed outside the structure of CDQ chamber.

j) 迁车台和焦罐检修站 Traverser and coke bucket maintenance

本项目在新建4#焦炉、5#焦炉及9#焦炉外侧各新建一座迁车台,用于存放、更换和检修电机车、焦罐车及湿熄焦车。

This project will construct a traverser on the outer side of the newly built 4 # coke oven, 5# coke oven and 9# coke oven for storing, replacing, and electrical locomotives, coke bucket cars, and wet quenching coke cars.

新建三套焦罐检修站,分别布置在三座迁车台外侧区域,用于焦罐的检修。当焦罐需要检修时,使用汽车吊将焦罐吊至焦罐检修站中进行检修。修理好的焦罐仍使用汽车吊吊回到运载车上。

Three newly built coke bucket maintenance stations are respectively arranged in the outer area of the traverser for the maintenance of coke buckets. When the coke tank needs maintenance, use a car crane to lift the coke bucket to the coke bucket maintenance for maintenance. The repaired coke bucket is still lifted back onto the transport vehicle using a carriage.

5.2.10.7 干法熄焦的环保措施 Environment Protection of CDQ

干熄焦装置采用了较完善的密封除尘措施:装入装置、干熄焦本体地下带式输送机、双岔溜槽、预存室放散及循环风机后放散处产生的烟尘均进入除尘地面站收集处理,而且对噪声也采取了一定的控制措施。

The CDQ unit adopts relatively complete sealing and dust removal

measures: the smoke and dust generated by the charging device, the underground belt conveyor of the CDQ chamber, the double-chute hopper, the pre storage room and the circulating fan are collected and processed at the dust removal ground station, and certain noise control measures are also taken.

5.3 焦处理系统 Coke Treatment System

5.3.1 概述 Overview

焦处理系统的是将干熄焦装置或湿熄焦后的焦炭进行输送,并按要求筛分成不同粒级进行贮存外运。

The coke processing system transports the coke after CDQ or wet quenching, and screens it into different particle sizes according to requirements for storage and transportation.

焦处理系统分三期建设,三期建设完成可满足 300 万吨焦炉产焦量。

The coke processing system will be constructed in three phases, and the completion of the third phase can meet the coke production capacity of 3 million tons of coke oven per year.

5.3.2 工艺流程 Process Flow

从焦台或干熄炉下排出来的焦炭经带式输送机运至筛焦楼筛分为 $<10\text{mm}$ 焦粉和 $\geq 10\text{mm}$ 焦炭两级,其中 $<10\text{mm}$ 入仓贮存后并由装车外运至指定区域, $\geq 10\text{mm}$ 焦炭即可入仓贮存后外运,也可经高架带式输送机送至贮焦场露天堆存。

The coke discharged from the coke table or dry quenching coke oven is transported by a belt conveyor to the coke screening building, which is divided into two stages: $<10\text{mm}$ coke powder and $\geq 10\text{mm}$ coke. Among them, $<10\text{mm}$ is stored in the coke storage bunker and transported by truck to the designated area. $\geq 10\text{mm}$ coke can be stored and transported out of the coke storage bunker, or transported to the coke yard for outdoor coke yard by an elevated belt conveyor.

整个系统主要由焦台、筛焦楼、贮焦场以及相应的带式输送机通廊和各转运站等设施组成。

The entire system mainly consists of coke platforms, coke screening station, coke storage yard, corresponding belt conveyor corridor, and various transfer station.

5.3.3 设施及主要设备 Process Facilities and Key Equipment

a) 焦台 Coke Wharf

焦台的作用是将湿法熄焦后的混合焦冷却、沥水、蒸发水分，并对剩余红焦补充熄焦。焦台共 1 座，长 54m，倾角 28°，凉焦时间~0.5h。采用刮板放焦机实现远距离操纵机械化放焦。刮板放焦机可把从焦台上滑下来的混合焦均匀地刮到焦台地坑内的运焦带式输送机上，送至筛焦楼进行筛分处理。

The function of the coke table is to cool the mixed coke after wet quenching, drain water, evaporate water, and supplement the remaining red coke quenching. There is one focal table with a length of 54m, an inclination of 28°, and a cooling focal time of ~0.5h. The scraper focusing machine is used to realize the remote control of mechanical focusing. The scraper can evenly scrape the mixed coke sliding off the coke platform to the coke belt conveyor in the coke platform pit and send it to the coke screening building for screening treatment.

b) 筛焦楼 Coke Screening Station

筛焦楼采用双排布置，总贮量约 800t。

The coke screening building is arranged in a Double row, and the total storage capacity is about 800t.

由焦台或干熄焦运来的混合焦，经振动筛(共 2 台, 1 开 1 备)筛分为 $\geq 10\text{mm}$ 、和 $< 10\text{mm}$ 两级。

The mixed coke transported from the coke wharf or the CDQ is divided into three levels of $\geq 10\text{mm}$, and $< 10\text{mm}$ by the vibrating screen (a total of 2 sets, 1 open 1 spare).

$< 10\text{mm}$ 焦粉入仓储存后通过仓口的电液动颚式闸门直接装汽车外运至指定区域； $\geq 10\text{mm}$ 即可入仓贮存也可高架带式输送机运往焦场。

$< 10\text{mm}$ coke powder is stored in the warehouse and directly transported by car to the designated area through the electro-hydraulic jaw gate at the warehouse entrance; $\geq 10\text{mm}$ can be stored in the warehouse or transported to the coke yard by elevated belt conveyor.

c) 贮焦场 Coke storage yard

由高架带式输送机运来的焦炭在贮焦场内有序堆放，并由推土机进行堆取焦炭的辅助作业和焦场的清底工作。

The coke transported by the elevated belt conveyor is stacked orderly in

the coke storage yard open coke field, and the auxiliary work of coke stacking and bottom clearing is carried out by the bulldozer.

贮焦场总贮量约为 12 万吨，分两期建设，一期建设贮量约 6 万吨，二期建设贮量约 6 万吨。

The total storage capacity of the coke storage yard is about 120000 tons, which will be constructed in two phases. The first phase will have a storage capacity of about 60000 tons, and the second phase will have a storage capacity of about 60000 tons.

d) 其他 Others

- 1) 筛焦楼的每个焦槽顶上分别设有雷达料位计，用来对焦槽中焦炭的料位情况实施监控；The top of each coke tank of the coke screening building is provided with a radar level meter to monitor the coke level in the coke tank;
- 2) 新建带式输送机均按照 DTⅡ(A)型带式输送机手册选型；The new belt conveyor is selected according to the DTⅡ (A) belt conveyor manual;
带式输送机能力 Capacity of belt conveyor: $B=1400\text{mm}$, $Q=400\text{t/h}$;
- 3) 根据带式输送机的使用情况不同，设有双向拉绳开关、跑偏开关、打滑检测器、纵向撕裂检测器、溜槽堵塞检测器等保护装置，确保系统安全运行；According to the different use conditions of belt conveyor, two-way rope switch, deviation switch, slip detector, longitudinal tear detector, chute blockage detector and other protection devices are provided to ensure the safe operation of the system;
- 4) 在出干熄焦的两条带式输送机上各设置 1 台电子计量秤，测量输送焦炭量；Install one electronic weighing scale on each of the two belt conveyors for CDQ to measure the amount of coke conveyed;
- 5) 带式输送机电机功率大于 45kW 时采用限矩型液力耦合器；When the motor power of belt conveyor is greater than 45kW, the torque limited fluid coupler is used;

- 6) 采用四班制操作, 工艺生产过程为 PLC 联锁自动控制。Four-shift operation is adopted, and the production process is automatically controlled by PLC interlock.

5.4 余热利用设施 Waste Heat Utilization Facilities

5.4.1 装机方案 Installation Plan

5.4.1.1 主机选型 Main Equipment Selection

本工程利用热回收焦炉废气余热, 本项目一、二、三期分期建设。一、二、三期各建设 2 套 152t/h 超高温超高压一次再热焦炉废气余热锅炉, 每 2 座焦炉对应 1 台废气余热锅炉。另在一期、二期、三期建设范围内, 各建设 1 套 140t/h 干熄焦装置配套 73t/h 超高温超高压一次再热干熄焦余热锅炉, 用于吸收焦炭显热。

This project utilizes waste heat from heat-recovery coke oven flue gas. The construction is divided into three phases (Phase I, II, and III). Each phase includes the installation of two 152 t/h ultra-high temperature and ultra-high pressure single-reheat coke oven waste heat boilers, with one waste heat boiler corresponding to every two coke ovens. Additionally, within the scope of Phase I, II, and III, one set of 140 t/h dry quenching (CDQ) system paired with a 73 t/h ultra-high temperature and ultra-high pressure single-reheat CDQ waste heat boiler will be constructed in each phase to recover sensible heat from coke.

本工程新建汽轮发电站 3 座, 一、二、三期各 1 座, 每座站房内设 2 台 NZK65-13.2/566/566 凝汽式汽轮机, 相应地配置 2 台 QFW-65-2 型发电机, 其额定功率 $N=65000\text{kW}$, 额定电压 $U=10500\text{V}$ 。

This project involves the construction of three new turbine-generator power stations, with one station built in each phase (Phase I, II, and III). Each station is equipped with two NZK65-13.2/566/566 condensing steam turbines and one QFW-65-2 generator configured for each turbine pair. The generator has a rated power output of 65,000 kW and a rated voltage of 10,500 V

5.4.1.2 主机型号及主要技术参数 Models and Main Technical Parameters

主机设备主要技术参数如下 (最终以正式资料为准):

The main technical parameters of the primary equipment are as follows (final official information shall prevail):

a) 焦炉废气余热锅炉 Coke oven waste heat boiler

型式 Type:	超高温超高压、自然循环、中间一次再热、汽包锅炉 ultra-high temperature and ultra-high pressure, natural circulation, intermediate reheating, drum boiler
数量 Quantity:	6 台（一期 2 台，二期 2 台，三期 2 台）6 units (2 unit in Phase I, 2unit in Phase II, 2 units in Phase III)
锅炉额定蒸发量 Rated evaporation of boiler:	152t/h
过热蒸汽压力 Superheated steam pressure:	13.8MPa
过热蒸汽温度 Superheated steam temperature:	570℃
给水温度 Feed water temperature:	133℃
再热蒸汽流量 Reheat steam flow rate:	146.8t/h（暂定）(tentative)
再热器进口蒸汽压力 Reheater inlet steam pressure:	~2.7MPa
再热器进口蒸汽温度 Reheater inlet steam temperature:	~355℃
再热器出口蒸汽压力 Reheater outlet steam pressure:	~2.5MPa

再热器出口蒸汽温度	570℃
Reheater outlet steam temperature:	
锅炉正常排污率	≤2%
Normal boiler discharge rate:	
过热汽温调节方式	给水喷水减温
Overheated steam temperature regulation method:	feeding water spray cooling
布置方式 Layout method:	露天布置（顶部设防雨棚） Outdoor layout (with a rain shelter at the top)

b) 干熄焦锅炉 Dry quenching boiler

型式 Type:	超高温超高压、自然循环、中间一次再热、汽包锅炉 ultra-high temperature and ultra-high pressure, natural circulation, intermediate reheating, drum boiler
数量 Quantity:	3 台（一期、二期、三期各 1 台） 3units(One unit each for Phase I, Phase II and Phase III)
锅炉正常蒸发量	63/h
Normal evaporation capacity of boiler:	
锅炉额定蒸发量	73t/h
Rated evaporation of boiler:	
过热蒸汽压力	13.8MPa
Superheated steam pressure:	
过热蒸汽温度	570℃

Superheated steam

temperature:

给水温度 133°C

Feed water temperature:

再热蒸汽流量 70t/h（暂定） (tentative)

Reheat steam flow rate:

再热器进口蒸汽压力 ~2.7MPa

Reheater inlet steam

pressure:

再热器进口蒸汽温度 ~355°C

Reheater inlet steam

temperature:

再热器出口蒸汽压力 ~2.5MPa

Reheater outlet steam

pressure:

再热器出口蒸汽温度 570°C

Reheater outlet steam

temperature:

锅炉正常排污率 ≤2%

Normal boiler discharge

rate:

过热汽温调节方式 给水喷水减温

Overheated steam

feeding water spray cooling

temperature regulation

method:

布置方式 Layout method:

露天布置（顶部设防雨棚）

Outdoor layout (with a rain shelter at the top)

c) 汽轮机 Steam turbine

型式 Type:

超高温超高压、中间一次再热、
双缸双排汽、凝汽式汽轮机

	ultra-high temperature and ultra-high pressure, intermediate
数量 Quantity:	6 台（一期、二期、三期各 2 台） 6 units (2 units each for Phase I, Phase II and Phase III)
额定功率 Rated power:	65MW
额定蒸汽温度 Rated steam temperature:	566°C
额定蒸汽压力 Rated steam pressure:	13.2MPa(a)
正常进汽量 Normal steam intake:	183.5t/h
最大进汽量 Maximum steam intake:	188.5t/h
高压缸排汽低温再热蒸汽压力 High pressure cylinder exhaust low-temperature reheat steam pressure:	~3.0MPa(a)
高压缸排汽低温再热蒸汽温度 High pressure cylinder exhaust low-temperature reheat steam temperature:	~355°C
高温再热蒸汽压力 High temperature reheat steam pressure:	~2.2MPa(a)
高温再热蒸汽温度 High temperature reheat steam temperature:	566°C
额定排汽压力 Rated exhaust pressure:	15kPa (a)

额定转速 Rated speed: 5000r/min（暂定） (tentative)

回热系统 1 除氧+2 低加

Regenerative system: 1: deoxygenation+2: low-pressure heater

乏汽冷却方式 直接空冷 Direct air cooling

Exhaust steam cooling method

d) 发电机 Generators

数量 Quantity: 6 台（一期、二期、三期各 2 台）
6 units (2 units each for Phase I, Phase II and Phase III)

额定功率 Rated power: 65MW

冷却方式 空内冷 internal air cooling

Cooling method:

功率因数 Power factor: 0.8

额定电压 10kV

Rated voltage:

额定转速 Rated speed: 3000r/min

额定频率 50Hz

Rated frequency:

绝缘等级 F 级 F level

Insulation level:

励磁方式 无刷励磁 brushless excitation

Excitation method:

5.4.2 设计条件 Design Conditions

焦炉废气余热锅炉设计依据为焦炉烟气参数，焦炉烟气参数及完全燃烧后锅炉出口烟气参数见下表（以下数据为单台锅炉的烟气量）：

The design basis of the coke oven waste heat boiler is the coke oven flue gas parameters. The coke oven flue gas parameters and the boiler outlet flue gas parameters after complete combustion are shown in the table below (the following data is the flue gas volume of a single boiler):

表 5-7 焦炉烟气参数表

Table5-7 Coke oven flue gas parameters table

序号 No.	项目 Project	单位 Unit	数值 Value	备注 Remarks
1	H ₂	Vol %	~2.97	
2	CO	Vol %	~7.05	
3	C _n H _m	Vol %	~0.72	
4	H ₂ O	Vol %	~26.66	
5	CO ₂	Vol %	~3.48	
6	N ₂	Vol %	~59.095	除上述气体外都按 N ₂ 考虑 Except for the aforementioned gases, all are considered as N ₂
7	H ₂ S	Vol %	~0.025	
8	余热锅炉入口烟气温度 Inlet flue gas temperature of waste heat boiler	°C	1200±50	
9	余热锅炉入口烟气体量 Inlet flue gas volume of waste heat boiler	Nm ³ /h	~180000	
10	粉尘 Dust	mg/Nm ³	~1500	
11	SO ₂	mg/Nm ³	~1200	
12	NO _x	mg/Nm ³	~300	

表 5-8 锅炉出口烟气参数

Table5-8 Boiler outlet flue gas parameters

序号 No.	项目 Project	单位 Unit	数值 Value	备注 Remarks
1	CO ₂	Vol %	~6.6	
2	N ₂	Vol %	~68.7	
3	O ₂	Vol %	~5.2	
4	H ₂ O	Vol %	~19.5	
5	SO ₂	mg/Nm ³	~1000	
6	NO _x	mg/Nm ³	≤150	
7	粉尘 Dust	mg/Nm ³	~1000	
8	余热锅炉出口烟气体量 Outlet gas volume at the outlet of waste heat boiler	Nm ³ /h	300000	
9	余热锅炉出口烟气温度 Outlet flue gas temperature of waste heat boiler	°C	180	

单台干熄焦锅炉循环气体参数如下：

The circulating gas parameters of a single dry quenching boiler are as follows:

表 5-9 干熄焦锅炉循环气体参数

Table5-9.Circulating gas parameters of dry quenching boiler

序号 No.	项目 Project	单位 Unit	数值 Value	备注 Remarks
1	正常循环气体量	m ³ /h	173974	标况

序号 No.	项目 Project	单位 Unit	数值 Value	备注 Remarks
	Normal circulating gas volume			Standard condition
2	最大循环气体量 Maximum circulating gas volume	m ³ /h	201000	标况 Standard condition
3	循环气体进口温度 Circulating gas inlet temperature	°C	880~1000	
4	循环气体出口温度 Circulating gas outlet temperature	°C	160~180	
5	循环气体压力 Circulating gas pressure	Pa	-1100~-1250	
6	循环气体含尘浓度 Dust concentration in circulating gas	g/m ³	≤20	
7	H ₂	%	0~2	
8	O ₂	%	0~1	
9	CO	%	3~5	
10	H ₂ O	%	5~7	
11	CO ₂	%	12~18	
12	N ₂	%	除以上均为 N ₂ Except for the above, all are N ₂	
13	SO ₂	mg/m ³	1500	

5.4.3 热力系统 Thermal System

5.4.3.1 热力系统拟定原则及特点 Principles and Characteristics of Thermal System Formulation

热力系统立足于系统运行安全可靠、系统效率较高、操作管理方便、衔接合理，按超高温超高压机组设计原则拟定，并考虑凝汽式机组运行、调节特点。

The thermal system is based on safe and reliable system operation, high system efficiency, convenient operation and management, and reasonable connection. It is formulated according to the design principles of ultra-high temperature and ultra-high pressure units, and takes into account the operation and regulation characteristics of condensing units.

5.4.3.2 主要系统设计 Main System Design

a) 主蒸汽、再热蒸汽及旁路系统 Main steam, reheat steam, and bypass system

主蒸汽管道从锅炉过热器集箱出口经区域综合管廊接至汽轮机主汽阀，再接至汽轮机高压缸。低温再热蒸汽管道从汽轮机高压缸排汽口引出，经高排止回阀

后,再经区域综合管廊接至锅炉再热器入口联箱。高温再热蒸汽管道从锅炉再热器出口联箱接出,经区域综合管廊接至汽轮机中压缸中压联合汽阀接至汽轮机中压缸。

The main steam pipeline is connected from the outlet of the boiler superheater header through the regional comprehensive pipe gallery to the main steam valve of the turbine, and then to the high-pressure cylinder of the turbine. The low-temperature reheat steam pipeline is led out from the exhaust port of the high-pressure cylinder of the steam turbine, passes through the high discharge check valve, and then connects to the inlet header of the boiler reheater through the regional comprehensive pipe gallery. The high-temperature reheat steam pipeline is connected from the outlet header of the boiler reheater, through the regional comprehensive pipe gallery, to the intermediate pressure cylinder of the steam turbine through the intermediate pressure combined steam valve.

一期主蒸汽管道系统: 1#、2#焦炉对应的废气余热锅炉的主蒸汽管道经区域综合管廊送至一期汽轮发电站。3#、4#焦炉对应的废气余热锅炉的主蒸汽管道与1#干熄焦锅炉主蒸汽管道在区域综合管廊合并至一根母管后,送至一期汽轮发电站,两路主蒸汽管道在汽轮发电站内合并,然后分两路送至两台汽轮机组做功。

Phase I Main Steam Piping System: The main steam pipelines from the waste heat boilers serving Coke Ovens #1 and #2 are conveyed through the regional utility corridor to the Phase I turbine-generator station. The main steam pipelines from waste heat boilers for Coke Ovens #3 and #4 merge with the main steam pipeline from the #1 CDQ waste heat boiler into a common header within the utility corridor before being delivered to the Phase I station. These two steam lines converge within the power station and are subsequently distributed to the two turbine-generator sets.

二期主蒸汽管道系统: 5#、6#焦炉对应的废气余热锅炉的主蒸汽管道与2#干熄焦锅炉主蒸汽管道在区域综合管廊合并至一根母管后,送至二期汽轮发电站,7#、8#焦炉对应的废气余热锅炉的主蒸汽管道经区域综合管廊送至二期汽轮发电站,两路主蒸汽管道在汽轮发电站内合并,然后分两路送至两台汽轮机组做功。

Phase II Main Steam Piping System: The main steam pipelines from waste heat boilers serving Coke Ovens #5 and #6 combine with the pipeline from the

#2 CDQ waste heat boiler into a common header in the utility corridor, then proceed to the Phase II turbine-generator station. The main steam pipelines from Coke Ovens #7 and #8 are directly routed through the utility corridor to the Phase II station. Both steam lines merge within the station before being divided to feed the two turbine units.

三期主蒸汽管道系统：9#、10#焦炉与 11#、12#焦炉对应的废气余热锅炉的主蒸汽管道以及 3#干熄焦锅炉主蒸汽管道在区域综合管廊合并一根母管后，送至三期汽轮发电站。然后分两路送至两台汽轮机组做功。

Phase III Main Steam Piping System: The main steam pipelines from waste heat boilers serving Coke Ovens #9-10 and #11-12, along with the pipeline from the #3 CDQ waste heat boiler, combine into a common header within the utility corridor and are delivered to the Phase III turbine-generator station, where they are distributed to the two turbine sets.

主蒸汽管道采用单母管制，管道采用无缝钢管，材质为 P91。

The main steam piping system employs a single-header configuration, utilizing seamless steel pipes manufactured from P91 alloy steel.

一期高温再热蒸汽管道系统：1#、2#焦炉对应的废气余热锅炉的高温再热蒸汽管道经区域综合管廊送至一期汽轮发电站。3#、4#焦炉对应的废气余热锅炉的高温再热蒸汽管道与 1#干熄焦锅炉高温再热蒸汽管道在区域综合管廊合并至一根母管后，送至一期汽轮发电站，两路高温再热蒸汽管道在汽轮发电站内合并，然后分两路送至两台汽轮机组做功。

Phase I High-Temperature Reheat Steam Piping System: The high-temperature reheat steam pipelines from the waste heat boilers serving Coke Ovens #1 and #2 are conveyed through the regional utility corridor to the Phase I turbine-generator station. The pipelines from waste heat boilers for Coke Ovens #3 and #4 merge with the high-temperature reheat steam pipeline from the #1 CDQ waste heat boiler into a common header within the utility corridor before delivery to the Phase I station. These two reheat steam lines converge within the power station and are subsequently distributed to the two turbine-generator sets.

二期高温再热蒸汽管道系统：5#、6#焦炉对应的废气余热锅炉的高温再热蒸汽管道与 2#干熄焦锅炉高温再热蒸汽管道在区域综合管廊合并至一根母管后，

送至二期汽轮发电站，7#、8#焦炉对应的废气余热锅炉的高温再热蒸汽管道经区域综合管廊送至二期汽轮发电站，两路高温再热蒸汽管道在汽轮发电站内合并，然后分两路送至两台汽轮机组做功。

Phase II High-Temperature Reheat Steam Piping System: The high-temperature reheat steam pipelines from waste heat boilers serving Coke Ovens #5 and #6 combine with the pipeline from the #2 CDQ waste heat boiler into a common header in the utility corridor, then proceed to the Phase II turbine-generator station. The high-temperature reheat steam pipelines from Coke Ovens #7 and #8 are directly routed through the utility corridor to the Phase II station. Both reheat steam lines merge within the station before being divided to feed the two turbine units.

三期高温再热蒸汽管道系统：9#、10#焦炉与 11#、12#焦炉对应的废气余热锅炉的高温再热蒸汽管道以及 3#干熄焦锅炉高温再热蒸汽管道在区域综合管廊合并一根母管后，送至三期汽轮发电站。然后分两路送至两台汽轮机组做功。

Phase III High-Temperature Reheat Steam Piping System: The high-temperature reheat steam pipelines from waste heat boilers serving Coke Ovens #9-10 and #11-12, along with the pipeline from the #3 CDQ waste heat boiler, combine into a common header within the utility corridor and are delivered to the Phase III turbine-generator station, where they are distributed to the two turbine sets.

高温再热蒸汽管道采用单母管制，管道采用无缝钢管，材质为 P91。

The high-temperature reheat steam piping system employs a single-header configuration, utilizing seamless steel pipes manufactured from P91 alloy steel.

低温再热蒸汽管道从汽轮机高压缸排汽口引出，经高排止回阀后，汇集至一根母管，然后经区域综合管廊接至各锅炉再热器入口联箱。低温再热蒸汽管道采用无缝钢管，材质为 15CrMoG。

The low-temperature reheat steam pipelines are extracted from the high-pressure cylinder exhaust outlets of the steam turbines. After passing through the high-pressure exhaust check valves (HP-ECVs), the steam flows are collected into a common header. The header is then routed through the regional utility corridor and connected to the reheater inlet headers of the respective

waste heat boilers. The low-temperature reheat steam piping system employs seamless steel pipes made of 15CrMoG alloy steel.

每台废气余热锅炉设置 1 套高压旁路装置。干熄焦锅炉设置 1 套高压旁路装置，主蒸汽经高压旁路减温减压后送入相应的低温再热蒸汽管道。

Each waste heat boiler is equipped with one set of high-pressure bypass device. The dry quenching boiler is equipped with one set of high-pressure bypass device, and the main steam is sent to the corresponding low-temperature reheat steam pipeline after being cooled and depressurized by the bypass.

b) 抽汽系统 Extraction system

每台汽轮机共设三级非调整抽汽，分别供给除氧器、2 号低压加热器、1 号低压加热器。各段抽汽管道上均装有止回阀和隔离阀，作为防止汽轮机进水和超速的保护措施。

The steam turbine is equipped with three stages of non adjustable extraction steam, which are respectively supplied to the deaerator, No. 2 low-pressure heater, and No. 1 low-pressure heater. Check valves and isolation valves are installed on each section of the extraction pipeline as protective measures to prevent water ingress and overspeed of the turbine.

干熄焦烘炉用蒸汽若厂区无低压蒸汽，则使用汽轮机的非调整抽汽。焦炉及脱硫装置用低压蒸汽，由汽轮机的非调整抽汽供应。

If no low-pressure steam is available within the plant area, non-regulated extraction steam from the steam turbine shall be utilized. The required low-pressure steam shall be provided by non-regulated extraction steam from the steam turbine.

每座汽轮发电站内设 2 台除氧器，除氧器的汽源为汽轮机的非调整抽汽。

Each turbine-generator power station is equipped with two deaerators, with steam supply sourced from non-regulated extraction points of the steam turbine.

c) 给水系统 Water Supply System

给水系统按焦炉废气余热锅炉和干熄焦锅炉连续蒸发量工况给水量进行设计。每座汽轮发电站内均设置 3 台 110%容量的电动调速给水泵，电动给水泵采用变频调速，能够满足机组负荷变化的要求。

The water supply system is designed to meet the continuous evaporation

demand of both coke oven waste heat boilers and coke dry quenching (CDQ) waste heat boilers. Each turbine-generator power station is equipped with three (3) electric variable-speed water feeding pumps, each with 110% capacity redundancy. The electric water feeding pumps employ variable frequency drive (VFD) speed control, ensuring adaptability to load fluctuations and operational flexibility.

给水泵出口再循环管道设置泵保护阀，以使机组在启动或低负荷运行时流经泵的流量大于其允许的最小流量，保证泵的安全运行。

A pump protection valve is installed on the discharge recirculation line of each water feeding pump to ensure the flow rate through the pump always exceeds its minimum allowable flow during.

主给水管道采用单母管系统，锅炉给水操作台设有三路：自动主路（100%容量）、旁路（50%容量）和手动旁路（100%容量）。

The main water supply pipe adopts a single-header system, with the boiler feed water control station comprising three parallel flow paths: Main Automatic Control Path (100% capacity)、Bypass Control Path (50% capacity)、Manual Bypass Path (100% capacity).

主给水系统还为焦炉废气余热锅炉和干熄焦锅炉过热器的减温器提供减温喷水。给水泵的中间抽头为锅炉再热器、高压旁路提供减温喷水。低压旁路减温水由凝结水泵供应。

The main water supply system also provides cooling water spray for the attemperators of the coke oven waste heat boiler and the dry quenching boiler superheater. The middle tap of the water feeding pump provides cooling water for the boiler reheater and high-pressure bypass. The low-pressure bypass cooling water is supplied by the condensate pump.

d) 凝结水系统 Condensed system

凝结水系统按汽轮发电机组阀门全开工况（VWO 工况）进行设计。每台机组配置 2 台 110%容量多级凝结水泵，1 运 1 备。凝结水泵进口管道上设置真空闸阀、滤网，出口管道上设置止回阀和截止阀。

The condensate system is designed according to the fully open valve condition (VWO condition) of the steam turbine generator set. Each unit is equipped with two 110% capacity multi-stage condensate water pumps, one in

operation and one as backup. Vacuum gate valves and filter screens are installed on the inlet pipeline of the condensate pump, and check valves and globe valves are installed on the outlet pipeline.

每台汽轮机的凝结水由凝汽器热井经总管引出，然后分两路至 2 台凝结水泵，合并成一路经轴封加热器后一部分经 1 号低加、2 号低加后，送至除氧器；另一部分凝结水从轴封后的凝结水母管引出，经区域综合管廊送至干熄焦的热管换热器加热后，回送至除氧器。

The condensate of each steam turbine is led out from the condenser hot well through the main pipe, and then divided into two paths to two condensate pumps. After merging into one path and passing through the shaft seal heater, a portion is sent to the deaerator after passing through the No.1 and No.2 low-pressure heaters; The other part of the condensate is led out from the condensate main pipe after the shaft seal, sent through the regional comprehensive pipe gallery to the heat pipe heat exchanger of the dry quenching coke for heating, and then returned to the deaerator.

汽封加热器为表面式热交换器，用以凝结轴封漏汽和低压门杆漏汽，其微真空状态由汽封加热器风机维持，以防止蒸汽漏入大气及汽机润滑油系统或者空气漏入汽机。

The steam seal heater is a surface type heat exchanger used to condense shaft seal leakage and low-pressure valve stem leakage. Its micro vacuum state is maintained by the steam seal heater fan to prevent steam from leaking into the atmosphere and the turbine lubricating oil system or air from leaking into the turbine.

低压加热器采用小旁路系统，可单独切除；除氧器水位调节阀设在除氧器前凝结水母管处；凝结水系统设有再循环管路，自汽封加热器出口的凝结水管路，经再循环阀回到凝汽器，以保证启动和低负荷期间凝结水泵最小流量运行，防止凝泵出现汽蚀；同时也保证在启动和低负荷时有足够的凝结水流经汽封加热器。

The low-pressure heater adopts a small bypass system and can be cut off separately; The water level regulating valve of the deaerator is located at the condensate main pipe in front of the deaerator; The condensate system is equipped with a recirculation pipeline. The condensate water pipeline from the outlet of the steam seal heater is returned to the condenser through the

recirculation valve to ensure the minimum flow operation of the condensate pump during start-up and low load periods, and to prevent cavitation of the condensate pump; At the same time, it also ensures that there is sufficient condensate water flowing through the steam seal heater during start-up and low load.

除氧器凝结水进水管上装一只止回阀,以防止除氧器内蒸汽倒流入凝结水系统而引起振动。

Install a check valve on the condensate inlet pipe of the deaerator to prevent steam from flowing back into the condensate system and causing vibration.

除氧器出力及水箱有效容积满足锅炉最大连续工况时所需给水量不小于 10 分钟。正常运行和启动补水均由除盐水泵直接打进凝汽器或除氧器,凝汽器热井水位通过补水调节阀控制。

The output of the deaerator and the effective volume of the water tank shall meet the required water supply for no less than 10 minutes under the maximum continuous operating condition of the boiler. Both normal operation and start-up water replenishment are directly pumped into the condenser or deaerator by the desalination water pump, and the water level of the condenser hot well is controlled by the water replenishment regulating valve.

在凝结水泵出口总管上接有汽封系统减温减压装置减温水、本体疏水扩容器减温水、低压缸喷水减温水等。

The condensate pump discharge header is connected to supply cooling water for multiple critical systems, including the steam seal system desuperheater, main steam drain flash tank cooling circuit, and low-pressure cylinder spray water system, ensuring comprehensive temperature and pressure control throughout the turbine assembly.

e) 加热器疏水系统 Heater drainage system

正常运行时,低加疏水系统为逐级自流系统。2 号低加疏水流入 1 号低加,1 号低加疏水自流进入凝汽器。

During normal operation, the low-pressure heater (LPH) drain system operates as a cascading gravity flow system: the drain water from No. 2 LPH flows into No. 1 LPH, while the drain water from No. 1 LPH flows by gravity into

the condenser.

每台加热器疏水管道上装设汽液两相流疏水阀以控制加热器水位。

Install steam liquid two-phase flow drain valves on the drainage pipes of each heater to control the water level of the heater.

f) 冷却水系统 Cooling water system

发电机空冷器、汽轮机冷油器、锅炉给水泵、水环真空泵等均采用循环冷却水冷却。

The generator air cooler, turbine oil cooler, boiler feed pump, and water-ring vacuum pump are all cooled by circulating cooling water.

g) 空冷系统 Air cooling system

本工程采用直接空冷系统，空冷岛型式为 A 型，空冷岛的设计参数按照《火力发电厂水工设计规范》(DL/T 5339-2018)确定。其中空冷岛设计气温根据典型年干球温度统计，按 5℃以上年加权平均法计算设计气温并向上取整，5℃以下按 5℃计算；空冷岛夏季计算气温根据典型年干球温度统计表，取 200h 气温数值。典型年干球温度应有当地气象局出具。由于业主方案阶段无法提供当地的典型年逐时气温资料（当地气象局出具），暂按周边地区气象资料进行估算，待业主提供资料后，再根据上述原则进行设计。

This project adopts a direct air cooling system, with an A-type air cooling island. The design parameters of the air cooling island are determined in accordance with the Hydraulic Design Specification for Thermal Power Plants (DL/T 5339-2018). The design temperature of the air-cooled island is calculated based on typical annual dry bulb temperature statistics, using the weighted average method for years above 5 °C and rounding upwards. For temperatures below 5 °C, it is calculated as 5 °C; The summer temperature calculation for air-cooled islands is based on the typical annual dry bulb temperature statistical table, and the temperature value for 200 hours is taken. The typical annual dry bulb temperature should be issued by the local meteorological bureau. Due to the inability of the owner to provide local typical annual hourly temperature data (issued by the local meteorological bureau) during the design phase, the estimation will be based on the meteorological

data of the surrounding area temporarily. After the owner provides the data, the design will be carried out according to the above principles.

h) 抽真空系统 Vacuum pumping system

每套机组设置 2 台 110%容量的水环真空泵，1 运 1 备。机组正常运行时，真空泵 1 台运行，1 台备用；当机组启动时，为了尽快建立真空，可同时启动 2 台真空泵。抽真空管路上设有真空破坏阀，当机组事故时，用以迅速破坏真空，缩短转子惰走时间。

Each unit is equipped with two 110% capacity water ring vacuum pumps, one in operation and one as backup. When the unit is operating normally, one vacuum pump is in operation and one is standby; When the unit is started, in order to establish vacuum as soon as possible, two vacuum pumps can be started simultaneously. There is a vacuum breaking valve installed on the vacuum pumping pipeline, which is used to quickly break the vacuum and shorten the rotor coasting time in case of unit accidents.

i) 疏放水系统 Drainage system

管道系统的疏水均进入汽轮机本体的疏水膨胀箱。

The drainage of the pipeline system enters the drainage expansion tank of the turbine body.

每台锅炉均设有连续排污扩容器和定期排污扩容器。连续排污水进入连续排污扩容器，连续排污扩容器所产的蒸汽进入除氧器，扩容后的水进入定期排污扩容器，定期排污扩容器后设有排污井，冷却后的水排入厂区排污管网。

Each boiler is equipped with continuous discharge flash tanks and regular discharge flash tanks. The continuous sewage is discharged into the continuous sewage expansion tank, and the steam produced by the continuous sewage expansion tank enters the deaerator. The expanded water enters the regular sewage expansion tank, which is equipped with a drainage well. The cooled water is discharged into the factory sewage pipeline network.

j) 锅炉吹灰系统 Boiler Soot Blowing System

为保证良好的换热效果，废气余热锅炉各受热面间设有吹灰器，具体数量及形式以施工设计为准。

To ensure good heat exchange efficiency, soot blowers are installed between the heating surfaces of the waste gas waste heat boiler. The specific

quantity and form are subject to the construction design.

5.4.3.3 热力系统主要附属设备选型（以设备厂正式资料为准） Selection of Main Auxiliary Equipment for Thermal System (Based on Official Data from Equipment Factory)

a) 除氧器及除氧水箱 Deaerator and Deaerator Water Tank

本工程每座汽轮发电站内设中压旋膜式除氧器 2 台。

Each turbine-generator power station in this project is equipped with two medium-pressure rotary film-type deaerators.

除氧器设备参数

Deaerator Technical Parameters

额定出力 Rated output: 205t/h

除氧水箱有效容积

Effective volume of deaeration

water tank: 50m³

工作压力 Working pressure: 0.2MPa

工作温度 Working temperature: 133°C

出水含氧量

Oxygen content in effluent: ≤7μg/L

b) 锅炉给水泵 Boiler Water Feeding Pump

本工程每座汽轮发电站内共设置 3 台多级卧式电动锅炉给水泵。

Each turbine-generator power station in this project is equipped with three horizontal multistage electric boiler water feeding pumps.

锅炉给水泵设备参数：

Boiler Water Feeding Pump Technical Parameters :

主流量 Main flow rate: 226m³/h

主扬程 Main head: 16.8MPa

中间抽头流量

Middle tap flow rate: 30m³/h

中间抽头扬程 Middle tap head: 5.23MPa

功率 Power: 1800kW（变频） (variable frequency)

电压 Voltage: 10kV

c) 凝结水泵 Condensate pump

本工程每台汽轮发电机组设置 2 台凝结水泵。

Each turbine-generator unit in this project is equipped with two (2) condensate pumps. .

凝结水泵设备参数:

Condensate Pump Technical Parameters

流量 Flow rate: 210m³/h

扬程 Lift: 1.54MPa

功率 Power: 185kW（变频） (variable frequency)

电压 Voltage: 380V

d) 定期排污扩容器 Periodic Blowdown Flash Tank

每台废气余热锅炉及干熄焦锅炉均设置定期排污扩容器 1 台。

Each waste heat recovery boiler and CDQ (Coke Dry Quenching) waste heat boiler is equipped with one periodic blowdown flash tank.

废气余热锅炉配置定期排污膨胀器的设备参数为:

Waste Heat Boiler Periodic Blowdown Flash Tank Technical Parameters:

容积 Volume: 3.5m³

工作压力 Working pressure: 0.2MPa

工作温度 Working temperatur: ≤133°C

材质 Material: Q345R

干熄焦锅炉配置定期排污膨胀器的设备参数为:

CDQ Waste Heat Boiler Periodic Blowdown Flash Tank Technical Parameters:

容积 Volume: 2.7m³

工作压力 Working pressure: 0.2MPa

工作温度 Working temperatur: ≤133°C

材质 Material: Q345R

e) 连续排污扩容器 Continuous Blowdown Flash Tank

每台废气余热锅炉及干熄焦锅炉均设置连续排污扩容器 1 台。

Each waste heat recovery boiler and CDQ (Coke Dry Quenching) waste heat boiler is equipped with one continuous blowdown flash tank.

废气余热锅炉配置连续排污膨胀器的设备参数为：

Waste Heat Boiler Continuous Blowdown Flash Tank Technical Parameters .

容积 Volume:	2.7m ³
工作压力 Working pressure:	0.2MPa
工作温度 Working temperature:	≤133℃

干熄焦锅炉配置连续排污膨胀器的设备参数为：

CDQ Waste Heat Boiler Continuous Blowdown Flash Tank Technical Parameters

容积 Volume:	1.5m ³
工作压力 Working pressure:	0.2MPa
工作温度 Working temperature:	≤133℃

5.4.3.4 辅助设施 Auxiliary Facilities

5.4.3.4.1 蒸汽系统 Steam System

每套干熄焦开工用 0.6MPa 蒸汽消耗量为 4t/h，最大 10t/h；焦炉清扫及生产用 0.6MPa 蒸汽量为 0.6 t/h；脱硫装置用 0.6MPa 蒸汽量为 24t/h。上述蒸汽由汽轮机抽汽供应。

The consumption of 0.6MPa steam for each set of dry quenching operation is 4t/h, with a maximum of 10t/h; The steam volume for coke oven cleaning and production at 0.6MPa is 0.6 t/h; The desulfurization device uses a steam flow rate of 24t/h at 0.6MPa. The above-mentioned steam is supplied by steam turbine extraction.

5.4.3.4.2 净化压缩空气系统 Purified Compressed Air System

净化压缩空气耗量约为 217.8m³/min，其中 179.3 m³/min 用于焦炉除尘机烟气脱硫，38.5 m³/min 用于仪表用气。上述净化压缩空气由新建压缩空气氮气站供应。

The consumption of purified compressed air is approximately 217.8m³/min, of which 179.3 m³/min is used for flue gas desulfurization in coke oven dust

collectors and 38.5 m³/min is used for instrument gas. The purified compressed air mentioned above is supplied by a newly built compressed air nitrogen station.

5.4.3.4.3 压缩空气系统 Compressed Air System

压缩空气耗量约为 45.99m³/min，主要用于煤塔震煤、补炉及清扫。上述压缩空气由新建压缩空气氮气站供应。

The compressed air consumption is about 45.99m³/min, mainly used for coal tower vibration, furnace replacement, and cleaning. The above compressed air is supplied by a newly built compressed air nitrogen station.

5.4.3.4.4 氮气系统 Nitrogen System

正常用氮气耗量约为 10.5m³/min，用于干熄焦循环风机轴封、焦粉冷却装置吹扫及仪表管吹扫。上述氮气由新建压缩空气氮气站供应。

The normal nitrogen consumption is about 10.5m³/min, which is used for the shaft seal of the dry quenching circulating fan, the blowing of the coke powder cooling device, and the blowing of instrument pipes. The above nitrogen is supplied by a newly built compressed air nitrogen station.

每套干熄焦事故用氮气由新建液氮气化站供应，耗量约为 26.35m³/min，用于干熄炉开工或事故充氮。

Each set of nitrogen gas for dry quenching accidents is supplied by a newly built liquid nitrogen gasification station, with a consumption of approximately 26.35m³/min, used for dry quenching furnace start-up or accident nitrogen filling.

5.4.3.4.5 保温油漆 Insulation Paint

本工程选用在安全使用温度下，理化性能稳定，价格适中的保温材料作为设备及管道的主保温层，保温材料和厚度的计算符合《火力发电厂保温油漆设计规程》(DL/T5072-2019)。

This project selects insulation materials with stable physical and chemical properties at safe operating temperatures and reasonable prices as the main insulation layer for equipment and pipelines. The calculation of insulation materials and thickness complies with the Design Specification for Thermal Power Plant Insulation Paints (DL/T5072-2019).

为了减少电厂热力设备及管道的散热损失，提高电厂运行的热效率，本工程对高温设备及管道均采用保温处理。设计温度≥300℃的设备及管道采用硅酸铝

棉毡；设计温度 $<300^{\circ}\text{C}$ 的设备及管道采用岩棉毡。

In order to reduce the heat loss of thermal equipment and pipelines in the power plant and improve the thermal efficiency of power plant operation, insulation treatment is adopted for high-temperature equipment and pipelines in this project. Equipment and pipelines with a design temperature of $\geq 300^{\circ}\text{C}$ shall use aluminum silicate cotton blankets; Equipment and pipelines with a design temperature of less than 300°C are made of rock wool products.

汽水管道采用 0.5mm 厚铝合金板作为外保护层。设备采用 1mm 厚铝合金板作为外保护层。

The soda water pipeline adopts 0.5mm thick aluminum alloy plate as the outer protective layer. The equipment adopts 1mm thick aluminum alloy plate as the outer protective layer.

锅炉本体保温油漆的设计要求，分别由锅炉厂负责。锅炉炉墙保温材料，包括炉膛浇注料等，由锅炉厂家提供。

The design requirements for the insulation paint of the boiler body are respectively the responsibility of the boiler factory. Boiler wall insulation materials, including furnace casting materials, shall be provided by the boiler manufacturer.

5.4.4 主厂房设计 Main Plant Design

5.4.4.1 主厂房设计的主要原则及配置 Main Principles and Configurations of the Main Plant Design

- a) 主厂房布置尽可能布局合理，工艺流程顺畅，配备卫生间，设置必要的检修设施及场地，必要的通风、采光及排水设施，为机组的安全运行，维护提供良好的工作环境及保障，主厂房设有室外消防楼梯；The main powerhouse layout shall be optimally designed with rational space allocation and smooth process flow. It shall include restroom facilities, necessary maintenance equipment and designated work areas, along with proper ventilation, lighting and drainage systems to ensure safe unit operation and maintenance while providing a favorable working environment. External fire escape staircases shall be installed for the main powerhouse.

- b) 汽机间需设集中检修场地，满足汽机检修需要；The turbine bay shall be equipped with a centralized maintenance area to meet all turbine overhaul requirements.
- c) 除氧跨设室内封闭楼梯，均能到达除氧跨各层及屋面。An enclosed indoor staircase shall be provided in the deaerator bay to allow access to all levels of the bay as well as the roof.

5.4.4.2 汽轮发电站布置 Turbine-Generator Power Station Layout

a) 汽机跨布置 Turbine Bay Layout

汽机跨跨距为 26m，分 2 层布置。汽轮发电机组均设有独立岛平台，岛平台顶面运转层标高+8.00m。岛平台进汽端设有副岛平台，平台分上下两层，标高分别为+8.00m 及+4.00m。

The turbine bay is designed with a 26m span and two-level layout. All turbine-generator units are installed on independent island platforms, with the operating level at +8.00m elevation. An auxiliary platform is provided at the steam inlet end, featuring two levels at +8.00m and +4.00m elevations respectively, to support equipment installation and maintenance access. The design ensures structural independence while providing comprehensive operational accessibility.

±0.00m 层：每座汽轮发电厂房布置 3 台电动给水泵。机头侧布置本体疏水扩容器、顶轴油泵等设备；布置润滑油间和减温减压装置。为了防止发生汽蚀损害，凝结水泵采取了地坑低位布置。汽轮机循环水管道地沟布置或埋地；

± 0.00m layer: Install 3 electric water feeding pumps. Equipment such as the main body drainage flash tank and top shaft oil pump are arranged on the head side of the machine; Arrange lubricating oil rooms and temperature and pressure reducing devices. In order to prevent cavitation damage, the condensate pump is arranged at a low position in a pit. Layout or burial of circulating water pipeline trenches for steam turbines;

+4.00m 层：副岛平台布置汽封加热器、低压加热器等设备；机头侧布置均压箱、汽封调节装置等设备；

+4.00m level: The auxiliary island platform is equipped with steam seal heaters, low-pressure heaters, and other equipment; Equipment such as pressure equalization box and steam seal adjustment device are arranged on

the head side of the machine;

+8.00m 层：机头侧布置自动主汽门操纵座等设备。

+8.00m level: Automatic main throttle control seat and other equipment are arranged on the nose side of the machine.

b) 除氧跨布置 Deoxygenation span layout

除氧跨跨距 10m，分 5 层布置。

The deoxygenation span is 10m and arranged in 5 layers.

±0.00m 层：布置厂用高低压配电室等；

± 0.00m layer: arrange high and low voltage distribution rooms for factory use, etc;

+4.00m 层：电缆及管道夹层，主要布置电缆桥架和部分给水、蒸汽及疏水管道；

+4.00m layer: cable and pipeline interlayer, mainly arranged with cable trays and some water supply, steam and drainage pipelines;

+8.00m 层：为运转层，主要布置集中控制室等；

+8.00m level: it is the operating level, mainly arranged with a centralized control room, etc;

+13.00m 层：为管道夹层，用于布置管道；

+13.00m layer: it is a pipeline interlayer used for arranging pipelines;

+16.00m 层：为除氧层，主要布置中压除氧器。

+16.00m layer: It is the deaeration layer, mainly equipped with medium pressure deaerator.

固定端设室内封闭楼梯，能到达除氧跨各层及屋面，除氧层露天布置。

An indoor enclosed staircase is installed at the fixed end, which can reach the various floors and roofs of the deoxygenation span. The deoxygenation layer is arranged outdoors.

c) 锅炉布置 Boiler layout

本工程分三期建设，每期建设 4×25 孔热回收焦炉，相应设置了 2 台烟气余热锅炉。废气余热锅炉与热回收焦炉紧靠布置，布置在两座焦炉间台。每期配套 1 套处理能力为 140t/h 的干熄焦装置，相应配套 1 座干熄焦锅炉布置在焦炉端台。

The project is constructed in three phases, with each phase comprising

4×25-ovens heat recovery coke ovens and correspondingly equipped with 2 waste heat boilers. The waste heat boilers are arranged adjacent to the heat recovery coke ovens, specifically positioned between two coke ovens on the intermediate platform. Each phase includes a set of coke dry quenching (CDQ) equipment with a processing capacity of 140 t/h, along with an associated CDQ waste heat boiler located at the end platform of the coke oven battery.

5.4.4.3 安装及检修设施 Installation and Maintenance Facilities

每座汽机间均设置 50/10t 电动双钩慢速桥式起重机, 轨面标高约+19.2m, 可满足日常检修要求。检修时, 主机及零部件可利用起重机就近放在主厂房 ±0.00m 层检修区域。

Each turbine hall is equipped with a 50/10t electric double-hook slow-speed overhead crane with a rail elevation of approximately +19.2m, meeting routine maintenance requirements. During maintenance, major components and parts can be transported by the crane and placed directly in the ±0.00m maintenance area within the main powerhouse.

每座废气余热锅炉及干熄焦锅炉的炉顶均设置 1 台 2t 单轨电动葫芦, 可将零部件自±0.00m 底层吊至锅炉炉顶。

Each waste heat recovery boiler and CDQ (Coke Dry Quenching) waste heat boiler is equipped with one 2t monorail electric hoist at the boiler top platform.

5.4.5 化学水处理 Chemical Water Treatment

5.4.5.1 设计依据及基础资料 Design Basis and Basic Data

5.4.5.1.1 机组型式 Unit type

本工程选用超高温超高压锅炉, 过热蒸汽压力为 13.8MPa, 温度为 570°C。

This project uses an ultra-high temperature and ultra-high pressure boiler, with a superheated steam pressure of 13.8 MPa and a temperature of 570 °C.

5.4.5.1.2 给水、炉水、蒸汽质量标准 Quality Standards for Water Supply, Boiler Water, and Steam

根据《火力发电机组及蒸汽动力设备水汽质量》GB/T12145-2016 标准, 本工程选用机、炉的给水、炉水及蒸汽质量标准为:

According to the GB/T12145-2016 standard for water and steam quality of

thermal power generation units and steam power equipment, the quality standards for water supply, boiler water, and steam selected for this project are:

表 5-10 锅炉给水质量表
Table 5-10 Boiler feeding water quality table

序号 No.	项目 Project	指标 Indicator	单位 Unit
1	硬度 Hardness	-	μmol/L
2	溶解氧 Dissolved oxygen	≤7	μg/L
3	铁 Iron	≤20	μg/L
4	铜 Copper	≤5	μg/L
5	二氧化硅 Silicon dioxide	应保证蒸汽中二氧化硅符合标准 The Silicon dioxide contained in steam shall meet relevant standard.	
6	TOCi	≤500	μg/L
7	氢电导率(25°C) Hydrogen conductivity	≤0.3	μs/cm
8	pH(25°C)	9.2~9.6	

表 5-11 蒸汽质量表
Table 5-11 Steam Quality Table

序号 No.	项目 Project	指标 Indicator	单位 Unit
1	钠 Sodium	≤5	μg/kg
2	二氧化硅 Silicon dioxide	≤15	μg/kg
3	铁 Iron	≤15	μg/kg
4	铜 Copper	≤3	μg/kg
5	氢电导率(25°C) Hydrogen conductivity	≤0.15	μs/cm

表 5-12 锅炉炉水质量表
Table 5-12 Boiler Water Quality Table

序号 No.	项目 Project	指标 Indicator	单位 Unit
1	磷酸根 Phosphate radical	≤3	mg/L
2	二氧化硅 Silicon dioxide	≤0.45	mg/L
3	电导率(25℃) Conductivity	<20	μs/cm

表 5-13 凝结水质量表
Table 5-13 Condensate Quality Table

序号 No.	项目 Project	指标 Indicator	单位 Unit
1	硬度 Hardness	≈0	μmol/L
2	溶解氧 Dissolved oxygen	≤40	μg/L
3	氢电导率(25℃) Hydrogen conductivity	≤0.3	μS/cm

5.4.5.2 锅炉补给水处理系统 Boiler Feeding Water Treatment System

本工程锅炉补给水由新建除盐水处理站供给。

The boiler feeding water for this project is supplied by a newly built desalination water station.

5.4.5.2.1 水源水质 Water Quality of Water Source

由于业主暂未提供原水水质全分析项目表，当前方案暂按照原水水质与《钢铁企业给水排水设计规范》(GB 50721-2011)中生产新水的指标相同进行设计，具体指标详见下表：

Due to the lack of a complete analysis project table for the raw water quality provided by the owner, the current plan is temporarily designed based on the same indicators as the production of new water in the "Design Specification for Water Supply and Drainage of Steel Enterprises" (GB 50721-2011). The specific indicators are detailed in the table below:

表 5-14 原水水质
Table 5-14 Raw water quality

序号 No.	指标 Indicator	单位 Unit	生产新水 Production New Water	备注 Remarks
1	pH	—	7~9	
2	悬浮物 Suspended solids	mg/L	≤10	
3	全硬度 Full hardness	mg/L	≤150	以 CaCO ₃ 计

序号 No.	指标 Indicator	单位 Unit	生产新水 Production New Water	备注 Remarks
				Calculated by CaCO ₃
4	Ca 硬度 Ca hardness	mg/L	≤100	以 CaCO ₃ 计 Calculated by CaCO ₃
5	M-碱度 M-alkalinity	mg/L	≤110	以 CaCO ₃ 计 Calculated by CaCO ₃
6	氯离子 Chloride ion	mg/L	≤220	以 Cl ⁻ 计 Calculated by Cl ⁻
7	硫酸根离子 Sulfate ion	mg/L	≤80	以 SO ₄ ²⁻ 计 Calculated by SO ₄ ²⁻
8	全铁 All iron	mg/L	≤1	以 Fe 计 Calculated by Fe
9	可溶性 SiO ₂ Soluble SiO ₂	mg/L	≤6	以 SiO ₂ 计 Calculated by SiO ₂
10	含油 Oil containing	mg/L	≤2	
11	电导率 Conductivity	μs/cm	≤500	
12	蒸发残渣 Evaporation residue	mg/L	≤300	溶解 Dissolution
13	氨氮 Ammonia nitrogen	mg/L	≤10	

5.4.5.2.2 锅炉补给水水质 Boiler Makeup Water Quality

根据《火力发电机组及蒸汽动力设备水汽质量》GB/T12145-2016 标准，本工程选用的锅炉补给水质量标准如下：

According to the GB/T12145-2016 standard for water and steam quality of thermal power generation units and steam power equipment, the quality standards for boiler feeding water used in this project are as follows:

表 5-15 锅炉补给水水质
Table 5-15 Boiler feeding water quality

序号 No.	项目 Project	单位 Unit	数值 Value	备注 Remarks
1	氢电导率 Hydrogen conductivity	μs/cm	≤0.3	25°C
2	铁 Iron	μg/L	≤20	
3	铜 Copper	μg/L	≤5	
4	二氧化硅 Silicon dioxide	μg/L	≤15	
5	TOCi	μg/L	≤500	
6	PH	-	9.2~9.6	

5.4.5.2.3 补给水量 Makeup Water Volume

表 5-16 汽水损失平衡表
Table 5-16 Soda loss balance sheet

序号 No.	损失类别 Loss Category	正常损失(t/h) Normal Loss	备注 Remarks
1	水汽循环损失 Water vapor cycle loss	11.31	取全部锅炉额定蒸发量的 3% Take 3% of the rated evaporation capacity of all boilers
2	排污损失 Pollution loss	7.54	取全部锅炉额定蒸发量的 2% Take 2% of the rated evaporation capacity of all boilers
3	锅炉启动或汽轮发电站事故 Boiler start-up or turbine power plant accident	15.2	取最大 1 台锅炉蒸发量的 10% Take 10% of the maximum evaporation capacity of one boiler
4	未计损失 Unexpected losses	1.96	
5	外供蒸汽	8.2	
	合计 Total	43.2	

上表为每期除盐水消耗量，正常补水量 29t/h，最大补水量为 45.2t/h，考虑一定的富余量，并考虑分期建设，本工程除盐水处理能力为 3×60t/h（EDI 装置）。分两阶段建设：其中一期建设 2×60t/h，三期建设 1×60t/h。

The demineralized water system is designed with a total treatment capacity of 3×60 t/h (EDI units) based on normal make-up water demand of 29 t/h and maximum demand of 45.2 t/h, incorporating sufficient design margin and considering phased construction. The system will be implemented in two stages: Phase I will include 2×60 t/h units, while Phase III will add the remaining 1×60 t/h unit.

5.4.5.2.4 锅炉补给水系统 Boiler Feeding Water System

为满足超高温超高压机组对给水水质的要求，本化学水处理拟选用多介质过滤器+超滤+两级反渗透+EDI 系统。

To meet the stringent feeding water quality requirements for ultra-high temperature and pressure power generation units, this chemical water treatment system is designed with a multi-stage purification process comprising: multi-media filtration + ultrafiltration (UF) + two-stage reverse osmosis (RO) + electrodeionization (EDI).

a) 系统出水水质 System effluent quality

电导率 Conductivity:	$\leq 0.30 \mu\text{S}/\text{cm}$
二氧化硅 Silicon dioxide:	$\leq 15 \mu\text{g}/\text{L}$
pH 值 PH value:	9.2~9.6（加氨后） (After adding ammonia)

b) 水处理系统配置 Water Treatment System Configuration

化学水处理系统主要工艺包括预处理系统、预除盐系统、精除盐系统、化学清洗及反渗透冲洗系统等。

The chemical water treatment system primarily comprises the following key processes: pretreatment system, pre-desalination system, polishing demineralization system, chemical cleaning system, and reverse osmosis flushing system.

1) 预处理系统 Preprocessing System

预处理系统由多介质过滤器和超滤组成。多介质过滤器主要用于去除工业原水中悬浮物、胶体、铁等物质的含量，以降低后续超滤工艺的进水负荷。超滤是去除水中悬浮物、有机物、胶体等杂质，使之满足后续反渗透装置的进水要求。

The pretreatment system consists of multi-media filters and ultrafiltration (UF) units. The multi-media filters are primarily designed to reduce the concentration of suspended solids, colloids, iron and other particulates in the raw industrial feeding water, thereby decreasing the hydraulic loading on the subsequent UF process. The UF system functions to remove suspended matter, organic compounds, colloidal substances and other impurities from water to meet the stringent feeding water quality requirements for the downstream reverse osmosis (RO) system.

多介质过滤器产水水质：悬浮物 $\leq 1.2 \text{mg}/\text{L}$ 。超滤装置产水水质：SDI₁₅<3。本工程设出力为 94t/h 多介质过滤器 3 套，出力为 84t/h 超滤装置 3 套。

The multi-media filtration system produces water with suspended solids (SS) content $\leq 1.2 \text{mg}/\text{L}$, while the ultrafiltration (UF) system delivers product water with a Silt Density Index (SDI₁₅) of less than 3. This project is configured with three multi-media filters each rated at 94 t/h capacity and three UF units each with 84 t/h processing capacity, all designed to meet stringent water quality standards.

2) 预除盐系统 Pre-desalination System

预除盐系统由两级反渗透系统组成。反渗透系统主要去除水中大部分溶解盐类。

The pre-desalination system consists of a two-stage reverse osmosis (RO) system, primarily designed to remove the majority of dissolved salts from water.

一级反渗透系统脱盐率 $\geq 97\%$ ，回收率为 75%；二级反渗透系统脱盐率 $\geq 97\%$ ，回收率为 85%。本工程设出力为 72t/h 一级反渗透装置 3 套，出力为 67t/h 二级反渗透装置 3 套。

The primary reverse osmosis (RO) system demonstrates a salt rejection rate $\geq 97\%$ with 75% recovery rate, while the secondary RO system achieves $\geq 97\%$ salt rejection at 85% recovery rate. The project configuration includes three primary RO units (72 t/h each) and three secondary RO units (67 t/h each).

每套反渗透装置包括：5 μ m 保安过滤器、高压泵及反渗透膜组件等。

Each reverse osmosis (RO) unit comprises: 5 μ m pre-filter (safety filter), high-pressure pump, and RO membrane modules and associated components.

反渗透系统的进水、产水和浓水管道上都装有一系列的控制阀门，监控仪表及程控操作系统，自动化水平较高。

The reverse osmosis system features a series of control valves, monitoring instruments, and programmable control systems installed on the feeding water, product water, and concentrate pipelines, demonstrating a high level of automation.

本工程二级反渗透浓水作为一级反渗透进水。

The secondary reverse osmosis concentrated water in this project serves as the primary reverse osmosis inlet water.

预除盐系统中设有三套加药装置，分别是还原剂加药装置、阻垢剂加药装置及碱加药装置，目的是为了防止一级反渗透浓水侧结垢和去除二级反渗透进水中的 CO₂。

The pre-desalination system incorporates three chemical dosing units - a reducing agent dosing unit, an anti-scalant dosing unit, and an alkali dosing unit - which collectively function to prevent scaling on the concentrate side of the primary RO system while effectively removing CO₂ from the secondary RO feeding water.

3) 精除盐系统 Fine Desalination System

精除盐系统由 3 套 EDI 装置组成，其作用是去除二级反渗透产水中残余的离子。

The precision desalination system consists of three EDI units designed to remove residual ions from the secondary reverse osmosis product water.

EDI 是连续电去离子过程。在电去离子过程中，进水流经阴阳离子交换膜隔开的淡水室内的离子交换树脂，生成除盐水。同时，装置各端的电极板在外加电压的作用下，驱动水的分解反应，并使得离子在离子交换树脂内向选择性透过膜迁移，被送到浓水室。

Electrodeionization (EDI) is a continuous demineralization process where feed water flows through ion exchange resins in the freshwater chambers separated by anion and cation exchange membranes, producing demineralized water. Simultaneously, electrode plates at both ends of the unit, under an applied voltage, drive water electrolysis to generate H^+ and OH^- ions, which enable continuous electrochemical regeneration of the ion exchange resins while forcing ionic species to migrate through the resins toward the selectively permeable membranes, ultimately being discharged into the concentrate chambers - achieving complete water purification without chemical regeneration.

在电去离子过程中，阴、阳离子交换树脂的交换界面-水在电场作用下发生极化并电解成 H^+ 和 OH^- ，随时对阴、阳离子交换树脂进行电化学再生，使树脂始终处在连续工作状态。整个再生过程无需酸碱。

During the EDI process, the water at the interface between anion and cation exchange resins undergoes polarization under the electric field and electrolyzes into H^+ and OH^- ions. These ions continuously regenerate the anion and cation exchange resins electrochemically, maintaining the resins in a constant working state. Notably, this entire regeneration process operates without requiring any acid or alkali chemicals.

EDI 装置回收率为 90%。本工程建设 3 套 EDI 装置，出力为 $3 \times 60 \text{ t/h}$ ，正常运行时，2 用 1 备，EDI 浓水作为二级反渗透进水。

The EDI system has a recovery rate of 90%. This project involves the construction of three EDI units with a capacity of $3 \times 60 \text{ t/h}$. During normal operation, two units will be in service while one serves as a backup. The EDI

concentrate will be used as feed water for the secondary reverse osmosis system.

每套 EDI 装置包括 EDI 模块、1 块、保安过滤器、整流器及相关配套控制阀门，监控仪表等。

Each EDI device includes an EDI module, 1 piece, security filter, rectifier, and related control valves, monitoring instruments, etc.

4) 化学清洗及反渗透冲洗系统 Chemical Cleaning and Reverse Osmosis Flushing System

化学清洗系统：当反渗透膜及 EDI 的性能下降时，其产水量减小，跨膜压差增至某一定值时，则需根据超滤、反渗透膜及 EDI 模块运行污染的情况，不定期的对膜组件进行合理的化学清洗，以恢复其原有特性。

When the performance of the reverse osmosis membranes and EDI declines—resulting in reduced water production and an increase in trans-membrane pressure to a certain threshold—the membrane elements should undergo periodic chemical cleaning based on the fouling conditions of the ultrafiltration, RO, and EDI systems. This process helps restore their original performance characteristics.

化学清洗使用清洗装置进行，系统共设置 1 套化学清洗装置，分别用于对超滤装置和反渗透、EDI 装置进行定期清洗，该装置包括 1 台化学保安过滤器，1 台不锈钢清洗泵，1 台清洗箱。

Chemical cleaning is performed using a dedicated cleaning system. The plant is equipped with one set of chemical cleaning unit, which is used for periodic cleaning of the ultrafiltration system, reverse osmosis system, and EDI system. The cleaning unit includes: 1 chemical safety filter、1 stainless steel cleaning pump、1 cleaning tank.

反渗透冲洗系统：为防止反渗透机组停机后浓水侧亚稳态的结垢物质出现结垢，采用反渗透出水对反渗透膜进行冲洗，本工程配有专用的反渗透冲洗水泵。反冲洗水采用一级反渗透系统出水。

Reverse osmosis flushing system: To prevent scaling from metastable substances on the concentrate side after shutdown of the reverse osmosis (RO) unit, the RO membranes are flushed using RO product water. This project is equipped with a dedicated RO flushing pump, and the flushing water is supplied

from the primary RO system product water.

5) 除盐水存储 Demineralized Water Storage

除盐车站设 1 台 200m³ 除盐水箱，用于存储制备好的除盐水，供锅炉补水用。

The desalination water station is equipped with one 200m³ desalination water tank, which is used to store the prepared desalination water for boiler replenishment.

6) 除盐水系统运行及控制 Operation and control of desalination water system

超滤系统的投运、停运、反洗，反渗透系统的投运、停运、延时自动冲洗以及 EDI 系统的运行、停运等操作均采用自动控制，各设备亦能在就地通过集中控制箱就地操作；超滤、反渗透、EDI 的化学清洗装置采用就地操作。

The operation, shutdown, and backwash of the ultrafiltration (UF) system; the startup, shutdown, and delayed automatic flushing of the reverse osmosis (RO) system; as well as the operation and shutdown of the EDI system are all automatically controlled. Additionally, all equipment can be operated locally via centralized control panels. For the chemical cleaning systems of the UF, RO, and EDI units, local manual operation is adopted.

5.4.5.3 汽水取样 Water Vapor Sampling

汽水取样范围包括热力系统的给水、炉水、凝结水及蒸汽品质，取样点均布置在集中取样架上。本工程每座汽轮发电站内设有 2 套汽水取样装置，供相应的废气余热锅炉及除氧发电系统使用。干熄焦锅炉的汽水取样装置设置在锅炉底部。高温架和仪表架分开布置，仪表架上设置在线仪表。并可实现计算机监视。高温架自带除盐水闭式循环冷却水设施。汽水在线监测项目详见下表：

The steam/water sampling system covers all key thermal cycle media including feeding water, boiler water, condensate and steam, with all sampling points arranged on centralized sample racks. Each turbine-generator station is equipped with two sets of sampling devices serving the waste heat boilers and deaerator power generation system, while the CDQ boiler sampling unit is installed at the boiler basement. The system features separate high-temperature and instrument racks - the high-temperature rack incorporates a closed-loop demineralized water cooling system, while the instrument rack

houses online analyzers connected to computerized monitoring systems.

Detailed online monitoring parameters are specified in the following table:

表 5-17 汽轮发电站内每套汽水在线监测项目表

Table 5-17 Steam/Water Online Monitoring Parameters Table for Turbine-Generator Station

序号 No.	取样点 Sampling Point	pH	电导率 Condu ctivity	溶解氧 Dissol ved	氢电导率 Oxygen Hydroge n	手动取样 Conducti vity Manual Sampling	显示地点 Display Location	备注 Remar ks
1	锅炉给水 Boiler feeding water	○	○	○	○	○	就地/中控 On site/central control	各 1 点 1 points each
2	汽包炉水 Drum boiler water	○	○			○	就地/中控 On site/central control	各 1 点 1 points each
3	饱和蒸汽 Saturated steam				○	○	就地/中控 On site/central control	各 1 点 1 points each
4	过热蒸汽 Superhea ted steam				○	○	就地/中控 On site/central control	各 1 点 1 points each
5	再热蒸汽 Reheat steam					○	就地/中控 On site/central control	各 1 点 1 points each
6	凝结水 Condens ed water			○	○	○	就地/中控 On site/central control	各 1 点 1 points each

表 5-18 每套干熄焦锅炉汽水在线监测项目表

Table 5-18 Steam/Water Online Monitoring Parameters Table for CDQ (Coke Dry Quenching) waste heat boiler

序号 No.	取样点 Sampling Point	pH	电导率 Condu ctivity	溶解氧 Dissol ved	氢电导率 Oxygen Hydroge n	手动取样 Conducti vity Manual Sampling	显示地点 Display Location	备注 Remar ks
1	锅炉给水 Boiler feeding water	○	○	○	○	○	就地/中控 On site/central control	各 1 点 1 points each
2	汽包炉水 Drum boiler water	○	○			○	就地/中控 On site/central control	各 1 点 1 points each
3	饱和蒸汽 Saturated				○	○	就地/中控 On	各 1 点 1

序号 No.	取样点 Sampling Point	pH	电导率 Condu- ctivity	溶解氧 Dissol- ved	氢电导率 Oxygen Hydroge- n	手动取样 Conducti- vity Manual Sampling	显示地点 Display Location	备注 Remar- ks
	steam						site/central control	points each
4	过热蒸汽 Superhea- ted steam				○	○	就地/中控 On site/central control	各 1 点 1 points each
5	再热蒸汽 Reheat steam					○	就地/中控 On site/central control	各 1 点 1 points each

5.4.5.4 给水、炉水处理 Water Supply and Boiler Water Treatment

a) 给水处理 Water Treatment

为防止热力系统设备管道腐蚀，需提高除盐水的 pH 值，本工程在每座汽轮发电站设置给水 PH 调节装置 1 套，每套配有计量加药泵 2 台，正常运行时加药泵 1 运 1 备。

To prevent corrosion in the thermal system equipment and piping, the pH value of demineralized water must be elevated. This project incorporates one set of feeding water pH adjustment system in each turbine-generator station, with each system equipped with two metering chemical dosing pumps operating in a "one duty/one standby" configuration during normal operation.

b) 炉水校正处理 Boiler Water Correction Treatment

为了使锅水保持一定浓度的 PO_4^{3-} ，防止 CaSO_4 、 CaSiO_3 等水垢形成，本设计在每座汽轮发电站内设置了 2 套磷酸盐加药装置。系统运行时，每套磷酸盐加药装置通过 2 台计量泵（1 开 1 备）将浓度为 1% 左右的磷酸三钠溶液注入锅炉汽包中，使之与锅水中的钙离子反应生成一种松软的水渣（碱性磷酸钙），通过锅炉排污系统排除。每座干熄焦锅炉底部设置 1 套磷酸盐加药装置，供干熄焦锅炉使用，每套磷酸盐加药装置配备 2 台计量泵（1 开 1 备）。

To maintain appropriate PO_4^{3-} concentration in boiler water and prevent scale formation (CaSO_4 , CaSiO_3), this design installs 2 phosphate dosing systems in each turbine-generator station. Each system injects approximately 1% trisodium phosphate solution into the boiler steam drum via 2 metering pumps (1 operating + 1 standby), facilitating a chemical reaction that converts

calcium ions into soft sludge (basic calcium phosphate) for removal through the blowdown system. Additionally, one phosphate dosing system is installed at the base of each CDQ boiler, also equipped with 2 metering pumps (1 operating + 1 standby) for dedicated CDQ boiler operation.

如果取样测得炉水样水中 PO_4^{3-} 浓度过高或过低，相应调节装置配备的计量泵，减少或增加磷酸三钠溶液的注入量。使锅炉运行更加稳定、可靠，更好的节能降耗。

If sampling indicates abnormally high or low $\text{PO}_3\text{-4}$ concentration in the boiler water, the dosing rate of the corresponding metering pumps shall be adjusted to reduce or increase the injection volume of the trisodium phosphate (TSP) solution. This ensures precise control of phosphate treatment levels, maintains water chemistry equilibrium, and enhances operational stability and reliability of the boiler system while achieving energy efficiency optimization and reduced consumption.

为防止如除氧器运行不当等原因可能使给水中溶解氧带入锅炉系统的情况，本设计采用了在炉外加丙酮肟的方法，作为旋膜式除氧器除氧的备用除氧措施。故本设计在每座汽轮发电站内设置了 1 套除氧剂加药装置。除氧剂加药装置通过配备的 2 台计量泵（1 开 1 备）将浓度为 0.5% 左右的丙酮肟溶液注入低压给水管路中，以确保锅炉及其汽水系统不出现氧化腐蚀现象。

To prevent the introduction of dissolved oxygen into the boiler system caused by factors such as improper operation of the deaerator, which may lead to oxygen ingress in feeding water, this design adopts an external acetone oxime dosing system as a backup deoxygenation measure to complement the rotary film-type deaerator. Accordingly, one set of oxygen scavenger dosing unit is installed in each turbine-generator power station. Each oxygen scavenger dosing unit is equipped with two metering pumps (one in operation and one standby) to inject an acetone oxime solution with a concentration of approximately 0.5% into the low-pressure feeding water pipeline, thereby ensuring the prevention of oxidative corrosion in the boiler and its associated steam-water systems.

如果取样测得给水样水中 O_2 浓度波动，相应调节装置配备的计量泵，增加或减少丙酮肟溶液的注入量。使锅炉汽水系统运行更加稳定、可靠。

If sampling indicates fluctuations in dissolved oxygen (O_2) concentration in the feeding water, the dosing rate of the associated metering pumps shall be adjusted accordingly to either increase or decrease the injection volume of the acetone oxime solution. This ensures optimized chemical dosing efficiency and maintains the dissolved oxygen content within specified limits, thereby enhancing the stability and reliability of boiler steam-water system operation and safeguarding the long-term operational integrity of the system.

5.4.6 润滑油净化设施 Lubricating Oil Purification Facilities

本工程不设集中油处理室，每台汽轮发电机组设置润滑油真空滤油机 1 台。

This project does not include a centralized oil treatment room. Instead, each turbine-generator unit is equipped with one vacuum oil purifier for lubricating oil treatment.

5.5 烟气脱硫系统 De-sulfuration System

5.5.1 概述 Overview

本系统将经过余热锅炉余热利用后的焦炉废气进行脱硫与除尘，使其达到国家环保要求的排放标准。本系统分三期建设，其中每期均建设 2 套烟气脱硫装置，每套脱硫装置对应处理 1 台废气余热锅炉及 1 套干熄焦装置的烟气。一期单独建设 1 套消化站，二期建设 1 套消化站与三期共用。

This system is designed to desulfurize and dedust the coke oven flue gas that has already utilized the waste heat in the waste heat boiler, so as to meet the emission standards required by national environmental protection regulations. The system will be constructed in three phases. In each phase, 2 sets of flue gas desulfurization devices will be built. Each set of desulfurization device is corresponding to treating the flue gas from 1 waste heat boiler for exhaust gas and 1 set of coke dry quenching device. One digestion station will be built in the first phase, and one digestion station will be built in the second phase and shared with the third phase.

5.5.2 设计基础数据 Design Basic Data

表 5-19 烟气脱硫系统设计参数
Table 5-19 Design Parameters of Flue Gas Desulfuration System

名 称 Name	参数 Parameter	备注 Remarks
烟气处理量 Flue gas processing	625500Nm ³ /h（标态） (standard state)	一期 Phase I

名 称 Name	参数 Parameter	备注 Remarks
capacity	625500m ³ /h（标态） (standard state)	二期 Phase II
	625500m ³ /h（标态） (standard state)	三期 Phase III
烟气进口温度 Flue gas inlet temperature	180°C	
烟气进口压力 Flue gas inlet pressure	-2500Pa	
烟气进口 SO ₂ 浓度 Flue gas inlet SO ₂ concentration	1000mg/m ³ （标态） (standard state)	
烟气进口颗粒物浓度 Flue gas inlet particulate matter concentration	1100mg/m ³ （标态） (standard state)	
SO ₂ 排放浓度 SO ₂ emission concentration	≤200 mg/m ³ （标态） (standard state)	
颗粒物排放浓度 Particulate matter emission concentration	≤30 mg/m ³ （标态） (standard state)	
原料 CaO raw material CaO	含量 content>80% 含水率 moisture content≤1.5% 活性 activity T ₆₀ ≤4min	

5.5.3 工艺方案比较与选取 Comparison and Selection of Process Schemes

常规的烟气脱硫方案包括湿法脱硫、半干法脱硫及干法脱硫三种。

Regular flue gas desulfurization schemes include wet desulfurization, semi-dry desulfurization and dry desulfurization.

湿法脱硫主要利用石灰石(CaCO₃)-石膏浆液(CaSO₄)洗涤烟气，使其与硫元素反应，其工艺通常更复杂。湿法脱硫通常具有较高的脱硫效率，可高达 95%-99%。能够较好地适应烟气量、二氧化硫浓度、温度等工况的大幅度变化。但初期投资大，运行成本高，设备腐蚀严重，且存在废水处理问题。湿法脱硫适用于烟气量大、对脱硫效率要求高的场合。

Wet desulfurization mainly uses limestone - gypsum slurry to wash the flue gas, making it react with sulfur elements. Its process is usually more complex. Wet desulfurization usually has a high desulfurization efficiency, which can be as high as 95% - 99%. It can well adapt to the large - scale changes in working conditions such as flue gas volume, sulfur dioxide concentration and temperature. However, it has large initial investment, high operation cost, serious equipment corrosion, and there is a problem of wastewater treatment.

Wet desulfurization is suitable for occasions with large flue gas volume and high requirements for desulfurization efficiency.

干法脱硫是一种在脱硫过程中烟气始终保持干态的工艺。干法脱硫通常使用石灰等作为脱硫吸收剂，并通过喷雾形式进行脱硫处理，其设备相对简单。干法脱硫的成本相对较低，且对环境污染小，不会产生废水排放，但其脱硫效率相对较低，往往在 80%左右。干法脱硫适用于烟气量小、对脱硫效率要求不高的场合。

Dry desulfurization is a process in which the flue gas remains in a dry state throughout the desulfurization process. In dry desulfurization, lime and other substances are usually used as desulfurization absorbents, and the desulfurization treatment is carried out in the form of spraying, and its equipment is relatively simple. The cost of dry desulfurization is relatively low, and it has little environmental pollution and will not produce wastewater discharge. However, its desulfurization efficiency is relatively low, often around 80%. Dry desulfurization is suitable for occasions with small flue gas volume and low requirements for desulfurization efficiency

半干法脱硫技术是在干法脱硫及湿法脱硫技术基础上发展起来的一种高效脱硫工艺。将石灰粉等脱硫剂制成浆液，喷入吸收塔内，同时向塔内喷入适量的水，使浆液在塔内处于半干状态。脱硫剂与烟气中的二氧化硫发生化学反应，生成亚硫酸钙和硫酸钙等物质，从而达到脱硫的目的。脱硫效率可达 90%-95%，能有效降低烟气中二氧化硫的排放浓度，满足严格的环保要求。系统相对简单，设备投资成本介于湿法和干法之间。

Semi - dry desulfurization technology is a highly efficient desulfurization process developed on the basis of dry and wet desulfurization technologies. Desulfurizing agents such as lime powder are made into slurry and sprayed into the absorption tower. At the same time, an appropriate amount of water is sprayed into the tower to keep the slurry in a semi - dry state. The desulfurizing agent reacts chemically with sulfur dioxide in the flue gas to form substances such as calcium sulfite and calcium sulfate, so as to achieve the purpose of desulfurization. The desulfurization efficiency can reach 90% - 95%, which can effectively reduce the emission concentration of sulfur dioxide in the flue gas and meet the strict environmental protection requirements. The system is

relatively simple, and the equipment investment cost is between that of the wet method and the dry method.

结合项目相关要求及现场的实际情况，本项目脱硫方案采用 CFB 半干法脱硫塔与旋转喷吹布袋除尘器相结合的工艺，并设置清洁烟气再循环系统，满足焦炉烟气低负荷时的正常运行。同时，系统设置旁路烟道系统，当脱硫塔、布袋除尘器需要换袋检修时，锅炉烟气可以直接从旁路烟道进入引风机排放，不影响发电。

Based on the relevant requirements of the project and the actual on - site situation, the desulfurization scheme for this project adopts a process that combines a CFB semi - dry desulfurization tower with a rotary blowing bag filter. A clean flue gas recirculation system is also set up to ensure the normal operation of the coke oven flue gas under low - load conditions. Meanwhile, the system is equipped with a bypass flue system. When the desulfurization tower or the bag filter needs bag replacement and maintenance, the boiler flue gas can directly enter the induced draft fan through the bypass flue for emission, without affecting power generation.

5.5.4 工艺流程 Process Flow

烟气脱硫装置主要由吸收塔、除尘器、烟风系统、脱硫灰循环系统、吸收剂供应系统、压缩空气系统、工艺水系统、蒸汽及凝结水系统、流化风系统等组成。

The flue gas desulfurization device is mainly composed of an absorption tower, a dust collector, a flue gas system, a desulfurization ash circulation system, an absorbent supply system, a compressed air system, a process water system, a steam and condensate water system, a fluidizing air system, etc.

消化站主要由吸收剂制备系统、吸收剂储运系统及废灰储运系统组成。

The slaking station is mainly composed of an absorbent preparation system, an absorbent storage and transportation system, and a waste ash storage and transportation system.

烟气经进口烟道从底部进入脱硫塔，在此处高温烟气与加入的脱硫剂、循环脱硫灰充分预混合，进行初步的脱硫反应。然后烟气通过脱硫塔底部的文丘里管进入循环流化床体，在文丘里的出口扩管段设一套喷水装置，喷入雾化水以降低脱硫反应器内的烟温，使烟温降至高于烟气露点 15℃左右，从而使得 SO₂ 与

$\text{Ca}(\text{OH})_2$ 的反应转化为可以瞬间完成的离子型反应。脱硫剂、循环脱硫灰在文丘里段以上的塔内进行第二步的充分反应，生成副产物 $\text{CaSO}_3 \cdot 1/2\text{H}_2\text{O}$ 、 $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ 等。脱硫塔入口烟气 SO_2 含量约 $1000\text{mg}/\text{m}^3$ ，经脱硫塔净化后烟气中 SO_2 含量可将至 $200\text{mg}/\text{m}^3$ 以下。

The flue gas enters the desulfurization tower from the bottom through the inlet flue. Here, the high - temperature flue gas is fully pre - mixed with the added desulfurizing agent and recycled desulfurization ash to carry out a preliminary desulfurization reaction. Then, the flue gas enters the circulating fluidized bed through the Venturi tube at the bottom of the desulfurization tower. A set of water - spraying devices is installed in the expanding section of the Venturi outlet. Atomized water is sprayed to reduce the flue gas temperature in the desulfurization reactor, bringing the flue gas temperature down to about 15°C above the flue gas dew point. As a result, the reaction between SO_2 and $\text{Ca}(\text{OH})_2$ is transformed into an ionic reaction that can be completed instantaneously. The desulfurizing agent and recycled desulfurization ash undergo a second - step full reaction in the tower above the Venturi section, producing by - products such as $\text{CaSO}_3 \cdot 1/2\text{H}_2\text{O}$ and $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. The SO_2 content in the flue gas at the desulfurization tower inlet is about $1000\text{ mg}/\text{m}^3$. After being purified by the desulfurization tower, the SO_2 content in the flue gas can be reduced to below $200\text{ mg}/\text{m}^3$.

净化后的含尘烟气从吸收塔顶部侧向排出，然后转向进入旋转喷吹布袋除尘器，由于大量净化飞灰的循环，除尘器的入口烟气粉尘浓度高达 $600\sim 1100\text{g}/\text{m}^3$ ，经布袋除尘器后的烟气含尘浓度低于 $30\text{mg}/\text{m}^3$ 。再通过引风机排入烟囱。经除尘器捕集下来的固体颗粒，通过除尘器下的再循环系统，返回吸收塔继续参加反应，多余的少量脱硫灰渣通过仓泵输送至脱硫废灰库。

The purified dusty flue gas is discharged laterally from the top of the absorption tower, and then turns to enter the rotary blowing bag filter. Due to the circulation of a large amount of purified fly ash, the dust concentration of the flue gas at the inlet of the dust collector is as high as 600 to $1100\text{ g}/\text{m}^3$. After passing through the bag filter, the dust concentration of the flue gas is lower than $30\text{ mg}/\text{m}^3$. Then, it is discharged into the chimney through the induced draft fan. The solid particles captured by the dust collector are returned to the

absorption tower through the recirculation system below the dust collector to continue participating in the reaction. A small amount of excess desulfurization ash and slag is transported to the desulfurization waste ash storage through the bin pump.

清洁循环烟气烟道两端接口分别位于脱硫引风机出口烟道和脱硫塔进口烟道，利用引风机出口正压烟气与脱硫塔入口负压烟气之间的压差形成动力，无需额外增加动力设备即可实现清洁烟气的循环。满足脱硫系统烟气低负荷时的正常运行。清洁循环烟气量通过烟气再循环风挡的开度控制。

The interfaces at both ends of the clean circulating flue gas flue are respectively located in the flue at the outlet of the desulfurization induced draft fan and the flue at the inlet of the desulfurization tower. The pressure difference between the positive-pressure flue gas at the outlet of the induced draft fan and the negative-pressure flue gas at the inlet of the desulfurization tower is utilized to form the driving force, enabling the circulation of clean flue gas without the need to additionally install power equipment. This ensures the normal operation of the desulfurization system when the flue gas is under low load. The amount of clean circulating flue gas is controlled by adjusting the opening degree of the flue gas recirculation damper.

外购的 CaO 经罐车及压缩空气输送到 CaO 仓内。在 CaO 仓底部设置干式消化系统。消化后的 Ca(OH)_2 通过罗茨风机配套喷射器输送 Ca(OH)_2 缓存仓内。成品 Ca(OH)_2 可通过气力输送或罐车送至各脱硫装置的 Ca(OH)_2 仓，作为烟气脱硫剂使用。

The externally - purchased CaO is transported to the CaO storage bin by tank trucks and compressed air. A dry digestion system is set at the bottom of the CaO storage bin. The digested Ca(OH)_2 is transported to the Ca(OH)_2 buffer bin by an ejector equipped with a Roots blower. The finished Ca(OH)_2 can be sent to the Ca(OH)_2 storage bins of each desulfurization unit through pneumatic conveying or tank trucks for use as a flue gas desulfurizing agent.

干式消化系统采用卧式 3 轴搅拌干式消化器，消化温度保持在 100°C 以上。消化后的 Ca(OH)_2 ，含水率低于 1.5%，比表面积达 $15\text{m}^2/\text{g}$ 以上。

The dry digestion system adopts a horizontal three-axis stirring dry digester, and the digestion temperature is maintained above 100°C . The water content

of the digested $\text{Ca}(\text{OH})_2$ is lower than 1.5%, and its specific surface area reaches more than $15 \text{ m}^2/\text{g}$.

5.5.5 工艺特点 Process Characteristics

a) 脱硫塔为空塔结构，设置文丘里加速。吸塔内无可移动部件或支撑结构等；

The desulfurization tower has an empty tower structure and is equipped with a Venturi for acceleration. There are no movable components or supporting structures, etc. inside the absorption tower.

b) 脱硫塔入口段设置导流装置，使气流均匀经过吸收塔；

Flow guiding device is installed at the inlet section of the desulfurization tower to ensure that the gas flow passes through the absorption tower evenly.

c) 脱硫塔高径比大，气流和物料在塔内横截面的分布均匀；

The desulfurization tower has a large height-to-diameter ratio, and the distribution of the gas flow and materials on the cross-section inside the tower is uniform.

d) 烟气在塔内的接触反应时间不低于 6s，颗粒停留时间不低于 1 分钟；

The contact reaction time of the flue gas inside the tower is not less than 6 seconds, and the particle residence time is not less than 1 minute.

e) 适应含硫量的大范围波动。脱硫率最高宜到 97%；

It can adapt to a wide range of fluctuations in sulfur content. The highest desulfurization rate should preferably reach 97%.

f) 吸收塔选用的材料适合工艺过程的特性，能承受烟气飞灰和脱硫工艺固体悬浮物的磨损，文丘里主要部位材质为 16Mn；

The materials selected for the absorption tower are suitable for the characteristics of the process, and can withstand the abrasion of flue gas fly ash and solid suspended substances in the desulfurization process. The main part of the Venturi is made of 16Mn material.

g) 采用低压脉冲旋转喷吹袋式除尘器，本体阻力小，喷吹压力低，滤袋使用寿命长；

A low-pressure pulse rotary blowing bag filter is adopted, which has a small resistance of the main body, a low blowing pressure, and a long service life of the filter bags.

h) 除尘器脉冲清灰旋转臂可以自由转动，滤袋更换更便捷；

The pulse cleaning rotary arm of the dust collector can rotate freely, making the replacement of the filter bags more convenient.

i) 灰仓的底部锥体，船型灰斗底部以及物料输送斜槽内均布置流化板，设置流化装置，以避免下料及物料输送系统的堵塞；

Fluidization plates are arranged at the bottom cone of the ash hopper, the bottom of the boat-shaped ash hopper and inside the material conveying chute, and fluidization devices are installed to avoid blockages in the feeding and material conveying systems.

j) 每套脱硫装置设置 2 台引风机，单台风机额定风量按布袋除尘器运行出口的额定风量的 70%选型。所有引风机流量考虑 10%余量，全压考虑 20%余量；

Each set of desulfurization device is equipped with 2 induced draft fans. The rated air volume of a single fan is selected according to 70% of the rated air volume at the operating outlet of the bag filter. A 10% margin is considered for the flow rate of all induced draft fans, and a 20% margin is considered for the total pressure.

k) 消化器转化率 $\geq 98\%$ ， $\text{Ca}(\text{OH})_2$ 含水率 $\leq 1.5\%$ ，比表面积 $\geq 15\text{m}^2/\text{g}$ 。

The conversion rate of the digester is $\geq 98\%$, the water content of $\text{Ca}(\text{OH})_2$ is $\leq 1.5\%$, and the specific surface area is $\geq 15\text{ m}^2/\text{g}$.

5.5.6 主要设备 Key Equipment

表 5-20 主要设备表
Table 5-20 Table of key equipment

序号 No.	设备名称 Equipment Name	主要材质 Main Material	台数 Quantity
1	脱硫塔 DN5400 H=45m Desulfurization Tower	碳钢 Carbon Steel	6
2	旋转喷吹除尘器 F=12070 m ² Rotary Blowing Dust Collector	碳钢 Carbon Steel	6
3	烟气引风机 Q=255000 Nm ³ /h P=6720Pa Flue Gas Induced Draft Fan	碳钢 Carbon Steel	12
4	消石灰仓 VN=40 m ³ Slaked Lime Silo	碳钢 Carbon Steel	6
5	高压水泵 Q=30m ³ /h H=400m High-pressure Water Pump	碳钢 Carbon Steel	12
6	压力回流式喷枪 Q=20 m ³ /h Pressure Recirculation Spray Gun	不锈钢 Stainless Steel	6
7	生石灰仓 VN=110 m ³ Quicklime Silo	碳钢 Carbon Steel	2
8	消石灰缓冲仓 VN=80 m ³ Slaked Lime Buffer Silo	碳钢 Carbon Steel	2
9	灰库 VN=260 m ³	碳钢	2

序号 No.	设备名称 Equipment Name	主要材质 Main Material	台数 Quantity
	Ash Silo	Carbon Steel	
10	三级干式消化器 Q=5t/h Three-stage Dry Digester	碳钢/不锈钢 Carbon Steel/Stainless Steel	2

5.6 化验室 Laboratory

5.6.1 概述 Overview

本工程化验室分为中心试验室和余热利用系统化验室，设于同一个独立建筑物内。

The engineering laboratory is divided into central laboratory and waste heat utilization system laboratory, which are located in the same independent building.

该建筑应远离震源（与锻锤安全距离>50m；与空压站安全距离>100m；与冲击性金属切削机床安全距离>20m；与厂内铁路安全距离>100m）、电磁波源（与总变电所的安全距离>100m），且同现场联系方便。该建筑应设在厂区内风向频率最小的下风侧（以避免灰尘和烟雾的影响）、环境清洁卫生、噪音小的位置。建筑物的朝向应为南北向。

The building should be far away from the source (safe distance from the hammer >50m; Safe distance from air compressor station >100m; Safe distance from impact metal cutting machine >20m; Safe distance from the railway in the plant >100m), electromagnetic wave source (safe distance from the main substation >100m), and convenient contact with the site. The building should be located on the downwind side of the factory with the least wind frequency (to avoid the impact of dust and smoke), the environment is clean and sanitary, and the noise is low. The orientation of the building should be south to north.

建筑物采用内廊式，开间 3.6m、进深 6.0m、廊宽 2.4m、层高 4.2m。

The building adopts the inner gallery type, the opening space is 3.6m, the depth is 6.0m, the corridor width is 2.4m, and the height is 4.2m.

本工程化验室使用面积约为 584m²。

The laboratory area of this project is about 584m².

5.6.2 中心试验室 Central Laboratory

5.6.2.1 概述 Overview

中心试验室的主要任务是对备煤车间、炼焦车间设施和辅助生产设施的各种物料、半成品、成品进行质量检验，配合生产装置进行中间控制分析。以物理方法、化学分析等手段进行各种原料、产品的各项指标的鉴定。

The main task of the central laboratory is to conduct quality inspection of various materials, semi-finished products and finished products in the coal preparation workshop, coking workshop facilities and auxiliary production facilities, and conduct intermediate control analysis with the production equipment. Physical methods, chemical analysis and other means to identify various raw materials, products of various indicators.

5.6.2.2 中心试验室的组成 Composition of the Central Laboratory

中心试验室由煤焦工业分析室、煤质分析室、胶质层测定室、热反应性室、煤岩分析室、配电室、办公室、数据传输室、维修室、仓库等专业生产房间和辅助房间组成。

The central laboratory consists of coal coke industry analysis room, coal quality analysis room, gum layer determination room, thermal reactivity room, coal rock analysis room, power distribution room, office, data transmission room, maintenance room, warehouse and other professional production rooms and auxiliary rooms.

5.6.2.3 各室的基本任务及主要设备选择 Basic Tasks and Main Equipment Selection for Each Room

煤焦工业分析室：该专业分析室由灼烧室、天平室组成，负责测定煤和焦炭的灰分、挥发分、全水分、煤和焦的硫含量等分析项目。本分析室所占面积7.2m×6m。配置了电阻炉、定硫仪、工业分析仪、干燥箱、电子精密天平等设备。灼烧室为高温房间，室内配有轴流风扇，用于散热。天平室使用的感量为0.1mg的电子精密天平设置在该室内，避免了腐蚀性介质和粉尘对天平的侵蚀有利于天平的维护和保养，延长其使用寿命。灼烧室、天平室两个功能室配合完成煤和焦炭的工业分析。

Coal coke industry analysis room: This professional analysis room is composed of burning room and balance room, responsible for the determination

of ash, volatile, total moisture, sulfur content of coal and coke and other analysis items. The analysis room occupies an area of 7.2m×6m. Equipped with resistance furnace, sulfur meter, industrial analyzer, drying box, electronic precision sky leveling equipment. The burning room is a high temperature room equipped with an axial fan for heat dissipation. The electronic precision balance with a sensitivity of 0.1mg used in the balance room is set in the room, which avoids the erosion of corrosive media and dust on the balance and is conducive to the maintenance and maintenance of the balance and prolonging its service life. Two functional chambers, the burning chamber and the balance chamber, cooperate to complete the industrial analysis of coal and coke.

煤质分析室：负责粘结指数分析项目该室配备粘结指数测定仪、电阻炉等分析设备。本分析室所占面积 3.6m×6m。

Coal quality analysis room: responsible for adhesive index analysis project This room is equipped with adhesive index tester, resistance furnace and other analytical equipment. The analysis room occupies an area of 3.6m×6m.

热反应分析室：由热反应控制室和电炉室组成。用于测定焦炭的反应性和反应后强度。本分析室所占面积 7.2m×6m，中间由玻璃墙隔开。该室配有两台焦炭反应性和反应后强度测定仪。电炉室配置通风橱，将反应炉放置在通风橱内，用于散热。热反应控制室配有空调，以保持环境温度恒定使得仪器正常运转，设置二氧化碳、氮气钢瓶的储存室。

Thermal reaction analysis room: composed of thermal reaction control room and electric furnace room. Used to determine the reactivity and post-reaction strength of coke. The analysis room occupies an area of 7.2m×6m and is separated by a glass wall. The chamber is equipped with two coke reactivity and post-reaction strength gauges. The electric furnace room is equipped with a fume hood in which the reactor is placed for heat dissipation. The thermal reaction control room is equipped with air conditioning to maintain a constant ambient temperature for normal operation of the instrument, and storage rooms for carbon dioxide and nitrogen cylinders are set up.

胶质层测定室：该室负责测定煤试样的最大胶质层厚度（Y 值）、最终收缩度（X 值）和记录体积曲线类型等指标，借以评定煤的粘结性能。本分析室所占面积 3.6m×6m。配备带有程序控温自动记录仪的胶质层测定仪两台。

Gummy layer determination chamber: This chamber is responsible for determining the maximum gummy layer thickness (Y value), final shrinkage (X value) and recording the type of volume curve of the coal sample to assess the bonding property of the coal. The analysis room occupies an area of 3.6m×6m. It is equipped with two glue layer measuring instruments with automatic temperature programmed recorder.

煤岩分析室：主要测定煤岩组分，焦炭显微结构、镜质组反射率等指标。本功能室配有煤岩分析仪一套，本分析室所占面积 3.6m×6m。该室还配有空调，以保持环境温度恒定使得仪器正常运转。

Coal and rock analysis room: mainly to determine coal and rock components, coke microstructure, vitrinite reflectance and other indicators. This functional room is equipped with a set of coal and rock analyzer, the analysis room occupies an area of 3.6m×6m. The room is also equipped with air conditioning to keep the ambient temperature constant for the normal operation of the instruments.

维修室：该室配备电气、仪表和维护和修理的专业人员，进行日常例行的维护和检修工作。

Maintenance room: This room is equipped with electrical, instrumentation and maintenance and repair professionals to carry out routine maintenance and overhaul work.

仓库：该仓库主要存放日常生产中必备的各种样本、试剂、药品等；存放生产中正常消耗的原材料、器皿及备用的设备和仪器。

Warehouse: The warehouse mainly stores all kinds of samples, reagents and drugs necessary for daily production; Store raw materials, utensils and spare equipment and instruments normally consumed in production.

5.6.3 余热利用系统化验室 Waste heat utilization system laboratory

5.6.3.1 概述 Overview

本工程余热利用系统化验室的主要任务是余热利用系统的水、汽和汽轮发电站的润滑油等项目的分析化验。

The main task of the laboratory of the waste heat utilization system of this project is to analyze and test the water, steam and lubricating oil of the turbine power station of the waste heat utilization system.

5.6.3.2 余热利用系统化验室的组成 Composition of Laboratory of Waste Heat Utilization System

本化验室设水质分析室和油分析室，分析室所占面积均为7.2m×6m。

The laboratory consists of water quality analysis room and oil analysis room, the analysis room occupies an area of 7.2m×6m.

5.6.3.3 主要任务 Main Tasks

水质分析室主要任务是对余热利用系统的水、汽的化验，包括：pH值、硬度、电导率、SiO₂、铁离子、铜离子、氯离子、钠离子、溶解氧、磷酸根离子、TOCi、悬浮物、浊度、淤泥密度指数、游离余氯、锰、铝、COD、BOD、碱度、硫酸根离子、含油、蒸发残渣（溶解）、氨氮。

The main task of the water quality analysis room is to test the water and steam of the waste heat utilization system, including: pH, hardness, conductivity, SiO₂, iron ion, copper ion, chloride ion, sodium ion, dissolved oxygen, phosphate ion, TOCi, suspended matter, turbidity, silt density index, free residual chlorine, manganese, aluminum, COD, BOD, alkalinity, sulfate ion, oil content, evaporation residue (dissolved), ammonia nitrogen.

油分析室主要任务是对汽轮发电站润滑油的化验，包括：运动粘度、闪点、机械杂质、洁净度、酸值、液相锈蚀、破乳化度、水分、起泡沫试验、空气释放值、旋转氧弹值。

The main task of the oil analysis room is to test the lubricating oil of the steam turbine power station, including: kinematic viscosity, flash point, mechanical impurities, cleanliness, acid value, liquid phase rust, demulsification, moisture, foam test, air release value, rotary oxygen bomb value.

5.6.3.4 主要设备 Main Equipment

本化验室配置钠度计、便携式氢电导率、二氧化硅分析仪、铁含量分析仪、铜含量分析仪、水质硬度检测仪、溶解氧分析仪、氯离子分析仪、TOCi 分析仪、pH 分析仪、磷酸根测定仪、电导率仪、悬浮物测定仪、淤泥密度指数测定仪、余氯分析仪、锰分析仪、铝分析仪、COD 测定仪、BOD 测定仪、浊度分析仪、总碱度浓度检测仪、硫酸根离子测定仪、油含量测定仪、蒸发残渣(溶解)测定仪、氨氮测定仪、运动粘度测定仪、开口闪点测定仪、闭口闪点测定仪、机械杂

质测定仪、清洁度测定仪、酸值测定仪、液相锈蚀测定仪、破乳化度测定仪、水分测定仪、起泡沫试验测定仪、空气释放值测定仪、旋转氧弹值测定仪、电子精密天平、电子天平、箱式电阻炉、电热鼓风干燥箱、紫外可见分光光度计、比重计、磁力搅拌器、秒表、电热板、万用电炉、恒温水浴锅、生化培养箱、超纯水机、冰箱。

The laboratory is equipped with sodium meter, portable hydrogen conductivity, silica analyzer, iron analyzer, copper analyzer, water hardness tester, dissolved oxygen analyzer, chloride ion analyzer, TOCi analyzer, pH analyzer, phosphate meter, conductivity meter, suspended matter meter, silt density index meter, residual chlorine analyzer, manganese analyzer, aluminum analyzer COD tester, BOD tester, turbidity analyzer, total alkalinity concentration tester, sulfate ion tester, oil content tester, evaporation residue (dissolution) tester, ammonia nitrogen tester, kinematic viscosity tester, open flash point tester, closed flash point tester, mechanical impurity tester, cleanliness tester, acid value tester, liquid phase rust tester, breaking emulsification tester Degree tester, moisture tester, foam test tester, air release value tester, rotating oxygen bomb value tester, electronic precision balance, electronic balance, box-type resistance furnace, electric blast drying oven, UV-visible spectrophotometer, hydrometer, magnetic stirrer, stopwatch, electric heating plate, universal electric furnace, constant temperature water bath, biochemical incubator, ultra-pure water machine, refrigerator.

5.7 总图运输 General Drawing Transportation

5.7.1 平面布置 Plane Arrangement

本工程平面布置是按新建换热热回收焦炉为主体进行配套布置的。

The project layout is based on the new heat exchange and recovery coke oven as the main body to carry out supporting layout.

5.7.1.1 车间组成 Workshop Composition

本工程主要由生产设施, 辅助生产设施、生产管理和生活福利设施三部分组成。

The project is mainly composed of production facilities, auxiliary production facilities, production management and living welfare facilities.

a) 生产设施 Production facilities

备煤车间：露天煤场、预粉碎机室、配煤仓、粉碎机室、煤塔顶以及相应的

带式输送机通廊和转运站组成。

Coal preparation workshop: coal storage yard, Pre-pulverizer room , Coal blending bunker , pulverizer room, top of coal tower and the corresponding belt conveyor corridor and transfer station.

炼焦车间：换热热回收焦炉、煤塔、熄焦塔、粉焦沉淀池、干熄焦装置、迁车台、焦罐检修站、焦台、转运站、焦皮带机通廊、筛焦楼、贮焦场等组成。

Coke workshop: heat recovery stamping heat exchanger coke oven, coal tower, coke quenching tower, powder coke sedimentation tank, dry quenching coke device, transfer platform, coke can overhaul station, coke platform, transfer station, coke belt machine corridor, coke screening building, storage field.

b) 辅助生产设施 Auxiliary production facilities

汽轮发电站（含除氧给水泵站及发电电气室）、空冷岛、除盐水处理站、压缩空气氮气站、液氮气化站、生产消防给水泵站、132kV 开闭站、车间变电所、装煤除尘地面站、出焦除尘地面站、烟气脱硫装置、干熄焦电气室、干熄焦排焦除尘地面站、循环水泵站、机修间、备品备件库、汽车衡等组成。

Steam turbine power station (including deoxygenated water supply pump station and power generation electrical room), air cooling island, salt water removal station, compressed air nitrogen station, liquid nitrogen gasification station, production fire water supply pump station, 132kV switching station, workshop substation, coke oven loading and discharging dust removal ground Station, coke oven pusher dedusting ground station, Flue gas desulphurization unit, dry quenching integrated electric room, coke oven discharge dust removal ground station, flue gas dust removal ground station, coke oven loading and pushing coke dust removal ground station, dry quenching environmental dust removal ground station, Circulating water pumping station, machine repair room, spare parts warehouse, truck scale, etc.

c) 生产管理和生活福利设施 Production management and welfare facilities

综合办公楼、浴室、值班宿舍、中心化验室。

Complex office building, canteen, bathroom, shift dormitory, central laboratory.

5.7.1.2 平面布置原则 Plane Layout Rules

平面布置原则是在满足生产工艺要求的基础上,根据交通运输、消防、安全、卫生、综合管网及施工等要求,预留发展用地等要求进行平面布置。

The layout principle is based on the requirements of the production process, transportation, fire protection, safety, health, integrated pipe network and construction, and reserve development land.

本项目原料煤储区与成品焦炭储区布置由西至东布置在厂区北侧。一期焦炉区域布置在原料煤储区南侧。二期焦炉区域布置在成品焦炭储区南侧,一期焦炉区域东侧。三期焦炉区域布置在二期焦炉区域南侧。汽轮发电站、发电循环水泵站、除盐水处理站、生产消防给水泵站等设施布置在焦炉区域内。生产管理区及生活福利区布置在厂区南侧。

The raw coal storage area and finished coke storage area of the Project are arranged on the north side of the plant from west to east. The coke oven area of Phase I is arranged at the south side of the raw coal storage area. The second phase coke oven area is arranged on the south side of the finished coke storage area and the east side of the first phase coke oven area. The third phase coke oven area is arranged on the south side of the second phase coke oven area. Steam turbine power station, circulating water pump station for power generation, demineralized water station, production fire water supply pump station and other facilities are arranged in the coke oven area. The production management and living welfare area is arranged on the south side of the plant area.

工程总用地面积(一期、二期和三期)为 580000m²。

The total land area of the project (Phase I 、 Phase II& Phase III) is 580000 m²

详见平面布置图。

See the floor plan.

5.7.2 竖向布置及场地排雨水 Vertical Layout and Site Drainage

本工程厂区竖向暂按水平型平坡式考虑。

The vertical of the plant area of this project is temporarily considered as horizontal slope type.

场地雨水排除暂按暗管排水方式考虑,即场地和道路上雨水排入道路上的雨

水口，经雨水排水管道收集汇总后排出厂外。

The rainwater drainage of the site is temporarily considered as the dark pipe drainage method, that is, the rainwater on the site and the road is discharged into the rainwater outlet on the road, collected by the rainwater drainage pipe and then discharged.

5.7.3 工厂运输 Factory Transportation

5.7.3.1 运输方式的选择 Choice of Transportation Mode

本工程的原料煤及产品焦炭均采用道路运输方式运输至厂内外。

The raw material coal and the product coke of this project are transported to and from the plant by road transportation.

备品备件、化学试剂、除尘灰、工业垃圾以及生活办公用品等采用道路运输方式。

Spare parts, chemical reagents, dust dust, industrial waste and daily office supplies are transported by road.

厂内散装物料（原料煤、焦炭）主要采用皮带输送机运输，液态、气态物料采用管道运输。

Bulk materials (raw coal, coke) in the plant are mainly transported by belt conveyor, and liquid and gaseous materials are transported by pipeline.

5.7.3.2 道路运输 Road Transport

本工程原料煤、化学药剂、备品、备件的运入以及产品焦炭、除尘灰、工业垃圾的运出均采用道路运输方式。

The transportation of raw materials coal, chemicals, spare parts and spare parts as well as the transportation of product coke, dust dust and industrial waste are all carried by road.

考虑到生产、消防、检修等需要，厂内道路呈环形和尽头两种布置形式，根据道路用途和车流量的大小，设置道路。道路宽度为 12.0m、9.0m，在有物料装卸的灰仓等处，设置回车场。

Taking into account the needs of production, fire protection, maintenance, etc., the road in the factory is arranged in two forms of ring and end, and the road is set up according to the road use and the size of the traffic flow. The road yard is 12.0m、9.0m, and the return yard is set up in the ash bin where the material is loaded and unloaded.

为满足物料计量需要，在贮焦场北侧道路设置一汽车衡，负责产品焦炭等的称重计量，配备 SCS-100A 型汽车衡一台，并配备衡器计量人员 2 人。

In order to meet the needs of material measurement, a truck scale is set up on the road on the north side of the coke storage yard, which is responsible for the weighing and measuring of product coke, and is equipped with a SCS-100A truck scale and 2 weighing personnel.

本工程所需生产用车、行政福利用车均由建设单位统一考虑。

The production vehicles and administrative welfare vehicles required by this project shall be uniformly considered by the construction unit.

5.7.4 绿化 Afforest

根据生产和环境保护、管线、交通线路布置的技术要求，并考虑到适合该厂栽植的树种和花卉等因素，对厂区进行绿化，以达到改善工厂生产环境、减少污染、净化空气、美化厂容之目的。

According to the technical requirements of production and environmental protection, pipeline and traffic line layout, and taking into account the tree species and flowers suitable for the plant, the plant is greening to achieve the purpose of improving the factory production environment, reducing pollution, purifying the air and beautifying the factory appearance.

绿化用地率为 15%，总绿化面积为 72525m²。

The green land rate is 15%, and the total green area is 72525 m².

5.7.5 消防 Fire Protection

本工程不新建消防站，消防事宜由建设单位统一考虑。

This project does not build a new fire station, fire control matters by the construction unit unified consideration.

5.7.6 总图运输主要技术经济指标表 General Layout and Transport Main Technical and Economic Indicators Table

表 5-21 主要技术经济指标表
Table 5-21 Table of main technical and economic indicators

序号 No.	项目 Project	单位 Unit	数量 Number	备注 Remarks
1	工程用地面积 Project land area	m ²	580000	
2	道路及回车场面积 Road & Return yard area	m ²	66350	

序号 No.	项目 Project	单位 Unit	数量 Number	备注 Remarks
3	绿化用地率 Green land rate	%	15	
4	绿化用地面积 Green land area	m ²	72525	

5.8 给排水 Water Supply & Drainage

5.8.1 概述 Overview

本设计是为热回收焦炉及其配套装置的给排水设计。

This design is water supply and drainage design for heat coke oven and its supporting equipment.

给排水系统设有生产给水系统、消防给水系统、生活给水系统及循环水系统；生产排水系统、生活排水系统。

The water supply and drainage system shall be equipped with the production water supply system, fire fighting water supply system, domestic water supply system, circulating water system, production drainage system, domestic drainage system.

5.8.2 水源 Water Source

本工程生活给水由厂区现有生活给水系统供给；生产水、消防水水源水由厂区水源水系统供给；生产给水、消防给水由新建生产消防给水泵站供给，循环水由新建循环水泵站供给。

The domestic water is supplied by the existing water supply system in the plant area. The production water and fire water supply water sources are provided by the plant's water source system. Plant water and Fire fighting water is supplied by new construction of process & fire water pump station. Circulating water is supplied by new construction of circulating water pumping station.

生产水水质应满足《钢铁企业给水排水设计规范》中的生产水水质标准，生活水水质应满足中国现行的生活饮用水卫生标准。

The quality of production water should meet the water quality indicators of the current Chinese "Water Supply and Drainage Design Specifications for Iron and Steel Enterprises", and the quality of domestic water should meet the water quality indicators in the current Chinese "Sanitation Standards for Drinking

Water".

表 5-22 生产水水质标准
Table 5-22 Water quality standards for production water

序号 No.	指标 Indicators	单位 Unit	生产水 Produce water
1	pH	—	7~9
2	悬浮物 suspended materials	mg/L	≤10
3	全硬度 Full hardness	mg/L (CaCO ₃)	≤150
4	Ca 硬度 Ca hardness	mg/L (CaCO ₃)	≤100
5	M-碱度 M-alkalinity	mg/L (CaCO ₃)	≤110
6	氯离子 Chloride ion	mg/L (Cl ⁻)	≤220
7	硫酸根离子 Sulfate radical	mg/L (SO ₄ ²⁻)	≤80
8	全铁 Full iron	mg/L (Fe)	≤1
9	可溶性 SiO ₂ Soluble SiO ₂	mg/L (SiO ₂)	≤6
10	含油 Contains oil	mg/L	≤2
11	电导率 Conductivity	μs/cm	≤500
12	蒸发残渣（溶解）The residue of evaporation (dissolution)	mg/L	≤300
13	氨氮 Ammonia nitrogen	mg/L	≤10
14	CODcr	mg/L	—

表 5-23 生活水水质标准
Table 5-23 Standard for domestic water quality

指标 Indicators	限值 Limit
1.微生物指标 microbe indicator	
总大肠菌群(MPN/100mL 或 CFU/100mL) Total coliform	不得检出 Not be detected
耐热大肠菌群(MPN/100mL 或 CFU/100mL) Heat-resistant coliform bacteria	不得检出 Not be detected
大肠埃希氏菌(MPN/100mL 或 CFU/100mL) E. coli	不得检出 Not be detected
菌落总数(CFU/mL) Total number of colonies	100
2.毒理指标 Toxicological indicators	
砷(mg/L) Arsenic	0.01
镉(mg/L) Cadmium	0.005
铬（六价，mg/L） Chromium (hexavalent,mg/L)	0.05
铅(mg/L) plumbum	0.01
汞(mg/L) mercury	0.001
硒(mg/L) selenium	0.01
氰化物(mg/L) prussiate	0.05
氟化物(mg/L) fluoride	1.0
硝酸盐（N，mg/L） nitrate	10（地下水源限制时为 20 When the underground water source is limited is 20）
3.感官和一般化学指标 sensory and general chemical indicators	

指标 Indicators	限值 Limit
色度（铂钴色度单位）chroma (platinum cobalt chromaticity unit)	15
浑浊度（NTU-散射浊度单位）turbidity NTU (NTU -scattering turbidity unit)	1（水源和净水技术条件限制为 3 Technical conditions for water sources and water purification are limited to 3）
肉眼可见物 naked eye	无 No
臭和味 Odor and taste	无异臭、异味 No odor, odor
pH	≥6.5 且 and≤8.5
铝(mg/L) aluminum	0.2
铁(mg/L) iron	0.3
锰(mg/L) manganese	0.1
铜(mg/L) copper	1.0
锌(mg/L) zinc	1.0
硫酸盐(mg/L) sulfate	250
溶解性总固体(mg/L) Total dissolved solids	1000
挥发酚类(以苯酚计, mg/L) Volatile phenols (phenol, mg/L)	0.002
氯化物(mg/L) chloride	250
总硬度（CaCO ₃ , mg/L）total hardness	450
4.放射性指标 Radioactivity index	指导值 Guides values
总 α 放射性(Bq/L) total alpha radioactivity	0.5
总 β 放射性(Bq/L) total beta radioactivity	1

5.8.3 生产给水系统 Plant Water System

生产用水主要供湿熄焦用水、余热锅炉排污井降温用水、脱硫除尘装置用水、除盐水处理站生产用水、循环水补水，以及汽轮发电站循环水事故时使用。

Production water is mainly used for wet quenching coke water, blowdown pit cooling water for waste heat boiler, water for desulfurization & dust removal system, demineralized water station process water, circulating water replenishment, and steam turbine power station circulating water accident.

建设 100 万吨/年热回收焦炉，采用干熄焦为主，湿熄焦备用的熄焦方式。干熄焦时：生产新水总量为 136.70m³/h。其中：废气余热锅炉用水 4m³/h；除盐水处理站用水 41.7m³/h；循环水补水 42m³/h，干熄焦锅炉用水 1m³/h，脱硫除尘装置用水 48m³/h。湿熄焦时：生产新水总量为 248.50m³/h。其中：湿熄焦用水 113.3m³/h；废气余热锅炉用水 4m³/h；除盐水处理站用水 41.7m³/h；循环水补水 41.5m³/h，脱硫除尘装置用水 48m³/h。

Construction of 1000,000 t/a heat recovery coke oven, using dry quenching as primary method with wet quenching as backup for coke cooling. The total new water consumption: 136.70m³/h (CDQ operation). Waste heat recovery boiler feeding water: 4.0 m³/h; demineralized water (DM) plant consumption: 41.7 m³/h; circulating water system make-up: 42.0 m³/h; CDQ boiler feeding water: 1.0 m³/h; flue gas treatment system water: 48.0 m³/h. The total new water consumption: 248.50m³/h (wet quenching). Waste heat recovery boiler feeding water: 4.0 m³/h; demineralized water (DM) plant consumption: 41.7 m³/h; circulating water system make-up: 41.50 m³/h; flue gas treatment system water: 48.0 m³/h; wet quenching water: 113.3 m³/h.

建设 200 万吨/年热回收焦炉，采用全干熄，干熄焦检修时，湿熄焦备用。采用干熄焦时，生产新水总量为 273.4m³/h。其中：废气余热锅炉用水 8m³/h，除盐水处理站用水 83.4m³/h，干熄焦锅炉用水 2m³/h，循环水补水 84m³/h，脱硫除尘装置用水 96m³/h。

Construction of 2000,000 t/a heat recovery coke oven, using full dry quenching. When the CDQ is maintenance, use wet coke quenching in reserve. The total new water consumption: 273.4m³/h (CDQ operation). Waste heat recovery boiler feeding water: 8.0 m³/h; demineralized water (DM) plant consumption: 83.4 m³/h; CDQ boiler feeding water: 2.0 m³/h; circulating water system make-up: 84.0 m³/h; flue gas treatment system water: 96.0 m³/h.

采用湿熄焦时，生产新水总量为 342.7m³/h。其中：湿熄焦用水 113.3m³/h；废气余热锅炉用水 8m³/h；除盐水处理站用水 83.4m³/h；循环水补水 42m³/h，脱硫除尘装置用水 96m³/h。

The total new water consumption: 342.7m³/h (wet quenching). wet quenching water: 113.3 m³/h; waste heat recovery boiler feeding water: 8.0 m³/h; demineralized water (DM) plant consumption: 83.4 m³/h; circulating water system make-up: 42.0 m³/h; flue gas treatment system water: 96.0 m³/h.

生产给水泵 5 台，Q= 96~160~192m³/h，H= 55~50~46m，P=37kW，U=380V，n=2950r/min，IP54；

5 sets production water supply pump, Q=96~160~192m³/h, H= 55~50~46m, P=37kW, U=380V, n=2950r/min, IP54；

生产给水管道采用焊接钢管，埋地敷设，干管管径为 D108×4~D325×6，管

网设计压力为 1.0MPa。

Welded steel pipes are used for production water supply pipes and buried-pipe laying. The diameter of the main pipe is D108×4~D325×6, and the design pressure of the pipe is 1.0MPa.

5.8.4 消防给水系统 Fire Fighting Water System

本工程消防系统供室外消火栓及室内消火栓使用，消防总用水量为 30L/s。

The firefighting system serves outdoor fire hydrants and indoor fire hydrants, with a total fire water flow rate of 30 L/s.

室外设置消火栓，汽轮发电厂房内设置室内消火栓。消防给水管道接自新建消防给水泵站。

Fire hydrants are installed outdoors, and indoor fire hydrants are provided inside the turbine-generator building. The fire water supply pipeline is connected to the newly constructed fire pump station.

室外设地上式消火栓，消火栓沿道路边缘不大于 5 米敷设，室外消火栓间距不超过 120m，保证保护半径不大于 120m，火灾延续时间为 3h。

Above-ground fire hydrants are installed outdoors, and the fire hydrants should be laid along the edge of the road no more than 5 meters. The distance between outdoor fire hydrants should not exceed 120 m. On the premise of ensuring that the protection radius is no more than 120 m. The fire duration is 3h.

所有建筑物室内，均按中国标准配置灭火器。

All buildings equipped with fire extinguishers meeting Chinese regulatory requirements.

消防水泵有两条出水管与环状管网连接。两连接管之间设切断阀，当其中一条出水管检修时，另一条出水管仍能供应全部消防用水量。

The fire pump has two outlet pipes connected with the ring system. A cut-off valve is arranged between the two connecting pipes. When one outlet pipe is repaired, the other outlet pipe can still supply all the fire fighting water.

消防给水系统由消防水池、消防水泵、增压泵、稳压装置及消防管网等组成。火灾时压力开关及火灾报警控制器联合启动消防水泵。

The fire water supply system consists of fire pool, fire pump, booster pump, pressure-regulated and fire pipe network. In case of fire, the pressure switch

and the fire alarm controller jointly start the fire pump.

电动消防给水泵 2 台, 1 用 1 备, $Q=108\text{m}^3/\text{h}$, $H=63\text{m}$, $P=30\text{kW}$, $U=380\text{V}$, $n=2950\text{r}/\text{min}$, IP54;

2 sets electric fire feed pump, 1 open 1 ready, $Q=108\text{m}^3/\text{h}$, $H=63\text{m}$, $P=30\text{kW}$, $U=380\text{V}$, $n=2950\text{r}/\text{min}$, IP54;

增压水泵 2 台, 1 开 1 备, $Q=18\text{m}^3/\text{h}$, $H=80\text{m}$, $P=7.5\text{kW}$, $n=2900\text{r}/\text{min}$;

2 sets of booster pump, 1 open 1 ready, $Q=18\text{m}^3/\text{h}$, $H=80\text{m}$, $P=7.5\text{kW}$, $n=2900\text{r}/\text{min}$;

附稳压罐 1 个, $\phi \times H=1200 \times 2960\text{mm}$, $V_{\text{调节}}=450\text{L}$, 附 2 块电接点压力表 $P=0 \sim 1.6\text{MPa}$, 附安全阀 1 个;

1 set of attached pressure stabilizing tank, $\phi \times H=1200 \times 2960\text{mm}$, $V_{\text{Adjustment}}=450\text{L}$, 2 set of electric contact pressure gauges ($P=0 \sim 1.6\text{ mpa}$) and 1 safety valve are attached.

消防水池有效容积为 400m^3 。水池为地上布置, 尺寸为 $14.8 \times 14.8 \times 4\text{m}$ 。

The effective volume of the fire pool is 400m^3 . The pool is above ground, with a size of $14.8 \times 14.8 \times 4\text{m}$.

消防给水室外管道采用无缝钢管, 材质为 20, 埋地敷设, 管网为环状, 干管管径为 $D114.3 \times 4 \sim D273 \times 7$, 室内、外明装管道为热浸镀锌无缝钢管, 材质为 20, 管网设计压力为 1.6MPa 。

The fire water supply outdoor pipe adopts Seamless steel pipe, buried-pipe laying, pipe network is annular, main pipe diameter is $D114.3 \times 4 \sim D273 \times 7$, Indoor and outdoor open-mounted fire water pipes are made of hot-dip galvanized welded seamless steel pipes, 20 material, pipe network design pressure is 1.6MPa .

5.8.5 生活给水系统 Drinking Water System

本工程生活用水由厂区生活水管网供给, 生活用水主要供辅助生产及行政福利设施内卫生间及化验室等用户。生活日用水量为 $38.31\text{m}^3/\text{d}$, 最大时用水量为 $11.39\text{m}^3/\text{h}$, 供水压力 0.35MPa 。

The domestic water is supplied by the existing domestic water supply network. The domestic water is mainly used for auxiliary production and the users of toilets and laboratories in the administrative welfare facilities. The daily

water consumption is 38.31 m³/d, and the maximum is 11.39 m³/h. The water supply pressure is 0.35MPa

生活给水室外管道采用聚乙烯管，埋地敷设，干管管径为 dn63~dn110。室内采用聚丙烯管，管网设计压力为 1.0MPa。各生活水用户入口处设水表计量。

The outdoor domestic water pipe is polyethylene pipe, buried and laid, and the diameter of the dry pipe is dn63~dn110. Polypropylene tubes are used in the interior and the design pressure of pipe network is 1.0 MPa. Meters are installed at each domestic water user's entrance.

5.8.6 循环水系统 Recirculating Water system

循环水系统运行中，循环水中的盐分会不断的浓缩，为了维持系统的正常运行，系统需要进行排污。循环冷却水的浓缩倍数按 4 设计，水的重复利用率按 ≥98%设计。为保证循环水水质，防止设备、管道的结垢和腐蚀，系统还设有旁滤系统，旁滤设备的反洗水排入厂区生产排水管网。

During the operation of the circulating water system, the salt in the circulating water will continue to concentrate. In order to maintain the normal operation of the system, the system needs to carry blowdown. The concentration ratio of circulating cooling water is designed according to 5. The circulating cooling water system shall be designed with water reuse rate ≥ 98%. In order to ensure the quality of circulating water and prevent scaling and corrosion of equipment and pipelines, the system is also equipped with a side filter system, and the backwash water of the side filter equipment is discharged into the production drainage network of the plant.

建设 100 万吨/年热回收焦炉，采用干熄焦时，循环水总量为 2458m³/h。其中：汽轮发电站 2374m³/h，装煤除尘地面站 3 m³/h，出焦除尘地面站 3m³/h，筛焦楼除尘地面站 3m³/h，脱硫除尘装置 30 m³/h，干熄焦装置 25 m³/h，汽水在线监测 20 m³/h。

The total circulating water for the construction of 1000,000 t/a heat recovery coke oven is 2458m³/h, when the coke uses dry quenching. The steam turbine power station: 2374m³/h, coal loading dedusting ground station: 3 m³/h coke oven side dust removal ground station: 3 m³/h, coke screening dedusting ground station: 3m³/h ; flue gas treatment system water: 96.0 m³/h; CDQ 25 m³/h; online steam-water monitoring 20 m³/h.

建设 100 万吨/年热回收焦炉, 采用湿熄焦时, 循环水总量为 2413m³/h。其中: 汽轮发电站 2374m³/h, 装煤除尘地面站 3 m³/h, 出焦除尘地面站 3m³/h, 筛焦楼除尘地面站 3m³/h, 脱硫除尘装置 30 m³/h。

The total circulating water for the construction of 1000,000 t/a heat recovery coke oven is 2413m³/h, when the coke uses wet quenching. The steam turbine power station: 2374m³/h, coal loading dedusting ground station: 3 m³/h; coke oven side dust removal ground station: 3 m³/h, coke screening dedusting ground station: 3m³/h ; flue gas treatment system water: 30.0 m³/h.

建设 200 万吨/年热回收焦炉, 采用干熄焦时, 循环水总量为 4916m³/h。其中: 汽轮发电站 4748m³/h, 装煤除尘地面站 6m³/h, 出焦除尘地面站 6m³/h, 筛焦楼除尘地面站 6m³/h, 脱硫除尘装置 60m³/h, 干熄焦装置 50 m³/h, 汽水在线监测 40 m³/h。

The total circulating water for the construction of 2000,000 t/a heat recovery coke oven is 4916m³/h, when the coke uses dry quenching. The steam turbine power station: 4748m³/h, coal loading dedusting ground station: 6 m³/h coke oven side dust removal ground station: 6 m³/h, coke screening dedusting ground station: 6m³/h ; flue gas treatment system water: 60.0 m³/h; CDQ 50 m³/h; online steam-water monitoring 40 m³/h.

建设 200 万吨/年热回收焦炉, 采用湿熄焦时, 循环水总量为 4826m³/h。其中: 汽轮发电站 4748m³/h, 装煤除尘地面站 6m³/h, 出焦除尘地面站 6m³/h, 筛焦楼除尘地面站 6m³/h, 脱硫除尘装置 60m³/h。

The total circulating water for the construction of 2000,000 t/a heat recovery coke oven is 4916m³/h, when the coke uses wet quenching. The steam turbine power station: 4748m³/h, coal loading dedusting ground station: 6 m³/h; coke oven side dust removal ground station: 6 m³/h, coke screening dedusting ground station: 6m³/h ; flue gas treatment system water: 60.0 m³/h.

建设 300 万吨/年热回收焦炉, 采用干熄焦时, 循环水总量为 7374m³/h。其中: 汽轮发电站 7122m³/h, 装煤除尘地面站 9m³/h, 出焦除尘地面站 9m³/h, 筛焦楼除尘地面站 9m³/h, 脱硫除尘装置 90m³/h, 干熄焦装置 75 m³/h, 汽水在线监测 60 m³/h。

The total circulating water for the construction of 3000,000 t/a heat recovery coke oven is 7374m³/h, when the coke uses dry quenching. The steam

turbine power station: 7122m³/h, coal loading dedusting ground station: 9 m³/h
coke oven side dust removal ground station: 9 m³/h, coke screening dedusting
ground station: 9m³/h ; flue gas treatment system water: 90.0 m³/h; CDQ 75
m³/h; online steam-water monitoring 60 m³/h.

建设 300 万吨/年热回收焦炉, 采用湿熄焦时, 循环水总量为 7239m³/h。其
中: 汽轮发电站 7122m³/h, 装煤除尘地面站 9m³/h, 出焦除尘地面站 9m³/h, 筛
焦楼除尘地面站 9m³/h, 脱硫除尘装置 90m³/h。

The total circulating water for the construction of 3000,000 t/a heat
recovery coke oven is 7239m³/h, when the coke uses wet quenching. The
steam turbine power station: 7122m³/h, coal loading dedusting ground station:
9 m³/h; coke oven side dust removal ground station: 9 m³/h, coke screening
dedusting ground station: 9m³/h ; flue gas treatment system water: 90.0 m³/h.

循环水系统由冷却塔、循环水泵、旁滤装置、水质稳定加药装置及循环水管
道等组成。循环水回水, 热季靠余压进入冷却塔进行降温冷却, 冷却后水进入吸
水井, 冷季循环水直接进入吸水井, 再由循环水泵加压供各装置循环使用。

Circulating water system consists of cooling tower, circulating water pump,
filter device, water quality stability dosing device and circulating water pipeline.
Circulating return water use residual pressure enter the water cooling tower to
cool down in hot season, the water shall enter the suction well after cooling.
The circulating return water enter the suction well in cold season Then it is
pressurized by circulating water pump for recycling of each device.

本工程一期、二期、三期分别建设地面式循环水泵站, 1 台 2500m³/h 钢筋
混凝土逆流式机械通风冷却塔, 循环水泵、全自动过滤器露天布置并设置防雨棚,
加药设备布置在加药间内。

The project's three phases include identical configurations: ground-level
pump stations, 2,500 m³/h mechanical draft cooling towers (counterflow,
reinforced concrete), and outdoor pump/filter arrays protected by rain shelters.
Chemical dosing systems are enclosed within indoor facilities.

系统中蒸发、风吹、泄漏等损失的水量, 根据循环水池水位自动补充, 100
万吨/年热回收焦炉干熄焦时补水量为 41.5m³/h, 湿熄焦时补水量为 42m³/h;
200 万吨/年热回收焦炉干熄焦时补水量为 83m³/h, 湿熄焦时补水量为 84m³/h;
300 万吨/年热回收焦炉干熄焦时补水量为 124.5m³/h, 湿熄焦时最大补水量为

126m³/h;。

The water lost by evaporation, wind blowing and leakage in the system is automatically replenished according to the water level of the circulating pool. The replenishment water of 1000,000 t/a heat recovery coke oven is 42m³/h, when the coke uses dry quenching. When the coke uses wet quenching, the make up water is 41.5 m³/h. The water supply of 2000,000 t/a heat recovery coke oven is 83m³/h during dry quenching and 84m³/h during wet quenching. The water supply of 3000,000 t/a heat recovery coke oven is 124.5m³/h during dry quenching and 126m³/h during wet quenching.

循环水设旁滤系统，1 台全自动浅层过滤器，过滤水量 100m³/h，利用循环水给水压力进入过滤器，旁滤水量为循环水量的 4.2%。

The circulating water is equipped with a side filter system, 1 automatic shallow filter, the filter water is 100m³/h. The circulating water supply pressure is used to enter the filter, and the side filter water volume is 4.2% of the circulating water volume.

利用循环水作为除尘加湿卸灰机用水，减少循环水排污，节约用水。

Circulating water is used for dedusting and humidification to reduce the sewage of circulating water.

每期汽轮发电循环水泵站设置汽轮发电循环水泵共 3 台，2 用 1 备。Q=1000~1300~1600m³/h，H=27m，P=132kW，n=1480r/min，IP54。

Each phase of the turbine-generator circulating water pump station is equipped with a total of 3 circulating water pumps for the turbine generator system. open 1 ready 1; Q=1000~1300~1600m³/h，H=28m，P=55kW，n=2960r/min，IP54.

全自动浅层过滤器 1 台，过滤器流量 Q=100m³/h。

1 sets of automatic shallow filter, each filter flow is 100m³/h.

逆流式钢筋混凝土机械抽风冷却塔 1 台，轴流风机 Q=20×10⁵m³/h，户外电机 P=132kW，防护等级 IP54。

1 set of reinforced concrete mechanical draught cooling tower, axial fan Q=20×10⁵m³/h, outdoor motor P=132kW, protection level IP54.

一期、二期、三期分别设置 1 套全自动投药装置，计量泵 2 台，P=0.55kW/台，搅拌机 2 台，P=0.55kW/台，溶药罐 2 个，φ=1000mm。

Each phase shares a set of automatic dosing devices, 2 metering pumps, $P=0.55\text{kW/ set}$, 2 mixers, $P=0.55\text{kW/ set}$, 2 dissolving tanks, $\phi=1000\text{mm}$.

汽轮发电循环水给水管道及回水管道采用碳钢材质，焊接钢管，埋地敷设，干管管径为 $D159\times 4.5\sim D720\times 8$ ，管网设计压力为 1.0MPa 。

The circulating water supply pipe and return water pipe of steam turbine power generation are made of carbon steel, welded steel pipe, buried and laid. The diameter of the main pipe is $D159\times 4.5\sim D720\times 8$, and the design pressure of the pipe network is 1.0MPa .

5.8.7 排水系统 Drainage system

5.8.7.1 概述 Overview

排水系统包括生产排水系统、生活排水系统，采用清污分流制，生产排水系统就近排入厂区外部生产排水系统中。生活污水排入厂区生活排水系统。

Drainage system includes production drainage system, and domestic drainage system, using the sewage separation system. The production drainage system is discharged into the nearby production drainage system outside the factory. Domestic sewage is discharged into the domestic drainage system of the factory.

5.8.7.2 生产排水系统 Production Drainage System

生产排水系统由排水管道、排水检查井等组成，主要收集焦炉及其配套装置区排出的地坪冲洗水、除盐车站、循环水排污等排水。

The production drainage system is composed of drainage pipes, drainage inspection wells, etc. It mainly collects the floor flushing water, circulating water drainage sewage, demineralized water station discharged from the coke oven unit area.

每期生产排水量约 $29\text{m}^3/\text{h}$ ，其中：废气余热锅炉 $8\text{m}^3/\text{h}$ ，干熄焦锅炉 $2\text{m}^3/\text{h}$ ，除盐车站排水 $13\text{m}^3/\text{h}$ （间断），循环水排污水 $6\text{m}^3/\text{h}$ 。生产排水污染物主要为 COD_{Cr} 、 SS ， COD_{Cr} 浓度 $\leq 80\text{mg/L}$ 、 SS 浓度 $\leq 50\text{mg/L}$ ，水质除水温略有升高外，污染物含量较低，满足《炼焦化学工业污染物排放标准》表 2 中的排放标准要求，排入厂区外部生产排水系统中。

The production displacement is about $29\text{m}^3/\text{h}$, including: waste heat recovery boiler feeding water $8\text{m}^3/\text{h}$, CDQ boiler $2\text{m}^3/\text{h}$, debrine station drainage $13\text{m}^3/\text{h}$ (intermittent), circulating water drainage $6\text{m}^3/\text{h}$. Production

drainage pollutants are mainly COD_{Cr} and SS, COD_{Cr} concentration $\leq 80\text{mg/L}$, SS concentration $\leq 50\text{mg/L}$, water quality in addition to slightly increased water temperature, the content of pollutants is low. It meet the discharge standards in Table 2 of the 'Pollutant Discharge Standards for Coking Chemical Industry', discharged into the production drainage system outside the plant.

排水管道: Drainage pipe

室内排水管道: 采用 PVC-U 排水塑料管, 干管管径为 dn75~De160;

Indoor drainage pipe: PVC-U drainage plastic pipe, main pipe diameter is dn75~De160.

室外排水管道: 采用 Q235B 钢管的, 干管管径为 DN50~DN300, 焊接连接。

Outdoor drainage pipe: use Q235B drainage welded joint steel pipe, the diameter of the main pipe is DN50~DN300.

室外排水管道: 排水管道采用 SN8 缠绕结构壁塑料管的, 干管管径为 DN/ID300~DN/ID400, 电熔焊接连接。

Outdoor drainage pipe: the drainage pipe adopts SN8 winding structural wall plastic pipe, and the diameter of the main pipe is DN/ID300~DN/ID400, electric fusion welding connection.

排水检查井间距 $\geq 40\text{m}$, 排水管道基础采用砂垫层。

The distance between the drainage inspection wells less than 40m, and the sand cushion layer is used as the foundation of the drainage pipeline.

5.8.7.3 生活排水系统 Domestic Sewage Drainage System

生活排水系统由排水管道、排水检查井、化粪池等组成, 主要收集卫生间排水等污水。

The domestic sewage drainage system consists of drainage pipes, drainage inspection wells, septic tanks, etc., and mainly collects sewage such as toilet drainage.

生活排水主要是卫生间等排水, 生活排水量: 一期昼夜 $19.58\text{m}^3/\text{d}$ 、最大时为 $5.82\text{m}^3/\text{h}$; 一、二期昼夜 $21.23\text{m}^3/\text{d}$ 、最大时为 $6.34\text{m}^3/\text{h}$; 一、二、三期昼夜 $32.56\text{m}^3/\text{d}$ 、最大时为 $9.68\text{m}^3/\text{h}$; 其污染物主要含 COD_{Cr}、BOD₅、SS、NH₃-N 等。生活污水经化粪池处理后进入厂区生活排水系统。

The domestic sewage is mainly the drainage of toilets, etc. The drainage volume of domestic sewage is $19.58\text{m}^3/\text{d}$, and the maximum is $5.82\text{m}^3/\text{h}$ on phase I. The drainage volume of domestic sewage is $21.23\text{m}^3/\text{d}$, and the maximum is $6.34\text{m}^3/\text{h}$ on phase II. The drainage volume of domestic sewage is $32.56\text{m}^3/\text{d}$, and the maximum is $9.68\text{m}^3/\text{h}$ on phase III. The pollutants mainly include COD_{Cr}, BOD₅, SS, NH₃-N and so on. Domestic sewage is discharged into the domestic drainage system of the factory after being treated in the septic tank.

排水管道: Drainage pipe

室内排水管道: 采用 PVC-U 排水塑料管, 干管管径为 dn75~dn160。

Indoor drainage pipe: used PVC-U drainage plastic pipe, and the diameter of the main pipe is dn75~dn160.

室外排水管道: 排水管道采用 SN8 缠绕结构壁塑料管, 干管管径为 DN/ID300, 电熔焊接连接。

Outdoor drainage pipe: the drainage pipe adopts SN8 winding structural wall plastic pipe, and the diameter of the main pipe is DN/ID300, electric fusion welding connection.

排水检查井间距 $\geq 40\text{m}$, 排水管道基础采用砂垫层。

The distance between the drainage inspection wells less than 40m, and the sand cushion layer is used as the foundation of the drainage pipeline.

5.8.7.4 生活污水处理装置 Domestic Sewage Treatment Equipment

一体化生活污水处理装置设计规模按 $20\text{m}^3/\text{d}$ 设计, 主要处理经化粪池处理后的卫生间粪便污水。

The design scale of the integrated domestic sewage treatment device is designed according to $20\text{m}^3/\text{d}$, which mainly treats the fecal sewage of the toilet after being treated by the septic tank.

一体化生活污水处理装置工艺流程: 经化粪池处理后的卫生间粪便污水进入机械格栅去除污水中大的杂物, 机械格栅置于格栅池中。

Integrated domestic sewage treatment device process flow: After septic tank treatment of toilet feces into the mechanical grille to remove large debris in the sewage, the mechanical grille is placed in the grille pool.

生活污水具有水质、水量波动性大的特点, 微生物的生长和新陈代谢需要在

相对稳定的环境中才能正常进行，使有机污染物得到降解，因此设置调节池，保证进入后续生化系统的污水水质、水量变化不会太大，同时使污水中部分较大的颗粒物沉淀，减小后续工艺处理负荷，确保生化系统正常运行。调节池设有提升泵，根据污水产量分别向污水处理系统供水。

Domestic wastewater exhibits significant fluctuations in both water quality and quantity. Microbial growth and metabolism require a relatively stable environment to effectively degrade organic pollutants. Therefore, an equalization tank is implemented to ensure minimal variations in the water quality and quantity entering the subsequent biological treatment system, while also facilitating the settling of larger particles within the wastewater. This process reduces the burden on subsequent treatment processes and safeguards the proper functioning of the biological treatment system. The equalization tank is equipped with a pump that delivers water to the wastewater treatment system based on production levels.

A/O 型生物接触氧化工艺中的缺氧池污水经过异养细菌的作用，去除部分污染物，提高了污水的可生化性。同时，从后续 MBR 池引入的回流污泥也在此进行反硝化作用。污水经过缺氧池后，BOD、COD、SS 等各项指标具有明显的降低，减小了后续处理工艺的处理负荷。

In the A/O type biological contact oxidation process, hypoxic pool sewage is treated by heterotrophic bacteria to remove some pollutants and improve the biodegradability of sewage. At the same time, the return sludge introduced from the subsequent MBR tank is also denitrified here. After the wastewater passes through the anoxic tank, the indexes of BOD, COD, SS and so on are significantly reduced, which reduces the processing load of the subsequent treatment process.

缺氧池出水自流入好氧池。本池是利用自养型好氧微生物进行生化处理的构筑物，功能是对污水中含碳有机物进行降解和对污水中的氨氮进行硝化。

The effluent from the anoxic tank flows into the aerobic tank. This tank is a structure that uses autotrophic aerobic microorganisms for biochemical treatment, and its function is to degrade carbon-containing organic matter in sewage and nitrate ammonia nitrogen in sewage.

好氧池出水自流进入 MBR 池，MBR 池内放置有 MBR 膜组件，组件下部设

有曝气系统, 组件的微滤膜孔径小于 $0.1\mu\text{m}$, 污泥被截留在 MBR 池中, 池中溶解氧大于 3.0mg/L , 污泥浓度高达 $8000\text{mg/L}\sim 12000\text{mg/L}$, 污泥负荷较低, 容积负荷高, 通过活性污泥的生化作用进一步去除污水中的有机污染物, 且实现氮的硝化。抽吸泵受 MBR 池中液位计的控制, 高液位工作, 低液位停止, 从 MBR 池中间断地将净水从 MBR 池中抽出, 进入清水池, 出水采用次氯酸钠消毒设备消毒处理达标后排至生活污水应急缓冲池。

The effluent from the aerobic tank flows into the MBR tank, MBR membrane component is placed in the MBR tank, and the aeration system is arranged at the lower part of the component. The microfiltration membrane aperture of the component is less than $0.1\mu\text{m}$. The sludge is trapped in the MBR tank, the dissolved oxygen in the tank is greater than 3.0mg/L , the sludge concentration is as high as $8000\text{mg/L}\sim 12000\text{mg/L}$, and the sludge load is low. The volume load is high, organic pollutants in sewage are further removed by biochemical action of activated sludge, and nitrogen nitrification is realized. The suction pump is controlled by the liquid level meter in the MBR pool, the high level works, and the low level stops. The clean water is extracted from the MBR pool intermittently and enters the clear pool. The effluent is disinfected with sodium hypochlorite disinfection equipment and then sent to the emergency buffer pool of domestic sewage.

MBR 池中多余的污泥定时由泵提升到污泥池, 污泥在该池内进行好氧消化, 上清液回流至调节池进行再处理。本工艺剩余污泥很少, 定期由污泥泵提升至污泥池, 经浓缩后在厂区回用。

The excess sludge in the MBR tank is regularly lifted by the pump to the sludge tank, where the sludge is aerobic digested, and the supernatant is returned to the conditioning tank for reprocessing. The residual sludge in this process is very small, which is regularly raised from the sludge pump to the sludge tank, and then reused in the factory after concentration.

MBR 膜在长期运行后, 会受到某些难以冲洗掉的污染, 因此必须使用化学药剂进行清洗, 以恢复正常的处理能力。

After long-term operation, the MBR membrane will be contaminated by some difficult to wash off, so it must be cleaned with chemical agents to restore normal processing capacity.

本工艺采用次氯酸钠消毒设备消毒后出水达到《城镇污水处理厂污染物排放标准》一级 A 标准，排至生活污水应急缓冲池。应急缓冲池出水排入厂外生产排水系统。

The process uses sodium hypochlorite disinfection equipment to disinfect the effluent to meet the "Pollutant Discharge Standards for Urban Sewage Treatment Plants" Grade A standard, and discharge it to the domestic sewage emergency buffer pool. The emergency buffer pool water is discharged into the off-site production drainage system.

5.8.7.5 雨水排水系统 Storm Water Drainage System

雨水排水系统由雨水排水管道、雨水算井及雨水检查井等组成，主要收集雨水排水。雨水排水的按当地暴雨强度公式计算。

The rainwater drainage system consists of rainwater drainage pipes, rainwater grates and rainwater inspection Wells, which mainly collect rainwater drainage. Rainwater drainage is calculated according to the local rainstorm intensity formula.

排水管道：Drainage pipe

室外排水管道：排水管道采用 SN8 缠绕结构壁塑料管，干管管径为 DN/ID300。

Outdoor drainage pipe: the drainage pipe adopts SN8 winding structural wall plastic pipe, and the diameter of the main pipe is DN/ID300.

排水检查井间距 \geq 40m，排水管道基础采用砂垫层。

The distance between the drainage inspection wells less than 40m, and the sand cushion layer is used as the foundation of the drainage pipeline.

5.9 通风、除尘 Ventilation, Dust Removal

5.9.1 概述 Overview

为排出生产车间内的放散热，保证车间内空气流通，设计采用自然通风、机械通风等措施；对含爆炸危险气体及粉尘的部分生产车间，设计采用事故通风，经通风换气，降低了室内有害气体浓度，改善了操作区的环境。

To eliminate heat dissipation in the production workshop and ensure air circulation, measures such as natural ventilation and mechanical ventilation are designed; For some production workshops containing explosive gases and dust,

accident ventilation is designed to reduce the concentration of harmful gases indoors and improve the environment in the operating area through ventilation and air exchange.

煤在破碎、粉碎过程中散发出大量的煤粉尘；焦炉在装煤、出焦过程中散发出大量的烟尘；干熄炉装焦、排焦过程中散发出大量的烟尘；对主要产尘点进行除尘净化，净化后的烟气经烟囱排入大气。

Coal emits a large amount of coal dust during the process of crushing and crushing; Coke ovens emit a large amount of smoke and dust during the process of coal loading and discharging; A large amount of smoke and dust is emitted during the coke loading and discharging process of the dry quenching furnace; Dust removal and purification are carried out on the main dust producing points, and the purified flue gas is discharged into the atmosphere through the chimney.

表 5-24 排放指标 (mg/m³)
Table 5-24 Emission allowance (mg/m³)

扬尘场所名称 Name	颗粒物 PM (mg/m ³)	SO ₂ (mg/m ³)	基准氧含量 (%)Reference oxygen content (%)
装煤除尘地面站 Coal loading and dust removal ground station	≤30	-	-
出焦除尘地面站 Coke and dust removal ground station	≤30	-	-
干熄焦环境除尘地面站 CDQ dust removal ground station	≤30	≤200	-
预粉碎机室除尘地面站 Pre-Crushing Room Dust Removal Ground Station	≤30	-	-
粉碎机室除尘地面站 Crushing Room Dust Removal Ground Station	≤30	-	-
筛焦楼除尘地面站（含 C103、C104 转运站）Coke Screening Building Dust Removal Ground Station (including C103 & C104 Transfer Stations)	≤30	-	-
焦转运站除尘地面站 Coke Transfer Station Dust Removal Ground Station	≤30	-	-

5.9.2 通风、空调 Ventilation and Air Conditioning

- a) 备煤车间煤塔等处设置风帽，充分利用有组织的通风来排除余热、余湿。改善工作区的劳动卫生条件；The coal tower of the coal preparation workshop is equipped with a cowl to make full use of organized natural ventilation to remove waste heat and humidity, and improving

occupational health conditions in the workplace;

- b) 干熄炉排焦地下室设置事故通风，以排除余热及 CO、CO₂、N₂ 等有害气体，改善维修人员操作环境。机械排风系统与 O₂ 和 CO 检测仪表连锁，当地下室 CO 浓度超过安全数值或 O₂ 浓度低于安全数值时事故排风系统会联锁启动；Emergency ventilation is set up in the coke exhaust basement of CDQ to remove waste heat and harmful gases such as CO, CO₂, N₂, and improve the operating environment of maintenance personnel. The mechanical ventilation system is interlocked with the O₂ and CO detection instruments. When the CO concentration in the basement exceeds the safe value or the O₂ concentration is lower than the safe value, the emergency ventilation system will be interlocked and started;
- c) 公辅设施厂房设置轴流风机进行机械通风以排除余热、余湿及有害气体；The factory of public and auxiliary facilities is equipped with axial fan for mechanical ventilation to remove waste heat, humidity and harmful gases;
- d) 各高低压配电室设置风冷柜式空调机，以保证仪表设备正常运行，变频器室设工业风冷空调；电容器室设置轴流风机进行有组织全面排风，并兼事故通风；Each high and low voltage distribution room is equipped with air conditioners to ensure the normal operation of instrument equipment, and the inverter room is equipped with industrial air-cooled air conditioning; The frequency converter room is equipped with axial fan for organized and comprehensive exhaust and emergency ventilation;
- e) 属于防爆区的场所均采用防爆型通风设备；Explosion-proof ventilation equipment is used in all places belonging to the explosion-proof zone;
- f) 值班室、操作室、休息室、办公室、会议室，设置风冷壁挂空调机、柜式空调机，用于防暑降温。Duty rooms, operation rooms, rest rooms, offices and meeting rooms are equipped with wall hanging air conditioner and cabinet air conditioner for heat prevention and cooling.

5.9.3 除尘 Dust Removal

本工程除尘设计按工艺工段、物料及生产过程的不同，划分为下表中多套除

尘系统，对各处产生尘点进行粉尘外逸的控制。

The dust removal design of this project is divided into multiple sets of dust removal systems in the following table according to different process sections, materials and production processes to control dust escape at various dust producing points.

除尘系统的设计参数详见下表：

The design parameters of the dust removal systems are detailed in the table below:

表 5-25 各除尘系统设计参数
Table 5-25 Design parameters of the dust removal systems

序号 No.	名称 Name	风量 Air volume (m ³ /h)	过滤面 积 Filter area (m ²)	主电机功 率 Main motor power (kW)	排放口直径 Diameter of discharge (mm)	排放口高 度 Height of discharge outlet (m)	粉尘处理 Dust process	套数 Qua ntity
1	装煤除尘地 面站 Coal loading and dust removal ground station	120000 (80°C)	2316	315	1700	30	加湿搅拌 wetting and stirring	3
2	出焦除尘地 面站 Coke and dust removal ground station	385000 (80°C)	7720	1000	2800	30	加湿搅拌 wetting and stirring	3
3	干熄焦环境 除尘地面站 CDQ dust removal ground station	140000 (110°C)	3088	355	1700	30	加湿搅拌 wetting and stirring	3
4	预粉碎机室 除尘地面站 Pre- Crushing Room Dust Removal Ground Station	73600 (常温)	1544	185	1200	30	返回工艺 皮带 return to the process belt	1
5	粉碎机室除 尘地面站 Crushing Room Dust Removal Ground Station	78000 (常温)	1544	185	1200	30	返回工艺 皮带 return to the process belt	1
6	筛焦楼除尘 地面站（含 C103、C104 转运站） Coke Screening Building	255200 (常温)	6176	630	2200	30	加湿搅拌 wetting and stirring	1

序号 No.	名称 Name	风量 Air volume (m³/h)	过滤面 积 Filter area (m²)	主电机功 率 Main motor power (kW)	排放口直径 Diameter of discharge (mm)	排放口高 度 Height of discharge outlet (m)	粉尘处理 Dust process	套数 Qua ntity
	Dust Removal Ground Station (including C103 & C104 Transfer Stations)							
7	C101/C102/C301 焦转运站除尘地面站 C101/C102/C301 Coke Transfer Station Dust Removal Ground Station	26400 (常温)	579	55	720	25	-	3
8	C302、C303 焦转运站除尘地面站 (C302 & C303 Coke Transfer Station Dust Removal Ground Station)	52800 (常温)	1158	132	1200	30	加湿搅拌 wetting and stirring	1
4	一、二次除尘粉收集贮存系统 Primary and secondary dust powder collecting storage and transportation system	-	-	-	-	-	加湿搅拌 wetting and stirring	3

5.9.3.1 备煤系统除尘 Dust Removal in Coal Preparation System

a) 预粉碎机室除尘系统 Pre-Crushing Room Dust Removal System

煤在预粉碎过程中，会有大量的粉尘外逸，严重污染环境。为保护环境及工人的身体健康，设计一套预粉碎机室除尘系统。

During the pre-crushing process of coal, a significant amount of dust is released, severely polluting the environment. To protect the environment and workers' health, a dedicated dust removal system is designed for the pre-crushing room.

预粉碎机室除尘系统采用平铺式布置，风机恒速运行。

The pre-crushing room dust removal system adopts a flat-deck layout with constant-speed operation of the fan.

本除尘系统负责对预粉碎机室的粉碎机给料溜槽、带式输送机头部及落料点处各扬尘点除尘。由于存在有些工艺设备不同时工作的可能，在对应工艺设备除尘管道上设置电动阀门，此阀门与相应的工艺设备联锁。

This system is responsible for capturing dust from the crusher feed chute, belt conveyor head, and discharge points within the pre-crushing room. Since some process equipment may not operate simultaneously, electric valves are installed on the corresponding dust removal pipelines. These valves are interlocked with the associated process equipment.

预粉碎机室各点的尘气经除尘罩捕集后，进入脉冲袋式除尘器净化。除尘器采用在线脉冲清灰方式，除尘器滤料采用覆膜防静电材质，风机采用防爆型。净化后的气体经风机及排气筒排至大气。脉冲袋式除尘器收集的粉尘返回工艺皮带。

Dust-laden air from all collection points in the pre-crushing room is captured by dust hoods and directed to a pulse bag filter for purification. The filter employs an online pulse cleaning method, with anti-static membrane-coated filter material, and the fan is explosion-proof. Purified gas is discharged into the atmosphere through the fan and exhaust stack. Collected dust from the pulse bag filter is returned to the process belt for reuse.

b) 粉碎机室除尘系统 Crushing Room Dust Removal System

煤在粉碎过程中，会有大量的粉尘外逸，严重污染环境。为保护环境及工人的身体健康，设计一套粉碎除尘系统。

During the coal crushing process, substantial dust emissions occur, causing severe environmental pollution. To mitigate this and safeguard workers, a dedicated dust removal system is designed for the crushing room.

粉碎机室除尘系统采用平铺式布置，风机恒速运行。

The crushing room dust removal system also features a flat-deck layout with constant-speed fan operation.

本除尘系统负责对粉碎机室的粉碎机给料溜槽、带式输送机头部及落料点处各扬尘点除尘。由于存在有些工艺设备不同时工作的可能，在对应工艺设备除尘管道上设置电动阀门，此阀门与相应的工艺设备联锁。

This system captures dust from the crusher feed chute, belt conveyor head, and discharge points within the crushing room. Electric valves are installed on the dust removal pipelines and interlocked with relevant process equipment to account for non-simultaneous operations.

粉碎机室各点的尘气经除尘罩捕集后，进入脉冲袋式除尘器净化。除尘器采用在线脉冲清灰方式，除尘器滤料采用覆膜防静电材质，风机采用防爆型。净化后的气体经风机及排气筒排至大气。脉冲袋式除尘器收集的粉尘返回工艺皮带。

Dust-laden air is collected via hoods and treated by a pulse bag filter using online pulse cleaning and anti-static membrane-coated filter material. The system utilizes an explosion-proof fan. Collected dust is returned to the process belt.

5.9.3.2 焦炉装煤、出焦除尘地面站 Dust Removal Ground Station for Push-side and Coke Discharge of the Coke Oven

针对焦炉装煤、出焦过程中散发出的大量烟尘和焦粉尘，分别设置焦炉机侧除尘地面站及出焦除尘地面站。

In response to the large amount of coke dust emitted by coke oven in the process of coal loading and coke discharge, the dust removal ground stations for push-side and coke discharge of the coke oven are set up respectively.

a) 焦炉装煤除尘地面站 Dust Removal Ground Station for Push-side of the Coke Oven

焦炉装煤时的炉门烟气具有如下特点：烟气中焦油含量高、含湿量大、露点温度高，且烟尘呈絮状，漂浮性很好等。要使除尘地面站能长期稳定地运行，就必须对焦油烟进行处理并对除尘器的滤袋加以保护，防止焦油及炭黑灰粘结滤袋以延长其使用寿命，并保证除尘器滤袋清灰及灰斗排灰顺畅。烟气吸附净化装置是对含有焦油的烟气进行处理的专用设备，布置在除尘器的前部。装煤时的炉门烟气在进入除尘器前要先经过烟气吸附净化装置，对焦油烟进行强制吸附净化，除去未燃烧尽的焦油。

The coke dust from the coke oven door during coal loading has the following characteristics: high tar content, large moisture content, high dew point temperature, and it is flocculent and has good floating property. To ensure the long-term stable operation of the dust removal ground station, it is necessary to treat the tar smoke and protect the filter bag of the filters, prevent

the tar and carbon black ash from sticking to the filter bag to extend its service life, and ensure the dust removal of the filter bag and the ash bucket smoothly. The flue gas adsorption and purification device is a special equipment for the treatment of the flue gas containing tar, which is arranged in the front of the filters. The flue gas of the coke oven door during coal loading must pass through the flue gas adsorption and purification device before entering the filters to carry out forced adsorption and purification of the tar smoke to remove the unburned tar.

装煤车走行到待装煤的炭化室定位后,利用装煤车导烟罩将机侧炉门上方逸散的烟尘收集后导至装煤皮带密封式除尘干管,同时向地面除尘系统发出电讯号,通风机从低速向高速运行,炉头烟自导烟罩吸入,经除尘连接管道进入地面站的脉冲袋式除尘器净化后,由通风机经烟囱排至大气。除尘器收集的粉尘由刮板机运到灰仓贮存,再经加湿搅拌机定期外运。卸灰间设在封闭的建筑物内。装煤结束后,地面除尘系统接受电讯号,通风机转入低速运行。

After the coal charging car is located in the coke chamber where coal is to be loaded, the flue gas hood of the coal charging car is used to collect the dust escaping above the push-side coke oven door and guide it to the sealed filters main pipeline of the coal loading belt. At the same time, the signal is sent to the ground dust removal system. The fan runs from low speed to high speed, and the flue gas from the stove head is inhaled from the flue gas removal hood. After being purified by the pulse bag filter at the ground station through the dust removal connection pipeline, it is discharged into the atmosphere through the chimney by the ventilation fan. The dust collected by the filters is transported by a scraper transporter to the silo for storage, and then regularly transported out through a dust moistening machine. The coke powder silo is located inside a closed building. After the coal loading is completed, the ground dust removal system receives a signal and the fan switches to low-speed operation.

b) 出焦除尘地面站 Dust removal ground station for coke discharge

装入焦炉炭化室的煤经高温干馏炼成焦炭后,赤热的红焦被推焦机按顺序从炭化室推出,焦炭通过导焦栅落入熄焦车内。赤热的焦炭从炭化室被推出后,发生破裂,并在空气中燃烧,产生大量阵发性烟气,严重污染环境。本设计出焦除尘采用干式除尘地面站工艺。

After the coal in the coke chamber of the coke oven is processed into coke by high temperature dry distillation, the red hot coke is pushed out from the coke chamber in sequence by the coke pusher, and the coke falls into the coke quenching car through the coke guide grid. After the red hot coke is pushed out of the coke chamber, it breaks and burns in the air, producing a large number of paroxysmal flue gas, which seriously pollutes the environment. The design of coke discharge using dry dust removal ground station technology.

出焦除尘地面站由三部分组成：

Dust removal ground station for coke discharge consists of three parts:

第一部分是固定在拦焦机上并随拦焦机一起移动的大型吸气罩，以及将烟气送入固定管道的转换设备。该套装置设置在拦焦机上，属于拦焦机设计范围。

The first part is a large suction hood that is fixed to the coke stopper and moves with the coke guide, and a conversion device that sends the flue gas into the fixed pipe. The device is arranged in the coke guide and belongs to the design scope of coke guide.

第二部分是设在焦侧除尘干管。

The second part is located on the coke side dust removal main pipe.

第三部分是设置于地面将烟气进行熄火、净化的最终设备。包括管道、蓄热冷却器、脉冲袋式除尘器、离心风机、烟囱等。

The third part is the final equipment that is set on the ground to extinguish and purify the flue gas. Including pipes, regenerative heat exchanger, pulse-jet bag filters, centrifugal fan, chimney and so on.

推焦机二次对位后，在推焦杆动作前 30s 向地面除尘系统发出电讯号，通风机由低速向高速运行。然后推焦杆进行推焦，出焦时产生的大量阵发性烟尘在烟尘热浮力及风机的作用下收入设置在拦焦机上的大型吸气罩，通过接口阀将烟尘导入除尘干管，送入蓄热冷却器冷却并粗分离，再经袋式除尘器最终净化后排入大气。出焦结束后，地面除尘系统接受电讯号，通风机转入低速运行。

After the second alignment of the coke pusher, a signal is sent to the ground dust removal system 30 seconds before the coke pusher rod is moved, and the fan runs from low speed to high speed. Then push the coke pusher rod to push the coke, and a large number of intermittent dust generated during coke discharge is collected into the large suction hood of the coke stopper under the

action of the thermal buoyancy of the flue gas and dust and the fan. Through the interface valve, the dust is introduced into the dust removal main pipeline, sent into the regenerative heat exchanger for cooling and primary separation, and then finally purified into the atmosphere by the bag filters. After the coke is discharged, the ground dust removal system receives the signal, and the fan is switched to low speed operation.

除尘器收集的粉尘由刮板机运到灰仓贮存，再经加湿搅拌机加湿后采用汽车定期外运。

The dust collected by the filters is transported by a scraper transporter to the silo for storage, and then regularly transported out through a dust moistening machine.

5.9.3.3 干熄焦环境除尘地面站 CDQ Dust Removal Ground Station

干熄焦工艺在生产过程中，主要产生烟尘或粉尘污染空气环境的部位有：干熄炉顶部在向干熄炉送入红焦之前，需先开启干熄炉顶盖。由于干熄炉内处于正压状态，启盖时会向外逸出大量烟尘；干熄炉预存室的放散管及风机后放散管放散的气体都含有烟尘，是烟尘排放源；干熄炉排焦处至带式输送机落料点，将产生大量焦粉尘外逸。上述这些无组织排放烟尘，如果不加以控制和净化就会严重污染环境。

During the CDQ production process, significant dust and fumes are emitted from the following key sources, causing air pollution: CDQ Furnace Top: Before charging red-hot coke into the CDQ furnace, the furnace lid must be opened. Due to the positive pressure inside the furnace, a large amount of fugitive dust escapes during lid opening. Pre-chamber Vent Pipe and Post-Fan Vent Pipe: Gases discharged from these vent pipes contain dust, acting as critical emission sources. Coke Discharge Zone: From the CDQ furnace discharge outlet to the belt conveyor discharge point, substantial coke dust is released. If these unorganized emissions are not properly controlled and treated, they will severely pollute the environment.

干熄焦环境除尘系统收集的尘源点主要有：干熄炉顶盖装焦处、干熄炉顶部预存放散口、循环风机后放散口（备用旁路）、平板闸门排灰口、干熄炉底部排焦溜槽、排焦落料点处。

The CDQ environmental dust removal system collects dust from: CDQ

furnace lid charging point, Pre-chamber vent port, Post-circulation fan vent port(Standby Bypass), Flat gate valve ash discharge port, CDQ furnace bottom discharge chute, Coke discharge point.

本设计将干熄炉顶盖装焦处、预存放散口、循环风机后放散口（备用旁路）产生的高温且含易燃易爆气体成分及火星的烟气，导入蓄热冷却器上部进行降温处理；将干熄炉底部排焦溜槽、排焦落料点等处含高浓度焦粉尘的气体导入蓄热冷却器下部与降温处理后的烟气混合，然后将温度低于 110℃ 的烟气送入脉冲袋式除尘器净化。除尘后的气体经风机、烟囱排至大气。循环风机后放散口产生的烟气属于高硫烟气，含硫浓度达到 1500mg/m³，送入焦炉脱硫系统进行脱硫除尘处理，达标后经焦炉烟囱排放。

High-temperature gases (containing flammable/explosive components and sparks) from the furnace lid charging point, pre-chamber vent, and post-fan vent(Standby Bypass) are directed to the upper section of the regenerative cooling unit for temperature reduction. High-concentration coke dust-laden gases from the furnace bottom discharge chute and discharge point are channeled to the lower section of the regenerative cooling unit, where they mix with cooled gases. The combined gas stream (cooled to <110°C) is then sent to a pulse bag filter for purification. The flue gas generated from the post-circulation fan vent port is classified as high-sulfur gas, with a sulfur concentration of 1500 mg/m³. It is directed to the coke oven desulfurization system for sulfur removal and dust treatment, and discharged through the coke oven chimney after meeting emission standards.

除尘器采用离线脉冲清灰方式，滤料采用防静电覆膜材质。由脉冲袋式除尘器净化后的气体已成为较干净的气体，其含尘浓度低于现行国家允许排放浓度，达到国家排放标准的要求。净化后的气体经风机排至大气。

The pulse bag filter employs an offline pulse cleaning method with anti-static membrane-coated filter material. Purified gas achieves a dust concentration below national emission standards and is discharged into the atmosphere via a fan and chimney.

除尘系统收集的粉尘通过刮板输送机、斗式提升机送入环境除尘地面站焦粉贮仓，再经加湿搅拌机加湿后采用汽车定期外运。

Collected dust is transported by a scraper conveyor and bucket elevator to

a coke dust storage silo in the environmental dust removal ground station. The dust is humidified by a wetting discharge machine and periodically removed for offsite disposal.

5.9.3.4 干熄焦工艺一、二次除尘粉收集储运系统 Primary and Secondary Dust Powder Collecting Storage and Transportation System

干熄焦工艺一、二次除尘器所收集的粉尘汇集后落入耐热刮板输送机中,再进入斗式提升机送入专用粉尘贮仓,再经加湿搅拌机加湿后采用汽车定期外运。

The dust collected by the CDQ primary and second dust collectors falls into the heat resistant embedded scraper transporter, and then send to the special dust storage bin, and then is humidified by the humidifying mixer and transported by car regularly.

5.9.3.5 筛运焦系统除尘 De-dusting of Coke Screening and Transportation System

a)筛焦楼除尘地面站(含 C103、C104 转运站)Ground Station of Screening Building

焦炭在筛分、贮运及汽车装焦过程中,会有大量的粉尘外逸,严重污染环境。为保护环境及工人的身体健康,设置相应的除尘系统。本项目设计将筛焦楼产尘点(包括振动筛、带式输送机受料点、汽车装车、C103、C104 转运站皮带机头部及皮带落料等处)设计一套筛焦楼除尘系统;除尘系统风机采用变频器调速。

In the process of screening, storage and transportation of coke, there will be a lot of dust escape, which seriously pollutes the environment. In order to protect the environment and the health of workers, the corresponding dust removal system is set up. The design of this project is to design a dust removal system for coke screening building (including vibrating screen, belt conveyor receiving point, car loading, belt conveyor head and belt blanking in C103, C104 transfer station). The fan of the dust removal system uses the frequency converter for speed regulation.

筛焦楼各点的尘气经除尘罩捕集后进入脉冲袋式除尘器净化,净化后的气体经风机排至大气,其排出气体的含尘浓度 $\leq 30\text{mg}/\text{Nm}^3$ 。除尘器滤料采用防静电材质。筛焦楼除尘系统收集的粉尘通过刮板输送机、斗式提升机送入筛焦楼焦粉贮仓,再经加湿搅拌机加湿后采用汽车定期外运。

The dust gas at each point of the coke screening building is collected by

the dust cover and purified by the pulse bag dust collector. The purified gas is discharged to the atmosphere by the fan, and the dust concentration of the discharged gas is less than 30mg/Nm³. The filter material of the dust collector is made of anti-static material. The dust collected by the dust removal system of the coke screening building is sent to the coke powder storage bin of the coke screening building through the scraper conveyor and bucket elevator, and then humidified by the humidifying mixer and transported by car regularly.

b) C101/C102/C301 焦转运站除尘地面站 Dust removal ground station of C101/C102/C301 coke transfer station

为 C101/C102/C301 转运站除尘点单独建一套除尘地面站，用于处理干熄焦后的焦炭在转运过程中产生的焦粉尘。除尘器滤料采用防静电覆膜材质，清灰方式为离线清灰，净化后的气体经风机排至大气。脉冲袋式除尘器收集的粉尘由气力输送至干熄焦环境除尘地面站焦粉贮仓。

A separate set of dust removal ground station is built for the dust removal point of C101/C102/C301 transfer station, which is used to deal with the coke dust generated during the transfer process of coke after dry quenching. The filter material of the dust collector is made of anti-static film material, and the cleaning method is off-line cleaning, and the purified gas is discharged to the atmosphere by the fan. The dust collected by the pulse bag dust collector is transported by air to the coke powder storage bin of the dry quenching environmental dust removal ground station.

c) C302、C303 焦转运站除尘地面站 Dust Removal Ground Stations of C302 and C303 Coke Transfer Stations

为 C302、C303 焦转运站除尘点合建一套除尘地面站，用于处理干熄焦后的焦炭在转运过程中产生的焦粉尘。除尘器滤料采用防静电覆膜材质，清灰方式为离线清灰，净化后的气体经风机排至大气。脉冲袋式除尘器收集的粉尘通过刮板输送机、斗式提升机送入 C302、C303 焦转运站焦粉贮仓，再经加湿搅拌机加湿后采用汽车定期外运。

A set of dedusting ground station is built for the dedusting points of C302 and C303 coke transfer stations, which is used to deal with the coke dust produced during the transfer process of coke after dry quenching. The filter material of the dust collector is made of anti-static film material, and the

cleaning method is off-line cleaning, and the purified gas is discharged to the atmosphere by the fan. The dust collected by the pulse bag dust collector is sent to the coke powder storage bin of C302 and C303 coke transfer station by scraper conveyor and bucket elevator, and then humidified by humidifying mixer and transported by car regularly.

5.9.4 消声与隔振 Noise Reduction and Vibration Isolation

各除尘系统风机外壳及前后管道均设隔声装置、风机进出口设软连接, 采用以上措施将噪声和振动控制在规范规定的范围内。

Each dust removal system fan casing and front and rear pipelines are equipped with sound insulation devices, and soft connections are installed at the inlet and outlet of the fans. The above measures are taken to control noise and vibration within the specified range.

5.9.5 防火防爆措施 Fire and Explosion Prevention Measures

- a) 除尘器采用连续排灰; Continuous ash exhausting by pulse-jet bag filters;
- b) 除尘器布袋采用防静电滤料; The filter bag adopts anti-static filter material;
- c) 除尘系统设防静电接地装置; Anti-static grounding device for dust removal system;
- d) 除尘器设安全泄爆装置; The pulse-jet bag filters are equipped with a safety detonation device;
- e) 除尘器为防积灰结构。The filters adopt anti-ash structure.

5.10 电气 Electrical

5.10.1 概述 Overview

5.10.1.1 设计范围 Design Range

本工程电气设计包括工程范围内的生产及辅助设施的供配电及发电、电气传动、电气照明、防雷及接地。

The electrical design of this project includes power supply and distribution, power generation, electrical transmission, electrical lighting, lightning protection and grounding of production and auxiliary facilities within the scope of the project.

5.10.1.2 用电负荷等级及供电电源 Electricity Load Grade and Power Supply

本工程主要负荷分级如下：

The main load classification of this project is as follows :

一级负荷中的特别重要负荷（应急负荷）：0.38kV 消防水泵、PLC/DCS 计算机控制系统、火灾自动报警系统、应急照明。

The particularly important load (emergency load) in the first grade load : 0.38kV fire pumps, PLC / DCS computer control system, automatic fire alarm system, emergency illumination.

一级负荷：装煤推焦车、拦焦车、装煤车、熄焦车、提升机、锅炉给水泵、助燃风机、发电循环水泵、水环真空泵、发电凝结水泵。

First grade load : coal coke pushing car, coke blocking car, coal loading car, coke quenching car, hoist, boiler feed water pump, combustion fan, power generation circulating water pump, water ring vacuum pump, power generation condensate pump.

二级负荷：备煤、筛焦、焦炉、熄焦、压缩空气氮气站、除尘系统、发电站、除盐水站等。

Second grade load : coal preparation, coke screening, coke oven, coke quenching, compressed air station, dust removal system, power station, demineralized water station, etc.

三级负荷：除上述一、二级负荷外的辅助生产装置及办公和生活辅助设施。

Third grade load : auxiliary production equipment and office and living auxiliary facilities in addition to the above-mentioned first and second-level loads.

由于本工程大部分负荷属于一二级负荷，因此受电电源应为双重电源。

Because most of the load of this project belongs to the first and second grade load, the power supply should be duplicate supply.

本工程新建一座 132kV 升压站，分三期建成。两路 132kV 电源由上级变电所提供，业主负责送至升压站。

A new 132 kV step-up station is built in this project, built in three phases. Two 132kV power sources are provided by the superior substation, and the owner is responsible for delivering them to the booster station.

5.10.2 供配电及发电 Power Supply and Distribution and Power Generation

5.10.2.1 电压等级及接地形式 Voltage Grade and Grounding Form

表 5-26 主要电压等级及接地形式
Table 5-26 Main voltage grade and grounding forms

名称 Name	电压 Voltage	接地形式 Grounding form	备注 Remarks
高压配电系统 high voltage distribution system	132 kV		
中压配电系统 medium voltage distribution system	10 kV、AC、50HZ	中性点不接地 neutral point ungrounded	
低压配电系统 low-voltage distribution system	380V、AC、50HZ	TN-S	
照明系统 lighting system	380/220V、3ph+N 50HZ	TN-S	

5.10.2.2 供配电系统 Power Supply and Distribution System

5.10.2.2.1 132 kV/10 kV 升压站 132kV/10kV Booster Station

a) 概述：Overview:

本工程新建一座 132 kV 开闭站，分三期建设，最终满足 300 万吨焦炉及整个工业园区供配电要求。132 kV 开闭站一期、二期、三期公共的用电设备及设施在一期建设中一次建成。

This project will construct a new 132 kV switching station in three phases, ultimately meeting the power supply and distribution requirements for a 3.0 million ton coke oven and the entire industrial park. The public electrical equipment and facilities for the first, second, and third phases of the 132 kV switching station will be built in one go during the construction of the first phase.

b) 建设规模：Construction scale :

- 1) 一期工程：业主提供两路 132 kV 电源，需上二台 90MVA 二绕组调压变压器；The first phase of the project : the owner provides two 132 kV power supply, which needs two 90 MVA two-winding voltage regulating transformers
- 2) 二期工程：需上二台 90MVA 二绕组调压变压器；Phase II: two 90 MVA two-winding voltage regulating transformers ;
- 3) 三期工程：需上二台 90MVA 二绕组调压变压器；Phase III: two 90 MVA two-winding voltage regulating transformers ;

- 4) 最终规划主变台数及容量为: 6×90MVA 二绕组调压变压器。The final planning of the number and capacity of the main transformer is : 6x180 MVA two winding voltage regulating transformer.
- c) 进出线回路数 The number of in-out line loop
- 1) 一期工程各等级电压进出线回路数: 132kV 进线 2 个回路, 132kV 出线 5 个回路(1#、2#发电机并网、煤矿东坑电源、煤矿西坑电源、GSP 项目电源); The number of voltage inlet and outlet circuits of each grade in the first phase of the project : 132kV inlet line 2 circuit, 132kV outlet line 5 circuits (1 #、2#generator grid connection, Dongkeng Coal Mine power supply, Xikeng Coal Mine power supply, GSP project power supply) ;
- 2) 二期工程各等级电压进出线回路数: 132kV 出线 2 个回路(3#、4#发电机并网); The number of voltage inlet and outlet circuits of each grade in the second phase of the project : 132kV outlet line 2 circuits (3 #、4 # generator grid connection) ;
- 3) 三期工程各等级电压进出线回路数: 132kV 出线 2 个回路(5#、6#发电机并网); The number of voltage inlet and outlet circuits of each grade in the third phase of the project : 132kV outlet line 2 circuits (5 #、6 # generator grid connection) ;
- 4) 最终规划: 132 kV 进线 2 个回路, 132kV 出线 9 个回路。Final planning : 132 kV incoming line 2 circuit, 132 kV outgoing line 9 circuits.
- d) 无功补偿装置: 132 kV 开闭站无功补偿统一由下级变电所进行补偿, 故 132 kV 开闭站不装设无功补偿装置; The reactive power compensation of the 132 kV switching station is uniformly compensated by the lower level substation, so no reactive power compensation device is installed in the 132 kV switching station;
- e) 电气主接线: 132kV 采用双母线, 最终出线 9 个回路。Electrical main wiring : The 132 kV adopts double busbar, and the final outgoing line 9 circuits.

5.10.2.2.2 厂内供配电 In-plant Power Supply and Distribution

本工程一期 10kV 侧为：有功功率：17.87MW，视在功率：19.43MVA；耗电量为 $98.30 \times 10^6 \text{kW} \cdot \text{h}$ 。

The 10kV side of the first phase of this project is : active power : 17.87MW, apparent power : 19.43MVA ; the power consumption is $98.30 \times 10^6 \text{ kW h}$.

本工程二期 10kV 侧为：有功功率：13MW，视在功率：14.14MVA；耗电量为 $71.539 \times 10^6 \text{kW} \cdot \text{h}$ 。

The 10kV side of the second phase of the project is : active power : 13MW, apparent power : 14.14MVA ; the power consumption is $71.539 \times 10^6 \text{ kW h}$.

本工程三期 10kV 侧为：有功功率：12.038MW，视在功率：13.084MVA；耗电量为 $66.207 \times 10^6 \text{kW} \cdot \text{h}$ 。

The 10kV side of the third phase of the project is : active power : 12.038MW, apparent power : 13.084MVA ; the power consumption is $66.207 \times 10^6 \text{ kW h}$.

根据总图布置及用电负荷分布情况，本工程设置下列主要变配电所或电气室：

According to the general layout and the distribution of power load, the following main substations or electrical rooms are set up in this project :

表 5-27 各变/配电所或电气室设置方案

Table 5-27 Setting schemes of each substation / distribution station or electrical room

序号 No.	名称 Name	主接线方案、供电范围概要说明 Main wiring scheme, power supply range overview
1	10kV 高压配电室 (分三期建设) 10kV high voltage distribution room (Construction in three phases)	<p>10 kV 系统:一期 10kV 主接线为单母线分段，两路电源引自 1#、2#发电机出口分支电抗器。供电范围包括 10/0.4kV 车间变电所 8 个、10kV 电动机 23 个。</p> <p>二期 10kV 主接线为单母线分段，两路电源引自 3#、4#发电机出口分支电抗器。供电范围包括 10/0.4kV 车间变电所 6 个、10kV 电动机 18 个。</p> <p>三期 10kV 主接线为单母线分段，两路电源引自 5#、6#发电机出口分支电抗器。供电范围包括 10/0.4kV 车间变电所 6 个、10kV 电动机 17 个。</p> <p>10 kV system : The 10 kV main wiring of the first phase is single bus section. Two power supply is from the 1 # 、2#generator outlet branch reacto. The power supply range includes 8 10 / 0.4 kV workshop substations and 23 10kV motors.</p> <p>The 10 kV main wiring of the second phase is single bus section. Two power supply is from the 3 # 、4#generator outlet branch reacto. The power supply range includes 6 10 / 0.4 kV workshop</p>

序号 No.	名称 Name	主接线方案、供电范围概要说明 Main wiring scheme, power supply range overview
		substations and 18 10kV motors. The 10 kV main wiring of the third phase is single bus section. Two power supply is from the 5 # 、6#generator outlet branch reacto.The power supply range includes 6 10 / 0.4 kV workshop substations and 17 10kV motors.
2	1#提升机 10/0.4kV 变电所 (一期建设放在 1#干熄焦电气室内) 1 # hoist 10 / 0.4kV substation (the first phase of construction in 1 # CDQ electrical room)	安装 1 台容量 500kVA、10/0.4kV 干式变压器, 负责为 1#提升机负荷供电。 Install one capacity 500kVA,, 10 / 0.4kV dry-type transformers, responsible for 1 # hoist load power supply.
3	1#干熄焦 10/0.4kV 变电所 (一期建设放在 1#干熄焦电气室内) 1 # CDQ 10 / 0.4kV substation (the first phase of construction in 1 # CDQ electrical room)	安装 2 台容量 630kVA、10/0.4kV 干式变压器, 负责为干熄焦, 干熄焦环境除尘地面站, 循环水泵站区域低压负荷供电。 Install two capacity of 630kVA, 10 / 0.4kV dry-type transformer, responsible for CDQ, CDQ environmental dust removal ground station, circulating water pump station of low-voltage load power supply.
4	1#发电 10/0.4kV 变电所 (一期建设放在 1#发电综合电气室内) 1 # power generation 10 / 0.4kV substation (the first phase of construction in 1 # power generation integrated electrical room)	安装 2 台容量 2000kVA、10/0.4kV 干式变压器, 负责为 1#发电站、除盐水泵站、压缩空气氮气站、消防水泵站、除氧给水泵站、中心化验室, 综合办公楼, 浴室及宿舍区域低压负荷供电。 Install two capacity 2000kVA, 10 / 0.4kV dry-type transformers, responsible for 1 # power station、demineralized water pumping station、 compressed air nitrogen station、 fire pump station、deoxygenation water supply pump station、responsible for the central laboratory、integrated office building、canteen、 bathroom and dormitory area of low-voltage load power supply.
5	1#空冷岛 10/0.4kV 变电所 (一期建设放在 1#空冷岛电气室内) 1 # air-cooled island 10 / 0.4kV substation (the first phase of construction in 1 # air-cooled island electrical room)	安装 2 台容量 2000kVA、10/0.4kV 干式变压器, 负责为 1#空冷岛区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry-type transformer, responsible for 1 # air-cooled island low-voltage load power supply.
6	1~4#焦炉 10/0.4kV 变电所 (一期建设放在 1~4#焦炉间台电气室内) 1~4# coke oven 10 / 0.4kV	安装 2 台容量 2000kVA、10/0.4kV 干式变压器, 负责为 1~4#焦炉、装煤除尘地面站、出焦除尘地面站区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry-

序号 No.	名称 Name	主接线方案、供电范围概要说明 Main wiring scheme, power supply range overview
	substation (the first phase of construction in 1~4# coke oven platform electrical room)	type transformer, responsible for 1~4# coke oven、coal loading and dust removal ground station、coke and dust removal ground station low-voltage load power supply.
7	备煤 10/0.4kV 变电所 (一期建设) Coal preparation 10 / 0.4 kV substation (phase I construction)	安装 2 台容量 1600kVA、10/0.4kV 干式变压器，负责为贮煤场及粉碎机室区域低压负荷供电。 Install two capacity of 1600kVA, 10 / 0.4kV dry-type transformer, responsible for the coal yard and crushing room area of low-voltage load power supply.
8	焦处理 10/0.4kV 变电所 (一期建设) Coke processing 10 / 0.4 kV substation (phase I construction)	安装 2 台容量 1600kVA、10/0.4kV 干式变压器，负责为焦处理区域低压负荷供电。 Install two capacity of 1600kVA, 10 / 0.4kV dry-type transformer, responsible for Coke processing low-voltage load power supply.
9	1#脱硫 10/0.4kV 变电所 (一期建设放在 1#发电综合电气室内) 1 # desulphurization 10 / 0.4kV substation (the first phase of construction in 1 # power generation integrated electrical room)	安装 2 台容量 800kVA、10/0.4kV 干式变压器，负责为 1#脱硫区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry-type transformer, responsible for 1 # desulphurization low-voltage load power supply.
10	2#提升机 10/0.4kV 变电所 (二期建设放在 2#、3#干熄焦电气室内) 2# hoist 10 / 0.4kV substation (the second phase of construction in 2 # 、3#CDQ electrical room)	安装 1 台容量 500kVA、10/0.4kV 干式变压器，负责为 2#提升机负荷供电。 Install one capacity 500kVA,, 10 / 0.4kV dry-type transformers, responsible for 2# hoist load power supply.
11	2#干熄焦 10/0.4kV 变电所 (二期建设放在 2#、3#干熄焦电气室内) 2 # CDQ 10 / 0.4kV substation (the second phase of construction in 2 #、3# CDQ electrical room)	安装 2 台容量 630kVA、10/0.4kV 干式变压器，负责为干熄焦，干熄焦环境除尘地面站，循环水泵站区域低压负荷供电。 Install two capacity of 630kVA, 10 / 0.4kV dry-type transformer, responsible for CDQ, CDQ environmental dust removal ground station, circulating water pump station of low-voltage load power supply.
12	2#发电 10/0.4kV 变电所 (二期建设放在 2#发电综合电气室内) 2# power generation 10 / 0.4kV substation (the second phase of construction in 2 # power generation integrated	安装 2 台容量 1600kVA、10/0.4kV 干式变压器，负责为 2#发电站、除盐水泵站、压缩空气氮气站、除氧给水泵站区域低压负荷供电。 Install two capacity 1600kVA, 10 / 0.4kV dry-type transformers, responsible for 2 # power station、demineralized water pumping station、compressed air nitrogen station、deoxygenation water supply pump station low-

序号 No.	名称 Name	主接线方案、供电范围概要说明 Main wiring scheme, power supply range overview
	electrical room)	voltage load power supply.
13	2#空冷岛 10/0.4kV 变电所 (二期建设放在 2#空冷岛电 气室内) 2 # air-cooled island 10 / 0.4kV substation (the second phase of construction in 2 # air- cooled island electrical room)	安装 2 台容量 2000kVA、10/0.4kV 干式变压 器, 负责为 2#空冷岛区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry- type transformer, responsible for 2 # air-cooled island low-voltage load power supply.
14	5~8#焦炉 10/0.4kV 变 电所 (二期建设放在 5~8#焦 炉间台电气室内) 5~8# coke oven 10 / 0.4kV substation (the second phase of construction in 5~8# coke oven platform electrical room)	安装 2 台容量 2000kVA、10/0.4kV 干式变 压器, 负责为 5~8#焦炉、装煤除尘地面站、出 焦除尘地面站区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry- type transformer, responsible for 5~8# coke oven、coal loading and dust removal ground station、coke and dust removal ground station low-voltage load power supply.
15	2#脱硫 10/0.4kV 变电所 (二期建设放在 2#发电综合 电气室内) 2 # desulphurization 10 / 0.4kV substation (the second phase of construction in 2 # power generation integrated electrical room)	安装 2 台容量 800kVA、10/0.4kV 干式变压 器, 负责为 2#脱硫区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry- type transformer, responsible for 2 # desulphurization low-voltage load power supply.
16	3#提升机 10/0.4kV 变电所 (三期建设放在 2#、3#干熄 焦电气室内) 3# hoist 10 / 0.4kV substation (the third phase of construction in 2 # 、 3#CDQ electrical room)	安装 1 台容量 500kVA、10/0.4kV 干式变压器, 负责为 3#提升机负荷供电。 Install one capacity 500kVA,, 10 / 0.4kV dry- type transformers, responsible for 3# hoist load power supply.
17	3#干熄焦 10/0.4kV 变 电所 (三期建设放在 2#、3#干 熄焦电气室内) 3 # CDQ 10 / 0.4kV substation (the third phase of construction in 2 #、3# CDQ electrical room)	安装 2 台容量 630kVA、10/0.4kV 干式变压 器, 负责为干熄焦, 干熄焦环境除尘地面站, 循环水泵站区域低压负荷供电。 Install two capacity of 630kVA, 10 / 0.4kV dry- type transformer, responsible for CDQ, CDQ environmental dust removal ground station, circulating water pump station of low-voltage load power supply.
18	3#发电 10/0.4kV 变电所 (三期建设放在 3#发电综合 电气室内) 3# power generation 10 / 0.4kV substation (the third phase of construction in 3 #	安装 2 台容量 1600kVA、10/0.4kV 干式变压 器, 负责为 3#发电站、除盐水泵站、压缩空气 氮气站、除氧给水泵站区域低压负荷供电。 Install two capacity 1600kVA, 10 / 0.4kV dry- type transformers, responsible for 3 # power station、demineralized water pumping

序号 No.	名称 Name	主接线方案、供电范围概要说明 Main wiring scheme, power supply range overview
	power generation integrated electrical room)	station、compressed air nitrogen station、deoxygenation water supply pump station low-voltage load power supply.
19	3#空冷岛 10/0.4kV 变电所 (三期建设放在 3#空冷岛电气室内) 3 # air-cooled island 10 / 0.4kV substation (the third phase of construction in 3 # air-cooled island electrical room)	安装 2 台容量 2000kVA、10/0.4kV 干式变压器, 负责为 3#空冷岛区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry-type transformer, responsible for 3 # air-cooled island low-voltage load power supply.
20	9~12#焦炉 10/0.4kV 变电所 (三期建设放在 9~12#焦炉间台电气室内) 9~12# coke oven 10 / 0.4kV substation (the third phase of construction in 9~12# coke oven platform electrical room)	安装 2 台容量 2000kVA、10/0.4kV 干式变压器, 负责为 9~12#焦炉、装煤除尘地面站、出焦除尘地面站区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry-type transformer, responsible for 9~12# coke oven、coal loading and dust removal ground station、coke and dust removal ground station low-voltage load power supply.
21	3#脱硫 10/0.4kV 变电所 (三期建设放在 3#发电综合电气室内) 3# desulphurization 10 / 0.4kV substation (the third phase of construction in 3 # power generation integrated electrical room)	安装 2 台容量 800kVA、10/0.4kV 干式变压器, 负责为 3#脱硫区域低压负荷供电。 Install two capacity of 2000kVA, 10 / 0.4kV dry-type transformer, responsible for 2 # desulphurization low-voltage load power supply.

各车间变电所低压系统主接线为单母线分段, 正常时两台变压器分列运行, 当其中一台变压器事故或检修时, 由另一台变压器承担 100%负荷。

The main wiring of the low-voltage system of each workshop substation is a single busbar section. When normal, two transformers operate separately. When one of the transformers is accident or overhauled, the other transformer bears 100 % of the load.

每台提升机由专用变压器供电, 每台提升机事故电机由干熄焦变压器提供一路应急电源。

Each hoist is powered by a dedicated transformer, and the accident motor of each hoist is provided with an emergency power supply by CDQ transformer.

5.10.2.3 发电 Power Generation

一期、二期、三期焦炉系统余热锅炉各配置一座汽轮发电站, 每座汽轮发电

站安装 2 台 10kV、65MW 汽轮发电机组。每台发电机通过升压变到 132kV，各经一路 132kV 电缆联络线并网至升压站 132kV 不同母线上。

The waste heat boilers of the first, the second, the third coke oven systems are each equipped with a steam turbine power station, each steam turbine power station and two 10kV and 65MW steam turbine generator sets are installed. Each generator is converted to 132kV through the boost voltage, and each 132kV cable connection line is connected to the grid to the different 132kV bus of the boost station.

电站正常发电后，发电系统将向系统外送电能，会对上级并网变电所的供电系统接线和继电保护配置等产生影响，此部分需由建设单位委托供电局做《接入系统设计》。

After the normal power generation of the power station, the power generation system will send electric energy to the system, which will have an impact on the power supply system wiring and relay protection configuration of the superior grid-connected substation. This part needs to be entrusted by the construction unit to the power supply bureau to do 'access system design'.

发电机采用同轴交流无刷励磁系统，自带励磁调节柜，满足自动与手动励磁调节及强励磁的要求，并有恒电压自动调节(AVR)与恒无功自动调节(AQR)系统，实现电压及功率因数自动调节。

The generator adopts a coaxial AC brushless excitation system with its own excitation regulation cabinet to meet the requirements of automatic and manual excitation regulation and strong excitation. It also has a constant voltage automatic regulation (AVR) and constant reactive power automatic regulation (AQR) system to realize automatic regulation of voltage and power factor.

发电机采用计算机系统控制，确保发电机的起动、运行、停机按照严格的逻辑要求执行。

The generator is controlled by computer system to ensure that the starting, running and stopping of the generator are carried out according to strict logical requirements.

发电机除设置继电保护装置及信号系统外，还装设手/自动准同期装置，同期点设置在发电机-变压器组出口断路器处。

In addition to the relay protection device and signal system, the generator

is also equipped with a manual/automatic quasi-synchronous device, and the synchronous point is arranged at the exit circuit breaker of the generator-transformer group.

表 5-28 电能平衡表（一期）

Tab. 5-28 Electric energy balance table (Phase I)

序号 No.	项目 Item	电量($\times 10^6 \text{kW}\cdot\text{h}$) Electricity quantity ($\times 10^6 \text{kW h}$)
1	年耗电量 Annual electricity consumption	98.3
2	年发电量 Annual electricity generation	1027.6
3	年外送电量 Annual electricity transmission	929.3

表 5-29 电能平衡表（二期）

Tab. 5 29 Electric energy balance table (Phase II)

序号 No.	项目 Item	电量($\times 10^6 \text{kW}\cdot\text{h}$) Electric quantity ($\times 10^6 \text{kW h}$)
1	年耗电量 Annual electricity consumption	71.539
2	年发电量 Annual electricity generation	1027.6
3	年外送电量 Annual electricity transmission	956.061

表 5-30 电能平衡表（三期）

Tab. 5 30 Electric energy balance table (Phase III)

序号 No.	项目 Item	电量($\times 10^6 \text{kW}\cdot\text{h}$) Electric quantity ($\times 10^6 \text{kW h}$)
1	年耗电量 Annual electricity consumption	66.207
2	年发电量 Annual electricity generation	1027.6
3	年外送电量 Annual electricity transmission	961.393

由电能平衡表得出，本期工程发电的电量在本厂自耗电能后，仍需外送电能。

It is concluded from the electric energy balance table that the electric energy generated by the project in this period still needs to be transmitted after the power consumption of the factory.

5.10.2.4 高压一次设备及操作电源 High Voltage Primary Equipment and Operating Power Supply

5.10.2.4.1 高压一次设备 High Voltage Primary Equipment

因无上级系统短路参数，10kV 高压开关柜的短路开断电流按 31.5kA 选择。高压电缆最小截面为 70mm²。

Because there is no upper-level system short-circuit parameter, the short-circuit breaking current of 10kV high-voltage switchgear is selected as 31.5kA. The minimum cross section of high voltage cable is 70mm².

132kV 配电装置采用气体绝缘金属封闭开关设备（GIS），配套断路器采用电动储能弹簧操作机构。

The 132kV distribution equipment adopts gas insulated metal enclosed switchgear (GIS), and the supporting circuit breaker adopts electric energy storage spring operating mechanism.

10kV 配电装置采用 KYN 型户内成套中置铠装式高压开关柜，配套真空断路器，采用电动储能弹簧操作机构；外壳防护等级不低于 IP3X。

The KYN type indoor complete set of armored high-voltage switchgear is adopted in the 10 kV distribution device, which is equipped with a vacuum circuit breaker and an electric energy storage spring operating mechanism. The protection level of the shell is not lower than IP3X.

5.10.2.4.2 高压操作电源 Power Supply for High Voltage Operation

高压设备操作电源及直流油泵采用由免维护铅酸电池屏提供的 220V 直流电源。在 1#、2#、3#发电综合电气室内分别设置一套 400Ah 直流电源屏。

The operation power supply of high voltage equipment and DC oil pump are 220V DC power supply provided by maintenance-free lead-acid battery panel. A set of 400Ah DC power supply panel is installed respectively in the 1# , 2#,3# power generation integrated electrical rooms.

5.10.2.5 微机综合自动化系统 Microcomputer Overall Automation System

5.10.2.5.1 微机综合自动化监控系统 Microcomputer Integrated Automatic Monitoring System

本工程在 1#、2#、3#发电综合电气室内各设置一套微机综合保护测控系统。系统采用分层、分布、开放式结构，由站控层、间隔层以及网络设备构成。监控系统对供电系统的电流、电压、有功功率、无功功率、功率因素、频率等各种实时数据以及开关状态等信息进行采集和处理；实现数据库的建立与维护、操作控制、对高压开关（除高压电动机）进行远距离分合闸操作、保护继电器定值远方整定和修改、防误操作闭锁、操作权限管理、事故报警和预告报警、事件顺序记录、动态实时画面生成与显示、报表管理及打印、时间同步、系统自诊断和自恢

复等功能。

This project will install one set of microcomputer comprehensive protection and measurement system in each of the 1 #, 2 #, and 3 # power generation comprehensive electrical rooms. The system adopts a layered, distributed and open structure, which is composed of station control layer, interval layer and network equipment. The monitoring system collects and processes various real-time data such as current, voltage, active power, reactive power, power factor, frequency and switch status of the power supply system. It realizes the functions of database establishment and maintenance, operation control, remote opening and closing operation of high voltage switch (except high voltage motor), remote setting and modification of protection relay setting value, anti-misoperation locking, operation authority management, accident alarm and warning alarm, event sequence recording, dynamic real-time picture generation and display, report management and printing, time synchronization, system self-diagnosis and self-recovery.

5.10.2.5.2 继电保护 Relay Protection

本工程采用数字式综合保护测控装置对高压设备进行保护、测量和控制。132kV 系统组屏安装相应的保护测控装置，10kV 系统的保护测控装置安装在相应的开关柜内。发电站组屏安装相应的保护测控装置。

This project uses digital integrated protection and control device to protect, measure and control the high voltage equipment. The 132kV system group screen is installed with the corresponding protection and control device, and the protection and control device of the 10kV system is installed in the corresponding switchgear. The power station group screen is installed with the corresponding protection and control device.

继电保护配置如下：

Relay protection configuration is as follows :

- a) 线路保护：纵联差动保护（用于外送 132kV 电源的供电线路）、带时限电流速断保护、过流保护。纵联差动保护装置由上级变电所提供，本工程配合安装；Line protection : longitudinal differential protection (power supply line for 132kV power supply), current quick-break protection with time limit, over-current protection. The longitudinal differential

protection device is provided by the superior substation, and the project cooperates with the installation ;

- b) 132/10kV 电力变压器: 差动保护、高后备保护、低后备保护、轻重瓦斯及温度保护等; 132 / 10kV power transformer : differential protection, high back-up protection, low back-up protection, light and heavy gas and temperature protection ;
- c) 10kV 分段母线: 设电流速断保护, 合闸瞬间投入, 合闸后自动解除; 10kV segmented bus : set current quick-break protection, put into operation at the moment of closing, and automatically lift after closing ;
- d) 10/0.4kV 电力变压器: 设电流速断保护、过电流保护、过负荷保护、单相接地保护、非电量保护等; 10 / 0.4kV power transformer : setting current quick-break protection, over-current protection, overload protection, single-phase grounding protection, non-electricity protection, etc. ;
- e) 10kV 高压电动机: 设电流速断保护、过负荷保护、单相接地保护、低电压保护; 10kV high voltage motor : set current quick-break protection, overload protection, single-phase grounding protection, low voltage protection ;
- f) 发电机保护: 纵联差动保护、复合电压起动的过电流保护、失磁保护、低周低压保护、定子接地保护、励磁回路两点接地保护、解列保护、过负荷保护。Generator protection : longitudinal differential protection, over-current protection of composite voltage starting, loss-of-excitation protection, low-cycle low-voltage protection, stator grounding protection, excitation circuit two-point grounding protection, islanding protection, overload protection.

5.10.2.6 功率因数补偿 Power Factor Compensation

为改善功率因数, 本工程供电系统在低压 0.4kV 侧采用自动无功补偿电容器装置进行补偿, 补偿后 0.4kV 侧功率因数达 0.85 以上; 10kV 侧利用发电机进行补偿, 不再加装补偿装置。

In order to improve the power factor, the power supply system of this project adopts the automatic reactive power compensation capacitor device to compensate the 0.4 kV side of the low voltage, and the power factor of the 0.4

kV side is more than 0.85 after compensation. The 10 kV side is compensated by the generator, and the compensation device is no longer installed.

5.10.2.7 电能计量与电气测量 Electric Energy Metering and Electrical Measurement

本工程与上级变电所计费关口在 132kV 高压进线及发电机出口处, 电能计量装置为 I 类; 其它电能计量装置为 IV 类。

The project and the superior substation billing gateway are at the 132 kV high-voltage inlet and generator outlet, and the energy metering device is Class I ; other electric energy metering devices are Class IV.

本工程在 132/10kV 主变压器低压侧出口、10kV 系统馈出回路、10/0.4kV 配电变压器低压侧出口及 0.4kV 配电系统至下一级配电装置的馈出回路装设电能表, 精度为 0.5。

In this project, electric energy meters are installed in the low-voltage side outlet of 132 / 10 kV main transformer, the feed-out circuit of 10 kV system, the low-voltage side outlet of 10 / 0.4 kV distribution transformer and the feed-out circuit of 0.4 kV distribution system to the next distribution device, with an accuracy of 0.5.

10kV 系统电气测量利用数字式综合保护测控装置, 不另外设置表计, 测量精度为 0.5。

The 10 kV system electrical measurement uses a digital integrated protection and control device without additional meter, and the measurement accuracy is 0.5.

380V 低压系统电流大于 100A 馈线回路、母线分段回路、55kW 及以上电动机及工艺有需求的供电回路装设电流测量装置。380V 低压配电装置受电回路装设电压表。测量精度数字式仪表为 0.5, 指针式仪表为 1.5。

The current measuring device is installed in 380 V low voltage system with current greater than 100 A feeder circuit, bus section circuit, 55 kW and above motor and power supply circuit with process demand. A voltmeter is installed in the receiving circuit of 380 V low voltage distribution device. The measurement accuracy of digital instrument is 0.5, and that of pointer instrument is 1.5.

5.10.3 电气传动 Electric Drive

5.10.3.1 低压配电及保护方式 Low voltage distribution and protection mode

低压配电采用 380/220V 电压，配电方式以放射式为主，个别非生产设备采用链式供电时一般不超过三个。由设在车间、工段配电室内的低压开关柜和动力配电箱向各用电设备送电。对移动设备通过滑触线或软电缆的方式供电。

Low-voltage distribution uses 380 / 220V voltage, and the distribution mode is mainly radial. When some non-production equipments use chain power supply, it generally does not exceed three. The low-voltage switchgear and power distribution box set in the workshop and section distribution room send power to each electrical equipment. The mobile device is powered by a sliding contact line or a soft cable.

低压供电线路短路及过负荷保护采用低压断路器，额定电流 630A 以上采用框架式断路器，额定电流 630A 及以下采用塑壳式断路器。

Low-voltage circuit breakers are used for short-circuit and overload protection of low-voltage power supply lines. Frame circuit breakers are used for rated current above 630 A, and molded case circuit breakers are used for rated current 630 A and below.

低压电动机短路保护设备采用低压断路器，电动机过负荷保护设备采用马达保护器，小于 3kW 电动机过负荷保护设备采用热继电器（或电动机过负荷保护设备采用热继电器）。

The short-circuit protection equipment of low-voltage motor adopts low-voltage circuit breaker, the overload protection equipment of motor adopts motor protector, and the overload protection equipment of less than 3kW motor adopts thermal relay (or the overload protection equipment of motor adopts thermal relay).

5.10.3.2 电动机起动、调速方式 Motor Starting, Speed Control Mode

容量小于 90kW 的低压电动机一般采用直接起动。

Low-voltage motors with a capacity of less than 90 kW are generally started directly.

容量为 90kW 及以上的风机或水泵类低压电动机采用软起动器控制。

The low-voltage motor of fan or water pump with capacity of 90 kW and above is controlled by soft starter.

5.10.3.3 电动机控制及操作方式 Motor Control and Operation Mode

对于生产用电设备，根据工艺要求采用“现场/远程”、“手动/自动”操作

及连锁控制方式。

For the production of electrical equipment, according to the process requirements, ' on-site / remote ', ' manual / automatic ' operation and chain control mode are adopted.

对于物料输送的连锁生产系统，采用逆料线顺序起动方式。

For the chain production system of material transportation, the reverse material line sequential starting mode is adopted.

对无特殊要求的单体设备，一般仅考虑机旁单机操作方式；对与机械设备成套供应的电气装置，除工艺要求连锁外，一般仅供电源。

For the single equipment without special requirements, only the single machine operation mode is generally considered. For the electrical equipment supplied with the complete set of mechanical equipment, except for the process requirements, it is generally only for power supply.

所有需要监视的生产用电设备的运行及事故信号送入计算机控制系统进行监视及事故报警。

All the operation and accident signals of the production electrical equipment that need to be monitored are sent to the computer control system for monitoring and accident alarm.

5.10.3.4 爆炸危险场所电气设备的选择 Selection of Electrical Equipment in Explosion Hazardous Areas

对火灾和爆炸危险场所，应根据其危险级别选择相适应的电气设备。爆炸危险场所电气设备的选择见下表：

For fire and explosion dangerous places, the appropriate electrical equipment should be selected according to its risk level. The selection of electrical equipment in explosive dangerous places is shown in the following table :

表 5-31 防爆区域电气设备选择
Table 5-31 Selection of electrical equipment in explosion-proof area

序号 No.	爆炸危险区域 划分 Explosive gas environment classification	电气设备保护级别 Electrical equipment protection level	防爆形式及类别 Explosion-proof forms and categories	防护等级 Protection level
1	1 区 1 region	Gb	ExdIIBT4	IP65
2	2 区 2 region	Gb、Gc	ExdIIBT4	IP65

序号 No.	爆炸危险区域 划分 Explosive gas environment classification	电气设备保护级别 Electrical equipment protection level	防爆形式及类别 Explosion-proof forms and categories	防护等级 Protection level
3	21 区 21 region	Db	ExtDA21 IIIC	IP65
4	22 区 22 region	Db、Dc	ExtDA21 IIIC	IP65

5.10.3.5 应急负荷供电 Emergency Load Power Supply

本工程应急负荷为消防水泵、PLC/DCS 计算机控制系统火灾自动报警系统、应急照明。

The emergency load of this project is fire water pump, PLC / DCS computer control system fire automatic alarm system and emergency lighting.

0.4kV 消防水泵电源由消防水泵站低压段提供，其电源引自 1#发电变电所不同母线，在末端采用双电源自动切换装置。

The 0.4kV fire pump power supply is provided by the low-voltage section of the fire pump station. The power supply is introduced from different buses of the 1 # power substation, and the dual power automatic switching device is used at the end.

PLC/DCS 计算机控制系统、火灾自动报警系统采用 UPS 供电。应急照明视具体情况分别采用 UPS、EPS、直流屏电源供电，或利用自储能灯具。

PLC / DCS computer control system and automatic fire alarm system are powered by UPS. Emergency lighting is powered by UPS, EPS, DC screen power supply or self-energy storage lamps according to the specific situation.

5.10.3.6 电缆选择及线路敷设 Cable Selection and Line Laying

本工程消防配电回路采用耐火电缆或矿物绝缘类不燃性电缆，高温场合选择高温电缆，计算机控制系统电缆选用屏蔽电缆。其它所有动力、控制电缆均采用阻燃铜芯交联聚乙烯电缆。直接埋地敷设选用铠装电缆，电缆敷设以电缆桥架、电缆沟为主，局部线路采用穿镀锌钢管沿墙、楼板下、平台下等明敷，或穿镀锌钢管埋地。

The firefighting power distribution circuit of this project adopts fire-resistant cable or mineral insulated non-combustible cable. High temperature cable is selected for high temperature occasions, and shielded cable is selected for

computer control system cable. All other power and control cables use flame retardant copper core cross-linked polyethylene cables. Armored cables are selected for direct buried laying. Cable laying is mainly cable bridge and cable trench. Local lines are laid along the wall, under the floor, under the platform, etc., or buried with galvanized steel pipes.

桥架将根据环境要求采用热浸锌钢制或环氧树脂材质。室内桥架（除粉尘较大环境）一般不加盖板，室外桥架凡上层能够覆盖下层时，上层加装盖板，下层不加盖板。桥架内的电力电缆和控制电缆原则上分层、分隔敷设。

The bridge frame will be made of hot-dip galvanized steel or epoxy resin according to environmental requirements. The indoor bridge (except for the dusty environment) generally does not add a cover plate. When the upper layer of the outdoor bridge can cover the lower layer, the upper layer is equipped with a cover plate, and the lower layer does not add a cover plate. The power cable and control cable in the bridge are layered and separated in principle.

电缆由室外进入室内入口处；桥架或电缆穿墙、楼板处；电缆引至电气柜、屏、台的开孔部位；电缆沟的分支处，采用防火隔板、阻火包、防火堵料进行封堵，封堵两端电缆刷防火涂料。

The cable enters the indoor entrance from the outdoor ; bridge or cable through the wall, floor ; the cable is led to the opening parts of the electrical cabinet, screen and platform ; at the branch of the cable trench, the fireproof clapboard, flame retardant package and fireproof plugging material are used to block the cable brush fireproof coating at both ends.

5.10.4 电气照明 Electrical Illumination

本工程的低压配电为 380/220V 中性点直接接地系统，且负荷较为平稳，故照明与动力共用一台变压器。各照明电源引自就近的低压开关柜或动力配电箱。照明网络电压采用 380/220V，一般照明为 AC220V。

The low-voltage distribution of this project is a 380 / 220V neutral point direct grounding system, and the load is relatively stable, so the illumination and power share a transformer. The lighting power supply is from the nearest low voltage switch cabinet or power distribution box. The illumination network voltage is 380 / 220V, and the general illumination is AC220V.

本工程为一般检修照明提供小于 12V 可充电便携式手提 LED 检修作业灯；

特殊需要固定的检修照明电源电压为 24（或 36）V，但在特别潮湿的场所或金属容器内为 12V。

This project provides less than 12 V rechargeable portable LED maintenance operation lamp for general maintenance illumination. Special needs Fixed maintenance illumination power supply voltage of 24 (or 36) V, but in a particularly humid place or metal container for 12V.

各建筑物内、生产装置区的人行走台、楼梯、道路及夜间有人工作的场所均设置照明。需要检修的地方设检修照明。烟囱及高层建、构筑物根据规范设航空障碍照明。

Illumination is set up in walking platforms, stairs, roads and places where people work at night in each building and production device area. The places that need to be repaired are equipped with maintenance illumination. Chimneys and tall buildings or structures according to the specification set aviation obstacle illumination.

控制室、高低压配电室、发电站、消防设施建筑物、爆炸危险场所为 1 区的建筑物等场所，设置正常照明失效时的备用照明或安全照明，保证必要的工作或活动继续进行。

In the control room, high and low voltage distribution room, power station, fire fighting facilities building, explosion dangerous place for area 1 buildings and other places, the stand-by illumination or safety illumination ensure that the necessary work or activities to continue when normal illumination failure.

高层厂房（库房）和甲、乙、丙类单、多层厂房、地下建构筑物等，需要确保人员安全疏散的出口、通道及封闭楼梯间，设置疏散照明及疏散指示。疏散照明一般采用自带蓄电池的应急灯具，供电时间不小于 30min。

High-rise plant (warehouse) and A, B, C single, multi-storey plant, underground structures, etc., need to ensure the safe evacuation of personnel exits, channels and closed stairwells, set up evacuation illumination and evacuation instructions. Evacuation illumination generally uses emergency lamps with batteries, and the power supply time is not less than 30 min.

根据环境情况选择相应的灯具型式。危险爆炸场所灯具的选择，在生产厂房、生产装置区等的非防爆场所选用防水防尘或防腐型照明灯具。照明光源以 LED 为主。

Selecting the appropriate lamp type according to the environmental conditions. For the selection of lamps in dangerous explosion sites, waterproof and dust-proof or anticorrosive lighting lamps are selected in non-explosion-proof places such as production plants and production device areas. The illumination source is mainly LED.

照明线路采用 BV 型铜芯电线，消防应急照明回路采用耐火电线。照明线路一般穿镀锌钢管视现场情况明敷或暗敷。

The lighting circuit adopts BV type copper core wire, and the fire emergency lighting circuit adopts refractory wire. Illumination lines generally wear galvanized steel pipe according to the situation of the scene or dark.

照明系统控制：室内生产场所根据需要在照明配电箱处集中控制或就地控制；综合电气室、办公楼、变电所、集控室等场所采用就地控制；户外生产装置和道路照明在照明配电箱处采用时控装置集中控制。

Illumination system control : indoor production sites according to the need in the lighting distribution box centralized control or local control ; the integrated electrical room, office building, substation, centralized control room and other places adopt local control ; outdoor production devices and road lighting are centralized controlled by time control devices at the lighting distribution box.

5.10.5 防雷及接地 Lightning Protection System and Grounding

对第一、二类防雷建筑物设计将考虑防直击雷、雷电感应及雷电波侵入的措施。对第三类防雷建筑物设计将考虑防直击雷及雷电波侵入的措施。

For the design of the first and second types of lightning protection buildings, measures to prevent direct lightning, lightning induction and lightning wave intrusion will be considered. The design of the third type of lightning protection building will consider the measures to prevent direct lightning and lightning wave intrusion.

电源系统考虑防雷电波侵入的措施，按保护分级及系统特征设置浪涌保护器。

The power system considers the measures of lightning protection wave intrusion, and sets the surge protector according to the protection classification and system characteristics.

电气装置的外露导电部分按系统的接地型式通过保护线（PE 线）接地。建筑物内的 PE 干线、接地干线、工艺金属管道、金属构件、功能性接地导体等导

电体作总等电位联结。低压电源引入建筑物处，PE 线设置重复接地装置。

The exposed conductive part of the electrical device is grounded through the protection line (PE line) according to the grounding type of the system. Conductors such as PE trunk lines, grounding trunk lines, process metal pipelines, metal components and functional grounding conductors in the building are used for total equipotential bonding. The low-voltage power supply is introduced into the building, and the PE line is equipped with a repeated grounding device.

低压接地采用 TN-S 系统，电气设备的工作接地、保护接地、静电接地及雷电保护接地采用共用接地装置（独立避雷针、焦炉烟囱、室外照明灯杆除外），接地电阻按其中各类接地系统中要求的最小电阻值确定。

The TN-S system is used for low voltage grounding. The common grounding device is used for the working grounding, protection grounding, electrostatic grounding and lightning protection grounding of electrical equipment (except for independent lightning rod, coke oven chimney and outdoor lighting pole). The grounding resistance is determined according to the minimum resistance value required in all kinds of grounding systems.

对于输送及装卸易燃易爆气体和液体的设备、管道、阀门、铁轨等，以及生产、输送可燃粉尘的设备和管道，采取防静电接地措施，静电接地电阻小于 100 欧姆。

Anti-static grounding measures are taken for equipment, pipelines, valves, rails, etc., which transport and load flammable and explosive gases and liquids, as well as equipment and pipelines that produce and transport combustible dust. The electrostatic grounding resistance is less than 100 ohms.

接地极及接地导体采用热浸镀锌扁钢、角钢、圆钢等材料。

The grounding electrode and grounding conductor are made of hot-dip galvanized flat steel, angle steel, round steel and other materials.

5.10.6 主要设备型式 Main Equipment Types

a) 132/10kV 电力变压器：选用油浸变压器；

132 / 10kV power transformer : oil-immersed transformer ;

10/0.4kV 配电变压器：选用 SCB 系列干式变压器；

10 / 0.4 kV distribution transformer : SCB series dry-type transformer

is selected ;

b) 高压开关柜: High voltage switch cabinet :

132kV 气体绝缘金属封闭开关设备 (GIS)

10kV 选用中置式开关柜;

132kV Gas insulated metal enclosed switchgear (GIS).

10kV select the central switch cabinet ;

c) 低压开关柜选用固定式;

The low-voltage switch cabinet is fixed ;

d) 操作箱、电源箱等: 户外选择 IP65; 户内 (除了粉尘较大选择 IP54) 一般选择 IP31。

operation box, power box, etc. : outdoor selection IP65 ; indoor (in addition to the larger choice of dust IP54) generally choose IP31.

5.11 电信 Telecommunications

5.11.1 设计内容 Design Content

通信系统、工业电视系统、火灾自动报警系统、有毒气体检测报警系统和电信外部线路。

Communication system, industrial television system, automatic fire alarm system, toxic gas detection alarm system and telecommunication external lines.

5.11.2 通讯系统 Communication System

包括厂区电话、手持无线对讲机。

Including factory telephone, handheld wireless walkie-talkie

厂区电话 Factory Phone

厂区电话系统拟采用虚拟电话网, 地方电话运营商将线路引至项目边界。在控制室、办公室等主要办公管理岗位设置厂区电话用户点。

The telephone system of the plant is to adopt a virtual telephone network, and the local telephone operator will lead the line to the project boundary. Setting up factory telephone user points in main office management posts such as control room and office.

5.11.2.1 便携式设备 Portable Devices

本工程配置数字型手持无线对讲机, 便携式有毒气体探测器。

This project is equipped with digital handheld wireless walkie-talkie and

portable toxic gas detector.

5.11.3 工业电视监控系统 Industrial TV Monitoring System

本工程设置一套网络高清视频监控系统。监视点覆盖煤系统、焦系统（含干熄焦）、焦炉及汽轮发电站、锅炉等主要生产岗位的重要生产环节和主要运行设备等，监控前端根据需要采用 200 万像素的网络高清摄像机，视频信号经接线箱通过光缆接入控制室工业电视系统专用网络视频交换机，解码至控制室内监控系统大屏幕。

This project sets up a network high-definition video surveillance system. Monitoring points cover the coal system, coke system (including dry quenching coke), coke oven and steam turbine power station, boiler and other major production positions of the important production links and main operating equipment, monitoring front-end according to the need to use 2 million pixel network high-definition cameras, video signals through the junction box through the cable access to the control room industrial television system dedicated network video switch, Decode to the large screen of the control room monitoring system.

5.11.4 火灾自动报警系统 Automatic Fire Alarm System

本工程设置集中火灾报警系统。集中火灾报警控制器及消防联动控制器设置在控制室内。系统下设区域火灾报警控制器，设置在汽轮发电站、变配电所或值班室内。

A centralized fire alarm system is set up in this project. The centralized fire alarm controller and fire control linkage controller are arranged in the control room. The fire alarm controllers are set under the system, which are set in the turbine power station, substation or duty room.

在电气室、变电所及机柜间等有火灾危险场所设置感烟、感温火灾探测器，手动报警按钮及声光报警器。火灾报警设备选用智能型总线制。

Set smoke and temperature fire detectors, manual alarm buttons and sound and light alarms in fire danger places such as electrical room, substation and cabinet. Intelligent bus system is used for fire alarm equipment.

5.11.4.1 消防电话 Fire Phone

消防专用电话网络为独立的消防通信系统，消防电话主机设置在控制室内。

The firefighting special telephone network is an independent fire

communication system, and the fire telephone host is set in the control room.

5.11.4.2 消防应急广播 Fire Emergency Broadcast

在电气室、操作室等人员密集的火灾危险场所设置消防应急广播扬声器,消防应急广播主机设置在控制室内。

Fire emergency broadcast speakers are set up in densely populated fire danger places such as the electrical room and operation room, and the fire emergency broadcast host is set up in the control room.

5.11.5 有毒气体检测报警系统 Toxic Gas Detection Alarm System

有毒气体检测报警系统独立设置,指示报警设备设置在焦电区域集中控制室内。

The toxic gas detection and alarm system is set up independently, indicating that the alarm equipment is set up in the centralized control room of the coking area.

在干熄焦装置等可燃/有毒气体可能泄漏的装置及单元设置固定式气体检测报警探测器,并在现场设声光报警器。

Fixed gas detection alarm detectors shall be set up where combustible/toxic gas may leak of dry quenching coke devices, and audible and visual alarm shall be set up on site.

5.11.6 电信外部线路 Telecommunication External Lines

本工程区域内各种电信设施传输线路均为单独网络,自成系统。视频电缆采用单模光缆或非屏蔽双绞线;电信线路在车间内穿管明敷设的方式,外网主要在电力电缆桥架控制电缆槽内敷设,局部采用地下直埋的敷设方式。

The transmission lines of various telecommunications facilities in this project area are separate networks with their own systems. The video cable adopts single mode optical cable or unshielded twisted pair cable; The telecommunication line is laid through the pipe in the workshop, and the external network is mainly laid in the control cable trough of the power cable bridge, and the local laying method is directly buried underground.

5.12 仪表 Instrumentation

5.12.1 概述 Overview

5.12.1.1 设计依据 Basis of Design

工程设计中的检测、控制等项目是依据工艺要求而设置。

Testing, control and other items in engineering design are set according to process requirements.

5.12.1.2 设计范围 Scope of Design

一期：100 万吨热回收焦炉、焦炉废气余热锅炉、脱硫除尘装置、干法熄焦（含干熄焦余热锅炉）、干熄焦环境除尘地面站、装煤除尘地面站、出焦除尘地面站、预粉碎机室除尘地面站、粉碎机室除尘地面站、筛焦楼除尘地面站、C101/C102 焦转运站除尘地面站、湿法熄焦、汽轮发电站（含除氧水泵站）、空冷岛、循环水泵站及冷却塔、除盐水泵站、压缩空气氮气站、消防水泵站等设施的工艺参数的检测与控制。其中除盐水泵站仪表随装置成套。

Phase I: Process parameter detection and control for facilities including 1 million-ton heat recovery coke oven, coke oven waste heat boiler, desulfurization and dedusting unit, dry quenching (including dry quenching waste heat boiler), CDQ environmental dedusting ground station, coal charging dedusting ground station, coke pushing dedusting ground station, pre-crusher room dedusting ground station, crusher room dedusting ground station, screening tower dedusting ground station, C101/C102 coke transfer station dedusting ground station, wet quenching, steam turbine power station (including deaerator pump station), air-cooled island, circulating water pump station and cooling tower, demineralized water station, compressed air & nitrogen station, and fire water pump station. The instrumentation for demineralized water station shall be supplied as complete package with the equipment.

二期：100 万吨热回收焦炉、焦炉废气余热锅炉、脱硫除尘装置、干法熄焦（含干熄焦余热锅炉）、干熄焦环境除尘地面站、装煤除尘地面站、出焦除尘地面站、汽轮发电站（含除氧水泵站）、空冷岛、循环水泵站及冷却塔、压缩空气氮气站等设施的工艺参数的检测与控制。

Phase II: Process parameter detection and control for facilities including 1 million-ton heat recovery coke oven, coke oven waste heat boiler, desulfurization and dedusting unit, dry quenching (including dry quenching waste heat boiler), CDQ environmental dedusting ground station, coal charging dedusting ground station, coke pushing dedusting ground station, steam

turbine power station (including deaerator pump station), air-cooled island, circulating water pump station and cooling tower, and compressed air & nitrogen station.

三期：100 万吨热回收焦炉、焦炉废气余热锅炉、脱硫除尘装置、干法熄焦（含干熄焦余热锅炉）、干熄焦环境除尘地面站、装煤除尘地面站、出焦除尘地面站、C301/C302/C303 焦转运站除尘地面站、湿法熄焦、汽轮发电站（含除氧水泵站）、空冷岛、循环水泵站及冷却塔、压缩空气氮气站等设施的工艺参数的检测与控制。

Phase III: Process parameter detection and control for facilities including 1 million-ton heat recovery coke oven, coke oven waste heat boiler, desulfurization and dedusting unit, dry quenching (including dry quenching waste heat boiler), CDQ environmental dedusting ground station, coal charging dedusting ground station, coke pushing dedusting ground station, C301/C302/C303 coke transfer station dedusting ground station, steam turbine power station (including deaerator pump station), air-cooled island, circulating water pump station and cooling tower, and compressed air & nitrogen station.

5.12.1.3 控制方式 Control Mode

采用集中控制，有关内容详见生产过程控制章节。

Adopting centralized control, details pertaining to this are further elaborated in the Production Process Control section.

5.12.2 主要测控方案 The Primary Measurement and Control Plan

以下仅列出主要装置的控制项目。

Below are listed the main control items for key installations.

5.12.2.1 炼焦 Coking Process

a) 焦炉 Coke Oven

- 1) 分烟道吸力测量；Draft measurement in branch flues;
- 2) 总烟道气体温度、吸力测量；Temperature and draft measurement in the main flue;
- 3) 焦炉用工业水压力、流量测量。Pressure and flow measurement of industrial water used in the coke oven.

b) 湿法熄焦 Wet Quenching

- 1) 熄焦水压力指示、调节；Indication and adjustment of quenching

water pressure;

- 2) 熄焦水槽液位测量。Measurement of water level in the quenching tank.

5.12.2.2 焦炉废气余热锅炉 Waste Heat Recovery Boiler for Coke Oven Gas

- a) 锅炉汽包水位、过热蒸汽流量、给水量三冲量调节; Three-element control of boiler drum level, superheated steam flow, and feeding water;
- b) 出锅炉过热蒸汽温度与入锅炉减温水流量串级调节; Cascade control of outlet steam temperature and desuperheating water flow into the boiler;
- c) 锅炉汽包水位报警、联锁; Boiler drum level alarms and interlocks;
- d) 低温再热蒸汽流量调节; Low-temperature reheat steam flow control;
- e) 高温再热蒸汽温度调节等。High-temperature reheat steam temperature control, etc.

5.12.2.3 汽轮发电站 Steam Turbine Power Plant

- a) 除氧器水位调节; Deaerator water level control;
- b) 除氧器蒸汽压力调节; Deaerator steam pressure control;
- c) 均压箱蒸汽压力调节; Pressure control of the equalizing box;
- d) 高压旁路蒸汽温度、压力调节; Temperature and pressure control of high-pressure bypass steam;
- e) 低压旁路蒸汽温度、压力调节; Temperature and pressure control of low-pressure bypass steam;
- f) 汽轮机超速报警、联锁; Turbine overspeed alarm and interlock;
- g) 排汽装置液位报警、联锁、调节; Condensate system level alarms, interlocks, and control;
- h) 汽轮机润滑油压力报警、联锁; Turbine lubricating oil pressure alarms and interlocks;
- i) 汽轮机轴瓦温度报警、联锁; Turbine bearing temperature alarms and interlocks;
- j) 汽轮机主油泵出口压力报警、联锁; Main oil pump outlet pressure alarms and interlocks;
- k) 汽轮机监视仪表系统 TSI (汽轮机成套); Turbine Supervisory Instrumentation System (TSI) – turbine package;

- l) 汽轮机数字电液控制系统 DEH (汽轮机成套); Digital Electro-Hydraulic Control System (DEH) for turbines – turbine package;
- m) 汽轮机紧急跳闸系统 ETS (汽轮机成套) 等。Emergency Trip System (ETS) for turbines – turbine package, etc.

5.12.2.4 干熄焦本体 Dry Quenching Furnace Body

- a) 干熄炉环形气道吸入空气量遥控调节; Remote control of air intake volume in the annular flue of the dry quenching furnace;
- b) 干熄炉预存室顶部压力调节; Pressure regulation at the top of the pre-storage chamber;
- c) 干熄焦循环气体旁通流量遥控调节; Remote control of bypass flow in the dry quenching gas circulation;
- d) 干熄炉预存室料位测量、报警、联锁; Measurement, alarms, and interlocks for the material level in the pre-storage chamber;
- e) 干熄焦循环气体成份(O_2 、 H_2 、 CO 、 CO_2)分析、报警; Analysis and alarms for the composition of dry quenching gas (O_2 , H_2 , CO , CO_2);
- f) 干熄焦排出焦炭温度测量、报警、联锁 (自动喷淋系统联锁) 等。Temperature measurement, alarms, and interlocks for discharged coke (linked to automatic spray system), etc.

5.12.2.5 干熄焦余热锅炉 Waste Heat Boiler for Dry Quenching

- a) 锅炉汽包液位、过热蒸汽流量、给水量三冲量调节; Three-element control of boiler drum level, superheated steam flow, and feeding water;
- b) 锅炉汽包液位报警、联锁; Boiler drum level alarms and interlocks;
- c) 锅炉出口过热蒸汽温度报警、联锁; Alarms and interlocks for the outlet superheated steam temperature;
- d) 出锅炉过热蒸汽温度与入锅炉减温水流量串级调节; Cascade control of outlet steam temperature and desuperheating water flow into the boiler;
- e) 主蒸汽压力放散调节; Main steam pressure relief control;
- f) 低温再热蒸汽流量调节; Low-temperature reheat steam flow control;
- g) 高温再热蒸汽温度调节等。High-temperature reheat steam

temperature control, etc.

5.12.2.6 干熄焦环境除尘地面站 CDQ Environmental Dedusting Ground Station

a) 除尘器脉冲阀顺序控制； Sequential control of pulse valves on the dust collector;

b) 输灰系统顺序控制； Sequential control of Fly ash system;

c) 风机轴承温度、振动报警、联锁； Alarms and interlocks for fan bearing temperature;

d) 电机定子、轴承温度报警、联锁； Alarms and interlocks for Stator of motor and bearing temperature

e) 除尘器前管道烟气温度报警、联锁； Alarms and interlocks for flue gas temperature before the dust collector;

f) 除尘灰仓的料位报警、联锁等； Dust removal ash silo level alarm, interlocking, etc.

5.12.2.7 干熄焦出焦除尘地面站 Environmental Dust Extraction Ground Station for Dry Quenching

a) 除尘器脉冲阀顺序控制； Sequential control of pulse valves on the dust collector;

b) 除尘器前管道烟气温度报警、联锁； Alarms and interlocks for flue gas temperature before the dust collector;

c) 风机轴承温度报警、联锁； Alarms and interlocks for fan bearing temperature;

d) 除尘灰仓高料位报警等。 High-level alarms for dust hopper, etc.

5.12.2.8 循环水泵站 Circulating Water Pump Station

循环水吸水井液位指示、报警、联锁。

Indication, alarms, and interlocks for the liquid level in the circulating water suction well.

5.12.2.9 脱硫除尘装置 Desulfurization and Dedusting unit

a) 脱硫塔入口烟气温度、烟气压力（三选中）监测；

Monitoring of flue gas temperature and pressure (Three choices) at the inlet of the desulfurization tower;

b) 脱硫塔出口烟气温度、烟气压力(三选中)监测;

Monitoring of flue gas temperature and pressure (Three choices) at the outlet of the desulfurization tower;

c) 脱硫塔出口烟气温度(三选中)调节;

Adjust the flue gas temperature (Three choices) at the outlet of the desulfurization tower ;

d) 脱硫塔进、出口差压监测、调节;

Monitoring and regulating the differential pressure at the inlet and outlet of the desulfurization tower;

e) 引风机轴承、电机轴承、电机定子温度监测、报警、联锁;

Temperature monitoring, alarm, and interlocking of induced draft fan bearings, motor bearings, and motor stator;

f) 引风机轴承振动监测、报警、联锁;

Vibration monitoring, alarm, and interlocking of induced draft fan bearings;

g) 除尘器灰斗料位监测、报警、联锁;

Dust collector ash hopper level monitoring, alarm, and interlocking;

h) 脱硫塔入口烟气流量监测、调节;

Monitoring and regulation of flue gas flow at the inlet of the desulfurization tower;

i) 布袋除尘器出口烟气流量监测、报警、调节;

Monitoring, alarm, and regulation of exhaust gas flow at the outlet of bag filter;

j) 喷枪出口工艺水流量监测、调节;

Monitoring and regulating the process water flow rate at the nozzle outlet.

g)CEMS 烟气(SO₂、粉尘)在线监测系统。CEMS smoke gas (SO₂, dust) online monitoring system, etc.

5.12.3 主要仪表设备选型 Selection of Main Instrumentation Equipment

5.12.3.1 一次仪表选型 Primary Instrument Selection

仪表选型原则是满足工艺过程检测及控制要求和适应工艺介质的特质,选用技术先进、安全可靠、便于维修且性能价格比合理的仪表设备。

The principle for instrument selection is to meet the requirements of process detection and control, adapt to the characteristics of the process

medium, and choose advanced, safe, reliable, easy-to-maintain, and cost-effective instrumentation equipment.

- a) 温度测量：根据被测介质温度选用热电阻、热电偶、双金属温度计。根据被测介质情况采用相应材质的保护套管。按上述原则焦炉烟气、干熄炉和循环气体的温度检测，采用耐高温耐磨保护套；锅炉给水和锅炉主蒸汽的温度检测，分别采用耐高压及耐高压耐高温保护套管；干熄炉排出焦炭的温度检测，采用非接触式辐射高温计；
Temperature Measurement: Resistance temperature detectors (RTDs), thermocouples, or bimetallic thermometers are selected according to the measured medium's temperature. Protective sleeves made of suitable materials are used according to the medium. For high-temperature and wear-resistant environments like coke oven flue gas, dry quenching furnace, and circulating gas, high-temperature resistant and wear-resistant protective sleeves are adopted. For boiler feeding water and main steam temperature measurements, high-pressure and high-temperature resistant sleeves are employed. Non-contact radiation pyrometers are used for measuring discharged coke temperature;
- b) 压力及差压测量：选用技术先进、高精度、稳定性好的二线制智能变送器，带现场指示表；差压测量如需要三阀组则由变送器成套。现场指示压力根据被测介质特点选用不锈钢压力表、不锈钢隔膜压力表等；
Pressure and Differential Pressure Measurement: Advanced, high-precision, and stable two-wire smart transmitters with local indicators are chosen. If required, three-valve manifolds are included with the transmitters. Stainless steel pressure gauges or diaphragm pressure gauges are selected based on the measured medium's characteristics for local indication;
- c) 流量测量：在条件允许的情况下，优选标准节流装置。对于余热锅炉给水、锅炉主蒸汽的流量测量采用耐冲击、阻力小的检测元件，如流量喷嘴或文丘里管；测量导电液体流量时，管径 \leq DN300 可选用电磁流量计；管径 $>$ DN300 可选用超声波流量计；在地下安装的电磁流量计或超声波流量计采用分体式、潜水型。采用公司专利技术测量干熄焦环形气道吸

入空气量和干熄焦循环风量；Flow Measurement: Standard orifice plates are preferred where feasible. For feeding water and main steam flows in waste heat boilers, low-resistance and shock-resistant elements like flow nozzles or venturi tubes are used. Electromagnetic flowmeters are utilized for conductive liquids in pipes \leq DN300, while ultrasonic flowmeters are used for larger diameters. Submerged and separated types are chosen for underground installation. Proprietary technology is applied for measuring the intake air volume of the dry quenching furnace's annular duct and the circulating air volume;

- d) 料位测量：对于工况条件较好的液位测量优先选用静压式液位计；循环水吸水井采用导波雷达液位计；锅炉汽包水位测量采用 3 套差压变送器、2 套电接点水位计和 1 个双色水位计、1 个自主发光磁浮液位计以保证安全（其中平衡容器、电接点水位计、双色水位计和自主发光磁浮液位计为锅炉厂配带）；干熄炉预存室的焦炭料位测量，采用高温型雷达料位计；预存室焦炭上料位和一次除尘器焦粉料位检测，采用耐高温耐磨、抗径向冲击的电容料位计；二次除尘器焦粉料位检测，采用耐磨、抗径向冲击的电容料位计；除尘灰仓采用阻移式料位开关；Level Measurement: Hydrostatic level transmitters are preferred for favorable liquid level conditions. Guided wave radar level transmitters are used for the circulating water suction well. Boiler drum levels are measured by three differential pressure transmitters, two electric contact level gauges, one bi-color level gauge, and one self-luminous magnetic float level gauge (the latter four are provided by the boiler manufacturer). High-temperature radar level gauges are employed for coke level in the pre-chamber. Capacitance level gauges resistant to high temperature, wear, and radial impact are used for coke powder level detection in the pre-chamber and primary dust collector. For the detection of coke powder levels in the secondary dust collector, capacitive level switches with wear resistance and the ability to withstand radial impact are adopted. Limit switches are used for ash silo level detection;

- e) 调节阀、切断阀优先采用电动式。快速切断阀采用气动型式。快速切断

阀根据需要配备电磁阀、限位开关、手轮等附件，快速切断阀的开关由气路上的电磁阀实现；废气余热锅炉给水及减温水所用调节阀采用耐高压、高压差的电动调节阀；锅炉主蒸汽压力放散所用调节阀采用耐高温高压差的气动活塞式调节阀；Control and Shut-off Valves: Electric actuators are preferred, with pneumatic ones for quick shut-off valves. Quick shut-off valves are equipped with solenoid valves, limit switches, and handwheels as needed, controlled by solenoid valves in the air line. High-pressure and high-differential pressure electric control valves are used for boiler feeding water and desuperheating water, the control valve used for pressure relief of the main steam of the dry quench heat boiler is a pneumatic piston type control valve which can withstand temperature and pressure difference;

- f) 循环气体成份分析：O₂ 分析仪表采用磁氧或激光分析仪，H₂ 分析仪表采用热导式氢分析仪（CO₂ 补正），CO 和 CO₂ 分析仪表采用红外线或激光气体分析仪。循环气体分析仪安装在彩钢板结构小屋内；Gas Composition Analysis: Oxygen is analyzed using magnetic or laser analyzers; hydrogen by thermal conductivity with CO₂ correction; CO and CO₂ by infrared or laser gas analyzers. The analyzers are housed in sheet metal shelters;

- g) 在脱硫除尘装置烟囱出口段设置 CEMS（烟气连续排放监测系统），实时监测 SO₂ 及粉尘浓度等关键排放参数，分析仪机柜布置在砖混结构分析小屋内，整套 CEMS 系统的日常运行维护由业主负责实施。业主负责监测数据与属地生态环境部门监管平台的联网传输工作，并负责完成当地环保主管部门对 CEMS 系统的技术验收、数据有效性审核及合规性认证等法定程序。The CEMS (Continuous Emission Monitoring System) shall be installed at the outlet section of the desulfurization and dust removal unit chimney to conduct real-time monitoring of key emission parameters including SO₂ and particulate matter concentrations. The analyzer cabinet shall be housed in a brick-concrete analyzer shelter. The Owner shall be responsible for the daily operation and maintenance of the entire CEMS system. Additionally, the Owner shall implement data transmission connectivity between the monitoring

system and the local ecological and environmental regulatory platform, and shall complete statutory procedures including technical acceptance inspection, data validity verification, and compliance certification of the CEMS system by the local environmental protection authority.

5.12.3.2 二次仪表选型 Secondary Instrument Selection

本设计不设二次仪表（工艺设备自带的除外）。

Secondary instruments are not included in this design, except those provided with process equipment.

5.12.4 仪表设备在特殊环境及特殊介质测量时采用的技术措施 Technical Measures for Special Environments and Media

- a) 为了保障仪表检测过程的正常进行，延长仪表使用寿命，户外安装的现场仪表防护等级不低于 IP65，室内安装的现场仪表防护等级不低于 IP54； Outdoor field instruments have an IP65 protection rating, and indoor ones at least IP54 to ensure normal operation and prolong lifespan;
- b) 所有露天安装的变送器根据安装形式设置仪表保护箱进行保护。仪表保护箱采用玻璃钢材质，电缆桥架采用热镀锌材质； Protection boxes made of fiberglass and galvanized cable trays are installed for all outdoor transmitters;
- c) 电缆选择及线路敷设：与控制系统相连的信号电缆选用阻燃型计算机用屏蔽控制电缆；多芯电缆采用阻燃型计算机用分屏总屏控制电缆；控制和仪表电源电缆选用聚氯乙烯护套、聚氯乙烯绝缘的屏蔽控制电缆。所有仪表电缆均采用穿保护管及电缆桥架内敷设方式。为了防止干扰，处于同一桥架内部的仪表信号电缆与动力电缆之间用隔板隔开。在高温的环境下，电缆选用耐高温电缆，桥架敷设需进行隔热处理。 Cables are selected and laid to resist interference. Flame-retardant shielded control cables are used for signals, multi-core cables use flame-retardant shielded control cables with separate shields, and power cables are PVC-insulated and shielded. All cables are run through conduits and cable trays, with barriers between power and signal cables in shared trays. High-temperature cables and insulated trays

are used in hot environments.

5.12.5 仪表电源 Instrument Power Supply

仪表电源根据重要性选用市电或 UPS 供电。UPS 供电系统详见控制系统相关部分叙述。

Instrument power comes from the mains or UPS based on importance. The UPS system is detailed in the control system section.

5.12.6 仪表气源 Instrument Air Supply

详见热力能源介质消耗表。

Refer to the Thermal Energy Medium Consumption Table.

5.12.7 仪表检修 Instrument Maintenance

仪表维修只考虑点检及小修，仪表大、中修按外委考虑。全厂仪表点检人员建议按 5 人考虑。

Routine inspection and minor repairs are considered for instrumentation, with major and intermediate repairs outsourced. A team of five is suggested for plant-wide instrument inspection.

5.13 生产过程基础级控制 Basic Level Control of Production Process

5.13.1 概述 Overview

根据华泰永创热回收焦炉工艺要求，为了确保生产过程安全稳定进行，提高控制与管理水平，发挥各装置的最大经济效益，提高劳动生产率，对于工艺操作所需要的各种操作参数均引至生产过程控制系统，并视其重要程度分别进行指示，调节，记录，积算，报警及联锁等，实现过程控制、顺序控制和逻辑控制。

According to the process requirements of HUATAI YONGCHUANG (BEIJING) TECH.CO.,LTD heat recovery coke oven, in order to ensure the safe and stable production process, improve control and management level, maximize the economic benefits of each device, and improve labor productivity, various operational parameters required for process operation are introduced to the production process control system, and are indicated, adjusted, recorded, accumulated, alarm, and interlocked according to their importance, to achieve process control, sequential control, and logical control.

本工程一期、二期、三期范围包括年产 100 万吨焦炭炼焦工段及配套余热利用（含发电）、干法熄焦系统，备煤工段、筛焦工段、装煤、出焦、烟气脱硫除

尘系统及车辆对位联锁系统等。一期、二期共建一套湿法熄焦系统，三期一套湿法熄焦系统。

The scope of the first, second and third phases of the project includes an annual output of 1 million tons of coke coking section and supporting waste heat utilization (including power generation), dry coke quenching system, coal preparation section, coke screening section, coal loading, coking extraction, flue gas desulfurization and dust removal system and vehicle alignment interlocking system. The first and second phases will jointly build a set of wet coke quenching system, and the third phase will build a set of wet coke quenching system.

5.13.2 标准规范 Standard Specification

《过程测量与控制仪表的功能标志及图形符号》	HG/T20505-2014
Functional Symbols and Graphical Symbols for Process Measurement and Control Instruments (HG/T20505-2014)	
《自动化仪表选型设计规范》	HG/T20507-2014
Design Specification for Selection of Automation Instruments (HG/T20507-2014)	
《仪表供电设计规范》	HG/T20509-2014
Design Specification for Instrument Power Supply (HG/T20509-2014)	
《信号报警及联锁系统设计规范》	HG/T20511-2014
Design Specification for Signal Alarm and Interlocking Systems (HG/T20511-2014)	
《仪表配管配线设计规范》	HG/T20512-2014
Design Specification for Instrument Tubing and Wiring (HG/T20512-2014)	
《仪表系统接地设计规范》	HG/T20513-2014
Design Specification for Instrument System Grounding (HG/T20513-2014)	
《钢制管法兰、垫片、紧固件》	HG/T20592~20635-2009
Design Specification for Instrument System Grounding (HG/T20513-2014)	
《外壳防护等级 (IP 代码)》	GB/T4208 -2017
GB/T4208-2017, Protection Level of Enclosures (IP Code)	
《自动化仪表工程施工及质量验收规范》	GB50093-2013
Code for Construction and Quality Acceptance of Automation Instrument	

Engineering (GB50093-2013)

5.13.3 控制系统组成 Control System Composition

5.13.3.1 划分 Partition

一期项目：Phase I project:

- a) 焦炉（含湿熄焦）及余热锅炉控制系统；Control system for coke oven (including wet quenching) and waste heat boiler;
- b) 干熄焦控制系统；Dry quenching control system;
- c) 备煤控制系统；Coal preparation control system;
- d) 筛运焦控制系统；Screening and coke transportation control system;
- e) 发电控制系统；Power generation control system.
- f) 车辆对位联锁系统；Vehicle alignment interlock system.
- g) 机侧除尘控制系统;Machine-side dust removal control system.
- h) 焦侧除尘控制系统;Coke side dust removal control system.
- i) 烟气脱硫除尘控制系统;Flue gas desulfurization and dust removal control system.

二期项目：Phase II project

- a) 焦炉及余热锅炉（含发电）控制系统；Control system for coke oven and waste heat boiler (including power generation);
- b) 干熄焦控制系统；Dry quenching control system;
- c) 备煤控制系统(系统扩容)；Coal preparation control system (system expansion);
- d) 发电控制系统。Power generation control system.
- e) 车辆对位联锁系统；Vehicle alignment interlock system.
- f) 机侧除尘控制系统;Machine-side dust removal control system.
- g) 焦侧除尘控制系统;Coke side dust removal control system.
- h) 烟气脱硫除尘控制系统；Flue gas desulfurization and dust removal control system.

三期项目：Phase III project

- a) 焦炉及余热锅炉（含发电）控制系统；Control system for coke oven and waste heat boiler (including power generation);
- b) 干熄焦控制系统；Dry quenching control system;

- c) 备煤控制系统(系统扩容); Coal preparation control system (system expansion);
- d) 发电控制系统。Power generation control system.
- e) 车辆对位联锁系统; Vehicle alignment interlock system.
- f) 机侧除尘控制系统; Machine-side dust removal control system.
- g) 焦侧除尘控制系统; Coke side dust removal control system.
- h) 烟气脱硫除尘控制系统; Flue gas desulfurization and dust removal control system.

基础级生产过程控制系统分为: The basic level production process control system is divided into

- a) 备煤控制系统 Coal preparation control system

备煤控制系统采用一套冗余 DCS 系统, 负责备煤区域设施的工艺参数的采集、显示、报警、控制等。根据总图情况适当设置远程 I/O 站, 远程 I/O 站根据距离情况采用光纤通讯。在控制室可以实现备煤系统所有设备的远程开停、事故报警、联锁, 及所有设备的状态监控和故障报警, 所有信号通过光缆上传总控制室, 在总控制可以实时监控现场运行情况。

The coal preparation control system adopts a redundant DCS system, responsible for collecting, displaying, alarming, and controlling the process parameters of the coal preparation area facilities. Set up remote I/O stations according to the overall plan, and use fiber optic communication for remote I/O stations based on distance. In the control room, remote start stop, accident alarm, interlocking, and status monitoring and fault alarm of all equipment in the coal preparation system can be achieved. All signals are uploaded to the main control room through optical cables, and real-time monitoring of on-site operation can be achieved in the main control room.

- b) 焦炉及余热锅炉控制系统 Control system for coke oven and waste heat boiler

采用 3 套冗余 DCS 控制系统, 负责一期、二期、三期焦炉、余热锅炉等设施的工艺参数的采集、显示、报警、控制等。

Three sets of redundant DCS control systems are used to collect, display, alarm and control the process parameters of the first, second and third phases of coke ovens, waste heat boilers and other facilities.

湿熄焦控制系统规划为炼焦系统的远程站，负责熄焦区域内清水池、储水槽液位监视和报警，及熄焦泵、清水泵运行监控。

The wet quenching control system is planned as a remote station for the coking system, responsible for monitoring and alarming the liquid level of the clean water tank and storage tank in the quenching area, as well as monitoring the operation of the quenching pump and clean water pump.

c) 干熄焦控制系统 Dry Quenching Control System

采用 3 套冗余 DCS 控制系统，负责实现过程控制、顺序控制和逻辑控制。系统范围包括：每套 CDQ 装置（含余热锅炉）1 套、CDQ 除尘地面站 1 座等。

Three sets of redundant DCS control systems are used to realize process control, sequence control and logic control. The scope of the system includes: 1 set of CDQ device (including waste heat boiler) and 1 CDQ dust removal ground station.

d) 筛焦控制系统 Coke screening control system

筛焦控制系统采用 1 套冗余 DCS 系统系统，负责筛焦区域设施的工艺参数的采集、显示、报警、控制等。根据总图情况适当设置远程 I/O 站，远程 I/O 站根据距离情况采用光纤通讯。二期、三期筛焦设备根据现场实际情况融入到一期远程 I/O 站中。在控制室可以实现筛焦系统所有设备的远程开停、事故报警、联锁，及所有设备的状态监控和故障报警，所有信号通过光缆上传总控制室，在总控制可以实时监控现场运行情况。

The coke screening control system adopts a redundant DCS system, responsible for collecting, displaying, alarming, and controlling the process parameters of the coke screening area facilities. Set up remote I/O stations according to the overall plan, and use fiber optic communication for remote I/O stations based on distance. The coking screening equipment for the second and third phases is integrated into the first phase remote I/O station based on the actual site conditions. In the control room, remote start stop, accident alarm, interlocking, and status monitoring and fault alarm of all equipment in the coke screening system can be achieved. All signals are uploaded to the main control room through optical cables, and real-time monitoring of on-site operation can be achieved in the main control room.

e) 发电控制系统 Power generation control system

采用 3 套冗余 DCS 控制系统，负责焦炉余热锅炉汽轮发电站、循环水泵站及空冷岛、消防给水系统、压缩空气站、外线管廊等设施的工艺参数的采集、显示、报警、控制等。

Three sets of redundant DCS control systems are used to collect, display, alarm and control the process parameters of coke oven waste heat boiler steam turbine power station, circulating water pumping station and air cooling island, fire water supply system, compressed air station, external pipe gallery and other facilities..

f) 焦炉车辆安全联锁系统 Safety interlock system for coke oven vehicles

包括一套焦炉的机车（出焦机、电机车、熄焦车等）。主要完成焦炉车辆的数据通信、位置检测、炉号识别，推焦生产计划编排，以及生产时的车辆作业安全联锁、生产作业管理等功能。

Including a set of coke oven locomotives (charging and decoking machine, lifting door machine, electric locomotive, coke quenching car). It mainly completes the functions of data communication, position detection, heat number identification, coke pushing production planning and arrangement, as well as vehicle operation safety interlocking and production operation management during production.

g) 机侧除尘控制系统 Machine-side dust removal control system

采用 3 套 PLC 控制系统，负责焦炉机侧在装煤、推焦等作业过程中产生的烟尘治理,包括除尘器设施的工艺参数的采集、显示、报警、控制等。

Three sets of PLC control systems are used to control the smoke and dust generated in the process of coal loading and coke pushing on the coke oven side, including the collection, display, alarm and control of the process parameters of the dust collector facilities.

h) 焦侧除尘控制系统 Coke side dust removal control system

采用 3 套 PLC 控制系统，负责焦炉焦侧在推焦、熄焦等作业过程中产生的烟尘治理,包括除尘器设施的工艺参数的采集、显示、报警、控制等。

Three sets of PLC control systems are used to control the smoke and dust generated on the coke side of the coke oven in the process of coke pushing and quenching, including the collection, display, alarm and control of the process parameters of the dust collector facilities.

i) 烟气脱硫除尘控制系统 Flue gas desulfurization and dust removal control system

采用 3 套 PLC 控制系统, 实现对烟气脱硫系统的整体控制, 达到控制 SO₂ 排放的目的, 包括脱硫设施的工艺参数的采集、显示、报警、控制等。

Three sets of PLC control systems are used to realize the overall control of the flue gas desulfurization system and achieve the purpose of controlling SO₂ emissions, including the collection, display, alarm and control of the process parameters of the desulfurization facilities.

5.13.4 控制系统装备水平 Control System Equipment Level

控制系统采用技术先进、成熟的国内外知名品牌产品。

The control system adopts advanced and mature domestic and foreign well-known brand products.

5.13.5 现场 PLC/DCS 控制站系统配置 On site PLC/DCS Control Station System Configuration

DCS 产品具有双机热冗功能、高速网络传输技术和硬件热插拔功能, 应具有较强的扩展能力、多协议的通讯能力、和较强的兼容性。PLC 控制系统为单机版控制系统。

DCS products have dual machine hot redundancy function, high-speed network transmission technology, and hardware hot swapping function, and should have strong scalability, multi protocol communication ability, and strong compatibility. The PLC control system is a standalone version control system.

配相应的电源模块、机架、通讯模块。

Equipped with corresponding power modules, racks, and communication modules.

I/O 接口模块有: 模拟量输入、输出模块, 开关量输入、输出模块、各类通讯模块。

I/O interface modules include analog input and output modules, switch input and output modules, various communication modules.

I/O 电源: 220VAC/24VDC, 包括数字量 I/O 接口和模拟量输出所需电源。

I/O power supply: 220VAC/24VDC, including digital I/O interface and power supply required for analog output.

远程 I/O: 支持光纤通讯方式。

Remote I/O: Supports fiber optic communication.

PLC/DCS 硬件配置按 20%I/O 余量、40%内存余量、20%空槽位的要求配置。

PLC/DCS hardware configuration is configured according to the requirements of 20% I/O margin, 40% memory margin, and 20% empty slots.

5.13.6 控制柜及操作台 Control Cabinet and Operation Panel

控制柜内配照明、风扇和检修电源插座等，柜体钢板厚度 2mm，柜内照明通过限位开关与门互锁。柜体表面采用静电喷塑工艺，独立的接地铜排，柜子尺寸：2200H×800W×800D，色标 RAL7035。

The control cabinet is equipped with lighting, fans, and maintenance power sockets. The thickness of the cabinet steel plate is 2mm, and the lighting inside the cabinet is interlocked with the door through limit switches. The surface of the cabinet adopts electrostatic spraying technology, with independent grounding copper bars. The cabinet size is 2200H × 800W × 800D, and the color code is RAL7035.

操作台内设置有断路器、插排，台内有独立接地铜排。每个操作台配操作椅一把。

The control panel is equipped with circuit breakers and sockets, and there is an independent grounding copper bar inside the panel. Each workstation is equipped with one operating chair.

5.13.7 工程师站、操作员站配置 Configuration of Engineer Station and Operator Station

5.13.7.1 工程师站及操作员站：采用当前主流配置，不低于以下配置：

Engineer Station and Operator Station: Adopting the current mainstream configuration, with no lower configuration than the following:

CPU: 不低于 i5

CPU: Not lower than I5

内存: 8G 以上

Memory: 8GB or above

硬盘: 不小于 1T

Hard drive: Not less than 1T

100/1000M 以上网卡，主板带网卡扩展槽

100/1000M or above network card, motherboard with network card expansion slot

具有 HDMI 和 VGA 显示器接口，显示器的接口须具备两种接口

Equipped with HDMI and VGA display interfaces, the display interface must have two types of interfaces

24"TFT 分辨率 1920×1080 显示器

24 "TFT resolution 1920 × 1080 display

预装正版操作系统

Pre installed genuine operating system

5.13.7.2 软件 Software

所有系统软件安最新版本，完整授权，提供正版授权及授权证书，方便升级。
应用软件开放、不加密。专用功能模块（程序）可提供详细的算法说明。

All system software must have the latest version, complete authorization, and provide genuine authorization and authorization certificates for easy upgrading. The application software is open and not encrypted. Specialized functional modules (programs) can provide detailed algorithm explanations.

5.13.8 UPS 不间断电源 UPS Uninterruptible Power Supply

UPS 不间断电源供各控制系统柜、上位机、现场测量仪表及调节阀使用，具体要求如下：

UPS uninterruptible power supply is used for various control system cabinets, upper computers, on-site measuring instruments, and regulating valves. The specific requirements are as follows:

功率满足所供系统、测量仪表耗电量总和，并留有一定裕量。

The power meets the sum of the power consumption of the supplied system and measuring instrument, and there is a certain margin.

具有远程显示 UPS 状态功能。

It has the function of remote display of UPS status.

UPS 持续供电时间不少于 30min。设置应急手动旁路切换检修开关。

The continuous power supply time of UPS shall not be less than 30 minutes.
Set up an emergency manual bypass switch for maintenance.

输入输出：380/220VAC 或 380/380VAC。

Input/output: 380/220VAC or 380/380VAC.

5.13.9 网络构成 Network Composition

基础级自动化系统的网络构成:

The network composition of the basic level automation system:

本工程 PLC/DCS 现场控制站与 HMI 监控站之间以及 PLC/DCS、PLC/DCS 之间均采用 100Mbps 工业以太网, TCP/IP 通讯协议;

100Mbps industrial Ethernet and TCP/IP communication protocol are used between the PLC/DCS on-site control station and HMI monitoring station, as well as between PLC/DCS and PLC/DCS in this project;

主干网采用单模千兆光纤, 交换机采用工业级交换机。以太网工业级交换机预留至少 20% 的备用端口。预留千兆以太光口, 方便以后管理系统的接入。

The backbone network adopts single-mode gigabit optical fiber, and the switches use industrial-grade switches. At least 20% of the spare ports are reserved for Ethernet industrial switches. The Gigabit Ethernet optical port is reserved to facilitate the access of the management system in the future.

5.13.10 基础控制级应用软件基本功能 Basic Functions of Basic Control Level Application Software

本项目控制系统应具备但不限于下述基本功能: 控制和计算功能; 输入值处理功能; 输出值处理功能; 操作和编程功能; 显示记录功能; 报警联锁功能; 打印功能; 信息管理功能; 通讯功能; 并具备丰富的软件支持, 且通用性强, 组态工作简明快捷, 系统应具备良好的开放性和扩展性。

The control system of this project should have, but not limited to, the following basic functions: control and calculation functions; Input value processing function; Output value processing function; Operation and programming functions; Display recording function; Alarm interlocking function; Printing function; Information management function; Communication function; And it should have sufficient software support, strong universality, concise and fast configuration work, and the system should have good openness and scalability.

5.13.11 控制室及机柜间设计 Design of Control Room and Cabinet Room

根据总图、工艺流程及装置区域, 本项目采用 1 个 CCR+多个 FAR 相结合的模式。设计原则按 HG/T20508 《控制室设计规范》。

According to the overall plan, process flow, and device area, this project

adopts a combination of one CCR and multiple FARs. The design principle is in accordance with HG/T20508 Control Room Design Specification.

FAR（现场机柜间）主要用于放置系统柜、UPS 及配电柜、电气机柜等。控制系统分别放在现场机柜间内。

FAR (Field Cabinet Room) is mainly used for placing system cabinets, UPS, power distribution cabinets, electrical cabinets, etc. The control systems are placed in the on-site cabinets.

CCR（中心控制室）主要用于布置全厂级各系统操作站、打印机等设备。供生产管理人员进行全厂生产操作、调度等。CCR 布置在综合办公楼。

CCR (Central Control Room) is mainly used to arrange various system operation stations, printers and other equipment at the factory level. For production management personnel to carry out factory wide production operations, scheduling, etc. CCR is located in the comprehensive office building.

FAR、CCR 均设有机柜、UPS、空调等。FAR 与 CCR 通过光纤连接。为便于电缆的敷设及安全，机柜间、控制室地面为金属陶瓷防静电活动地板。

FAR and CCR are equipped with cabinets, UPS, air conditioning, etc. FAR and CCR are connected through optical fibers. For the convenience of cable laying and safety, the floor of the cabinet room and control room is made of metal ceramic anti-static raised floor.

5.13.12 信号配电、隔离设计原则 Principles of Signal Distribution and Isolation Design

当采用控制系统的 AI（指 4~20mA.DC 信号输入）卡件不能对外供电时，采用配电器供电并采样，而 DO 经继电器隔离后输出。

When the AI (referring to 4-20mA. DC signal input) card of the control system cannot be powered externally, the distributor is used for power supply and sampling, while the DO is output after being isolated by a relay.

5.13.13 控制系统接地 Control System Grounding

控制系统的交流工作接地、直流工作接地、安全保护接地应与控制室的防雷接地共用一组接地装置，接地装置的接地电阻值必须按接入设备中要求的最小值确定。

The AC working grounding, DC working grounding, and safety protection grounding of the control system should share a set of grounding devices with

the lightning protection grounding in the control room. The grounding resistance value of the grounding device must be determined according to the minimum value required in the connected equipment.

控制室（机柜间）设等电位连接网络。控制室（机柜间）内设备的金属外壳、机柜、机架、金属管、槽、屏蔽线缆外层、防静电接地、安全保护接地等均应以最短的距离与等电位连接网络的接地端子连接。

The control room (cabinet room) is equipped with an equipotential connection network. The metal casing, cabinets, racks, metal pipes, slots, outer layers of shielded cables, anti-static grounding, safety protection grounding, etc. of equipment in the control room (cabinet room) should be connected to the grounding terminal of the equipotential connection network at the shortest distance.

5.13.14 通讯线路的选型、敷设方式及抗干扰措施 Selection, Laying Method and Anti-interference Measures of Communication Lines

- a) 现场至机柜间的电缆采用点对点敷设，所有电缆均穿镀锌钢管过渡至电缆桥架敷设；The cables from the site to the cabinet room are laid point-to-point, and all cables are threaded through galvanized steel pipes for transition to cable tray laying;
- b) 与控制系统相连的信号电缆选用带屏蔽的计算机用控制电缆；其余电缆选用聚氯乙烯护套、聚氯乙烯绝缘的屏蔽控制电缆。在温度高的环境下，电缆选用耐高温电缆，桥架敷设需进行隔热处理；Select shielded computer control cables for the signal cables connected to the control system; The remaining cables are shielded control cables with PVC sheaths and PVC insulation. In high temperature environments, high-temperature resistant cables should be selected, and insulation treatment should be carried out for cable tray laying;
- c) 网络通讯线路选用系统专用的工业级产品，根据通讯信号传输距离采用电缆或光缆传输介质。Industrial grade products specialized for the system are selected for network communication lines, and cable or optical cable transmission media are used according to the communication signal transmission distance.

通讯线缆在电缆桥架内敷设方式。为了防止干扰，原则上通讯线路与信号电

缆敷设，不允许与动力桥架一起敷设。

The method of laying communication cables in cable trays. In order to prevent interference, communication lines and signal cables are generally not allowed to be laid together with power cable trays.

5.14 建筑与结构 Architecture and Structure

5.14.1 主要建（构）筑物 Major Buildings and Structures

- a) 备煤车间：通廊、转运站、粉碎机室、预粉碎机室、煤场地坪；Coal Preparation Workshop: Corridor, Transfer Station, Crusher Room, Pre crusher room ,Coal Yard Floor;
- b) 炼焦车间：焦炉基础、煤塔间台、焦炉端台、焦炉机焦侧操作台、煤塔、焦炉烟囱、焦炉烟道、锅炉构架基础、装煤推焦车轨道基础、熄焦车轨道及基础、熄焦泵房、熄焦塔、粉焦沉淀池、粉焦抓斗操作室；Coking Workshop: Coke Oven Foundation, Coal Tower Inter Platform, Coke Oven End Platform, Coke Oven Machine Coke Side Operation Console, Coal Tower, Coke Oven Chimney, Coke Oven Flue, Boiler Structure Foundation, Coal Loading and Pushing Car Track Foundation, Coke Quenching Car Track and Foundation, Quenching Pump Room, Quenching Tower, Powder Coke Sedimentation Tank, Powder Coke Crab Bucket Operation Room;
- c) 运焦系统：焦台及配电室、通廊、转运站、筛焦楼及配电室、焦场地坪；Coke Transportation System: Coke Platform and Power Distribution Room, Corridor, Transfer Station, Coke Screening Building and Power Distribution Room, Coal Yard Floor;
- d) 干熄焦系统：干熄炉本体基础（含提升井架基础、排出装置振动给料器推出检修平台及基础、排出装置格式密封阀推出检修平台）、本体室外基础（包括一次除尘构架基础、二次除尘器构架基础、给水预热器构架基础、锅炉构架基础、楼电梯基础，循环风机基础，对位装置基础及油沟，加压泵、焦粉沉淀槽、煤气水封槽基础，循环气体管道支架基础，排焦粉螺旋输送机支架基础等）、本体钢结构（含提升井架）、一次除尘器框架、二次除尘器框架、热管换热器框架、楼电梯钢结构、一二次除尘粉收集贮运间、干熄焦排焦除尘地面站、干熄焦电气室、迁车台、焦罐检

修站；CDQ System:CDQ Foundation (including lifting well frame foundation, maintenance platform and foundation for pushing out vibrating feeder of discharge device, and maintenance platform for pushing out sealing valve of discharge device), Outdoor foundation of CDQ (including primary dust removal framework foundation, secondary dust removal framework foundation, water supply preheater framework foundation, boiler framework foundation, building elevator foundation, circulating fan foundation, alignment device foundation and oil ditch, booster pump, coke powder sedimentation tank, gas water sealing tank foundation, circulating gas pipeline support foundation, coke powder spiral conveyor support foundation, etc.), CDQ Main Body Steel Structure (including lifting well frame), Primary Dust Collector Frame, Secondary Dust Collector Frame, Heat Pipe Exchanger Frame, Elevator Steel Structure, Primary and Secondary Dust Removal Powder Collection, Storage and Transportation Room, CDQ Dust Removal Station, CDQ Electrical Room, Transfer Platform, Coke Tank Maintenance Station;

- e) 辅助生产设施：汽轮发电站（含除氧给水泵站及发电电气室）、空冷岛及配电室、除盐水处理站、压缩空气氮气站、液氮气化站、消防给水泵站、132kV 开闭站、循环水泵站、汽车衡及操作室、门卫室等组成；Auxiliary Production Facilities: Steam Turbine Power Station (including deaeration feeding water pump station and power generation electrical room), Air Cooling Island and Distribution Room, Desalinated Water Station, Compressed Air Nitrogen Station, Liquid Nitrogen Gasification Station, Firefighting Water Supply Pump Station, 132kV switching station, Car Scale and Operation Room, Guard Room, etc;
- f) 生产管理和生活福利设施：综合办公楼、浴室、倒班宿舍、机修间、备品备件库。Production Management and Living Welfare Facilities: Office Building, Shower Room, Shift Dormitory, Repairing Workshop, Spare Parts Warehouse.

5.14.2 建筑设计 Architectural Design

5.14.2.1 设计原则 Design Principles

- a) 建筑设计适用、经济、美观。建筑平面、剖面的设计在满足工艺生产、操作和检修的同时，应满足防火、防腐等要求； Architectural design should be practical, economic and aesthetic. The design of building plans and sections should not only meet the requirements of process production, operation, and maintenance, but also meet the requirements of fire prevention, corrosion prevention, etc;
- b) 屋面：采用新型防水材料 SBS（一级设三道防水，二级设两道防水，三级设一道防水），一般采用有组织排水。钢结构屋面排水坡度采用 10%，由结构起坡；钢筋混凝土屋面排水坡度一般不小于 2%，如为上人钢筋混凝土屋面则设置混凝土保护板。屋面保温隔热层采用阻燃型聚苯乙烯泡沫塑料板 50mm 厚； Roof: Waterproof material SBS(with three layers of waterproofing for the first level, two layers of waterproofing for the second level, and one layer of waterproofing for the third level) is being used. Generally, organized drainage is being used. Steel structure roof drainage slope adopts 10% and designed by structural engineers. The drainage slope of reinforced concrete roofs is generally not less than 2%. If it has the function of pedestrian access, concrete protective panels should be installed. The roof thermal insulation layer adopts 50mm flame retardant polystyrene foam plastic plate;
- c) 墙体：建筑外墙采用 240 厚红砖砌筑，内墙采用 240 厚红砖砌筑，汽轮发电站 8.65 米平台以上外墙采用 50 厚岩棉夹芯板； Wall: The interior and exterior walls of the building are constructed using 240mm red brick. The exterior walls above the 8.65m platform of the steam turbine power station are constructed using 50mm thick rock wool sandwich panels;
- d) 楼地面：一般采用 C20 混凝土、水泥砂浆面层；配电室、办公室、卫生间等采用防滑面砖；有防静电要求的楼地面应采用防静电地板； Floor: Generally, C20 concrete and cement mortar surface layer are used; Non slip tiles are used in the distribution room, office, bathroom, etc; Floors with anti-static requirements should use anti-static flooring;
- e) 装修：一般建筑内外墙面抹灰刷涂料并作踢脚板（钢筋混凝土竖壁、柱不抹灰，直接刷涂料）；卫生间贴瓷砖；一般建筑顶棚不抹灰只刷涂料，

办公室等抹灰刷涂料；一般建筑物楼梯间采用水泥砂浆楼面、楼梯栏杆采用钢栏杆； Decoration: Generally, the interior and exterior walls of buildings are plastered with paint and assembled with skirting boards (reinforced concrete vertical walls and columns are not plastered, but directly coated); Tiling the bathroom; Generally, the ceiling of a building is not plastered and only painted and offices are plastered and painted; Generally, cement mortar floors are used for stairwells in buildings, and steel railings are used for stair railings;

- f) 门窗：小门为钢防盗门（市售成品），有特殊要求时采用彩板钢大门、变压器室钢门窗、隔音门、防火门等。窗一般采用单框双玻塑钢窗，有特殊要求时采用隔音窗、防火窗、钢百页窗等。 Doors and windows: Steel anti-theft door for wicket gate(marketing finished product available), and where there are special requirements, colored steel doors, transformer room steel doors and windows, soundproof doors, fireproof doors are used. Single frame double glass plastic steel windows are generally used for windows. When there are special requirements, soundproof windows, fireproof windows, steel blind windows are used.

5.14.2.2 防噪声措施 Anti-Noise Measures

对产生噪声较大的生产厂房，在声源附近的操作室均采用隔音门窗。

Soundproof doors and Windows are used in the operation room near the sound source for the production plant with large noise.

5.14.2.3 防火措施 Fireproof Measures

- a) 设计中应贯彻“预防为主，防消结合”的原则，对所有建筑物的防火要求，包括材料的选用、布置、构造、疏散等均按现行的建筑设计防火规范执行； The principle of "prevention first, combined with fire fighting" should be implemented in the design. And the fire prevention requirements of all buildings, including material selection, layout, construction, evacuation, etc., should be implemented in accordance with the current building design fire prevention standards;
- b) 建筑物、转运站与通廊连接处的门洞均设置防火隔断； Fire barriers are installed at the doors connecting buildings, transfer stations, and

corridors;

- c) 易燃与可燃性物质生产厂房或库房的门窗应向外开; The doors and windows of producing workshop or warehouses for flammable and combustible substances should open outward;
- d) 生产区域必须设安全通道, 安全通道净宽不得小于 1m, 仅通向一个操作点或设备的不得小于 0.8m。An exit passageway must be set up in the production area, with a net width of no less than 1m. The passageway that only leads to one operating point or equipment must not be less than 0.8m.

5.14.3 结构设计 Structure Design

5.14.3.1 设计原则 Design Principles

结构设计年限 50 年。

Design life: 50 years.

5.14.3.2 技术规定 Technical Regulations

a) 基础 Foundation

柱下一般采用现浇钢筋混凝土独立基础, 砖墙下采用素混凝土条形基础或钢筋混凝土基础梁, 设备基础采用混凝土基础, 特殊设备 (汽轮发电机、粉碎机) 基础采用钢筋混凝土框架式基础; 有防水要求的构筑物 (如地下室、水池、地坑、排污井等) 采用防水混凝土, 设计抗渗等级按《地下工程防水技术规范》相关要求采用。

Generally, cast-in-place reinforced concrete independent foundations are used under columns. Plain concrete strip foundations or reinforced concrete foundation beams are used under brick walls. Concrete foundations are used for equipment. And reinforced concrete frame foundations are used for special equipment (turbine generators, crushers); Structures with waterproof requirements (such as basements, water pools, pits, sewage wells, etc.) shall be made of waterproof concrete, and the design impermeability level shall be in accordance with the relevant requirements of the Technical Specification for Waterproofing of Underground Engineering.

建 (构) 筑物基础及设备基础的防腐, 外露部分的面层做法与防腐地面做法相同, 地下部分按《工业建筑防腐蚀设计标准》采取相应措施。

The anti-corrosion treatment of building (structure) foundations and

equipment foundations: the surface layer method of the exposed parts is the same as the anti-corrosion ground method. And corresponding measures are taken for the underground parts in accordance with <Standard for anticorrosion design of industrial constructions>.

b) 钢结构：所有钢平台板均采用花纹钢板 Steel structure: All steel platform plates are made of patterned steel plates

除锈：梁、柱、支撑钢结构除锈等级为 Sa2.5 级；楼板、钢梯、栏杆等其他钢结构动力工具除锈 St3 级。

Derusting: The derusting grade for beams, columns, and supporting steel structures is Sa2.5; Other steel structures such as floor slabs, steel ladders, railings, etc. shall be derusted by power tools and to St3.

涂漆：环氧富锌底漆 2 道 60 微米，环氧云铁中间漆 1 道 40 微米，聚氨酯（脂肪族）面漆 2 道 60 微米，总干漆膜厚度 160 微米。

Painting: Epoxy zinc-rich primer 2 times (60μm), epoxy iron intermediate paint 1 times (40μm); polyurethane (aliphatic) top paint 2 times (60μm), the total dry film thickness of 160.

c) 一次除尘器上部钢结构 Upper steel structure of primary dust removal
除锈：除锈等级为 St2.5 级。

Derusting: The steel structures derusting grade is Sa2.5.

涂漆：底漆涂 E06-28 无机硅酸锌底漆两遍，涂膜总厚度 50μm 以上，面漆涂 W61-64 有机硅高温防腐漆两遍，涂膜总厚度 50μm 以上。

Painting: Apply two coats of E06-28 inorganic zinc silicate primer as the primer, with a total film thickness of 50 μm or more. Apply two coats of W61-64 organic silicon high-temperature anti-corrosion paint as the topcoat, with a total film thickness of 50 μm or more.

d) 主要建（构）筑物的结构型式 The structural types of major buildings (structures)

表 5-32 主要建（构）筑物结构形式一览表
Table 5-32 List of Major Structural Forms of Buildings (Structures)

序号 No.	建（构）筑物名称 Names	结构形式 Forms
1.	粉碎机室 Crusher Room	钢筋混凝土框架结构+构架式设备基础 Reinforced concrete frame structure + Framework-based equipment foundation
2.	煤转运站	钢筋混凝土框架结构

序号 No.	建（构）筑物名称 Names	结构形式 Forms
	Coal Transfer Station	Reinforced concrete frame structure
3.	煤通廊 Coal Corridor	地下：防水钢砼箱型结构 Underground : Waterproof reinforced concrete box structure 地上：钢结构 Overground: Steel structure
4.	焦台 Coke Platform	地下：抗渗钢筋混凝土底板、竖壁 Underground: Waterproof Reinforced concrete box structure with impermeable reinforced concrete bottom plate and vertical wall 地上：钢筋混凝土框架 Overground: Reinforced concrete frame
5.	焦转运站 Coke Transfer Station	钢筋混凝土框架结构 Reinforced concrete frame structure
6.	焦通廊 Coke Corridor	地下：防水钢砼箱型结构 Underground : Waterproof reinforced concrete box structure 地上：钢结构 Overground: Steel structure
7.	筛焦楼 Coke Screening Building	钢筋混凝土筒仓结构 Reinforced concrete silo structure
8.	焦炉基础及抵抗墙 Coke Oven Foundation and Resistance Wall	钢筋混凝土基础 Reinforced concrete foundation
9.	端台 End Platform	钢筋混凝土框架结构 Reinforced concrete frame structure
10.	间台 Inter Platform	钢筋混凝土框架结构 Reinforced concrete frame structure
11.	机、焦侧操作台 Side Operation Platform	钢结构 Steel structure
12.	推焦车轨道 Pushing Coke Car Track	钢筋混凝土带形基础 Reinforced concrete strip foundation
13.	熄焦车轨道 Coke Quenching Car Track	钢筋混凝土带形基础 Reinforced concrete strip foundation
14.	煤塔 Coal Tower	钢筋混凝土框架剪力墙+筒仓结构 Reinforced concrete frame shear wall + silo structures
15.	烟囱 Chimney	钢筋混凝土烟囱 Reinforced concrete chimney
16.	熄焦塔 Quenching Tower	钢筋混凝土框架剪力墙结构 Reinforced concrete frame shear wall
17.	粉焦沉淀池 Powder Coke Sedimentation Tank	钢筋混凝土排架结构 Reinforced concrete frame structure
18.	熄焦泵房 Quenching Pump Room	钢筋混凝土框架结构 Reinforced concrete frame structure
19.	汽轮发电站 Steam Turbine Power Station	钢筋混凝土框排架结构+构架式设备基础 Reinforced concrete frame truss structure + Framework-based equipment foundation
20.	空冷岛 Air Cooling Island	钢筋混凝土框架结构 Reinforced concrete frame structure

序号 No.	建（构）筑物名称 Names	结构形式 Forms
21.	压缩空气氮气站 Compressed Air Nitrogen Station	钢筋混凝土框架结构 Reinforced concrete frame structure
22.	除盐水站 Demineralized Water Station	钢筋混凝土框架结构 Reinforced concrete frame structure
23.	液氮站 Liquid Nitrogen Station	钢筋混凝土设备基础 Reinforced concrete equipment foundation
24.	循环水泵站 Circulating Water Pump Station	防水钢混凝土水池 Waterproof steel concrete water tank 钢筋混凝土框架结构 Reinforced concrete frame structure
25.	消防水泵站 Fire Water Pump Station	防水钢混凝土水池 Waterproof steel concrete water tank
26.	本体基础 CDQ Foundation	防水钢筋砼箱型基础 Waterproof reinforced concrete box foundation
27.	本体钢结构（含提升井架及楼梯） CDQ steel structure (including lifting well frame and stairs)	钢框架-支撑结构 Braced frame structure
28.	一次除尘器上部钢结构 Upper Steel Structure of Primary Dust Removal	钢结构 Steel structure
29.	一次除尘器框架 Primary Dust Removal Frame	上部：钢结构 Upper: Steel structure 下部：钢筋混凝土框架结构 Lower: Reinforced concrete frame structure
30.	二次除尘器框架 Secondary Dust Removal Frame	钢筋混凝土框架结构 Reinforced concrete frame structure
31.	热管换热器框架 Heat Pipe Heat Exchanger Frame	钢筋混凝土框架结构 Reinforced concrete frame structure
32.	电梯井道 Elevator Shaft	钢圆筒结构 Steel cylindrical structure
33.	一二次除尘粉收集贮运间 Primary and Decondary Dust Removal Powder Collection, Storage and Transportation Room	钢筋混凝土框架结构 Reinforced concrete frame structure
34.	装煤除尘地面站 Coal Charging And Dust Removal Ground Station	除尘器：落地布置，钢筋混凝土基础 Dust collector: floor-standing arrangement, reinforced concrete foundation 烟囱：钢结构 Chimney: Steel structure 除尘支架：钢结构 Dust removal frame: steel structure
35.	干熄焦环境除尘地面站 CDQ Environmental Dust Removal Ground Station	除尘器：落地布置，钢筋混凝土基础 Dust collector: floor-standing arrangement, reinforced concrete foundation 烟囱：钢结构 Chimney: Steel structure 除尘支架：钢结构 Dust removal frame: steel structure
36.	干熄焦电气室	钢筋混凝土框架结构

序号 No.	建（构）筑物名称 Names	结构形式 Forms
	CDQ Electrical Room	Reinforced concrete frame structure
37.	变电所 Electric Power Substation	钢筋混凝土框架结构 Reinforced concrete frame structure
38.	干熄焦除尘地面站配电室 CDQ Dust Removal Ground Station Distribution Room	钢筋混凝土框架结构 Reinforced concrete frame structure
39.	132kV 开闭站 132kV Opening and closing station	钢筋混凝土框架结构 Reinforced concrete frame structure
40.	迁车台 Transfer Platform	钢筋混凝土带形基础 Reinforced concrete strip foundation
41.	焦罐检修站 Coke Tank Maintenance Station	钢筋混凝土框架结构 Reinforced concrete frame structure
42.	机修间 Repairing Workshop	门式刚架结构 Portal frame structure
43.	备品备件库 Spare Parts Warehouse	门式刚架结构 Portal frame structure
44.	综合办公楼 Office Building	钢筋混凝土框架结构 Reinforced concrete frame structure
45.	值班宿舍 Shift Dormitory	钢筋混凝土框架结构 Reinforced concrete frame structure
46.	警卫室 Guard Room	钢筋混凝土框架结构 Reinforced concrete frame structure
47.	中心化验室 Central Laboratory	钢筋混凝土框架结构 Reinforced concrete frame structure
48.	烟气脱硫装置 Flue Gas Desulfurization Device	钢结构 Steel structure
49.	消化站及灰库 Digestion Station And Ash Storage	钢结构 Steel structure
50.	区域综合管廊 Comprehensive Pipe Gallery	地下：钢筋混凝土 Underground: Reinforced concrete 地上：钢结构 Overground: Steel structure

e) 地基处理及抗震设防 Foundation Improvement and Anti-seismic Fortification

1) 地基处理 Foundation Improvement

由于暂无地勘报告，按天然地基，施工设计根据地质详勘资料采取相应处理措施。

Due to the lack of geological survey reports, corresponding treatment measures will be taken for the construction design based on geological detailed survey data for natural soils base.

2) 抗震设防 Seismic Fortification

按现行的《建筑抗震设计规范》、《构筑物抗震设计规范》等国家及行业的规范、标准及规程进行地震作用计算并采取抗震措施。

Seismic effects calculating and seismic measures should be in accordance with current national and industry norms, standards, and regulations: <Code for seismic design of buildings> and <Design code for antiseismic of special structures>.

6 环境保护 Environmental protection

6.1 设计依据及采用标准 Design Basis and Applicable Standards

6.1.1 设计依据 Design Basis

- a) 《建设项目环境保护管理条例》(根据 2017 年 7 月 16 日《国务院关于修改〈建设项目环境保护管理条例〉的决定》修订); Regulations on environmental protection management of construction projects (Revised according to the Decision of the state council on amending the regulations on environmental protection management of construction projects on July 16, 2017);
- b) 《中华人民共和国环境保护法》(2014 年 4 月 24 日第十二届全国人民代表大会常务委员会第八次会议修订, 2015 年 1 月 1 日起施行)。Environmental protection law of the people's republic of china(Revised at the 8th meeting of the standing committee of the 12th National People's Congress on april 24, 2014, and implemented on January 1, 2015).

6.1.2 采用的标准 Standards Adopted

- a) 《炼焦化学工业污染物排放标准》(GB16171-2012); Emission standard of pollutants for coking chemical industry(GB16171-2012);
- b) 《工业企业厂界环境噪声排放标准》(GB12348-2008); Emission standard for industrial enterprises noise at boundary(GB12348-2008);
- c) 《一般工业固体废物贮存和填埋污染控制标准》(GB18599-2020); Standard for pollution control on the non-hazardous industrial solid waste storage and landfill(GB18599-2020);
- d) 环境质量标准参照《National Ambient Air Quality Standards》中的要求; The environmental quality standards shall refer to the requirements specified in the National Ambient Air Quality Standards;
- e) 排放的废水, 执行《炼焦化学工业污染物排放标准》表 2 中的标准限值; The discharged wastewater shall comply with the standard limits in Table 2 of the Emission standard of pollutants for coking chemical industry;

f) 生产过程中所产生的固体废弃物、废渣则主要参照《中华人民共和国环境保护法》中的有关规定执行。一般固废执行《一般工业固体废物贮存和填埋污染控制标准》中规定；The solid waste and residue generated during the production process are mainly implemented in accordance with the relevant provisions of the Environmental Protection Law of the People's Republic of China. General solid waste shall comply with the pollution control standards for storage and landfill of general industrial solid waste;

g) 厂界噪声执行《工业企业厂界环境噪声排放标准》中表 1 的 3 类标准。The boundary noise shall comply with the Class 3 standards in Table 1 of the Emission standard for industrial enterprises noise at boundary.

6.2 建设地区环境现状 Current Environmental Situation in the Construction Area

6.2.1 地理位置 Geographical Location

本项目位于 Makhado 地区。厂址紧邻 N1 公路（纵贯南非和非洲大陆的最大交通主干公路，南北走向）。周边现有 Mopane 火车站，距厂区的公路距离约 20 公里。距 Nzhelele 水坝约 8-10 公里。

The project is located in the Makhado area. The site is adjacent to the N1 Highway (the largest north-south arterial road traversing South Africa and the African continent). The existing Mopane Railway Station is situated approximately 20 kilometers from the plant area by road, and the Nzhelele Dam is approximately 8-10 kilometers away.

6.2.2 工程地质 Engineering Geology

6.2.3 气候特征 Climate Characteristics

气候为半干旱，夏季炎热至极热，冬季温暖至凉爽，全年降水最少。该地区在 10 月至 3 月之间为温暖潮湿的夏季，然后在 5 月至 8 月之间有凉爽干燥的冬季。4 月和 9 月是过渡月份。最高温度出现在初夏的几个月，温度在 20℃到 33℃之间。最低温度在冬季中期，范围在 7℃到 28℃之间。冬天通常是温和的，霜冻很少发生。降雨具有很强的季节性，夏季主要以强对流雷暴的形式出现。年平均

降雨量在 285 毫米至 622 毫米之间。

The climate is semi-arid, characterized by hot to extremely hot summers and warm to cool winters, with minimal annual precipitation. The region experiences warm and humid summers from October to March, followed by cool, dry winters between May and August. April and September are transitional months. The highest temperatures occur in the early summer months, ranging between 20°C and 33°C, while the lowest temperatures during mid-winter range from 7°C to 28°C. Winters are generally mild, with rare frost occurrences. Rainfall is highly seasonal, predominantly occurring as intense convective thunderstorms in summer. The average annual rainfall varies between 285 mm and 622 mm.

6.2.4 水文地质 Hydrogeology

6.2.5 地震烈度 Seismic Intensity

6.3 工程概述 Engineering Overview

6.3.1 工程概况 Engineering Overview

本工程分三期建设年产 300 万吨焦炭热回收焦炉项目。一期建设年产 100 万吨焦炭的 1~4#热回收焦炉（4×25 孔）及配套余热利用设施（带发电）、1#湿熄焦系统，1#干熄焦装置预留。二期建设年产 100 万吨焦炭的 5~8#热回收焦炉（4×25 孔）及配套余热利用设施（带发电）、1#、2#干熄焦装置。三期建设年产 100 万吨焦炭的 9~12#热回收焦炉（4×25 孔）及配套余热利用设施（带发电）、3#干熄焦装置、2#湿熄焦系统。同时建设与之配套的备煤车间、焦处理车间和公用辅助设施。

This project is divided into three phases for the construction of a heat recovery coke oven project with an annual output of 3 million tons of coke. In Phase I, heat recovery coke ovens No. 1 to 4 (4×25 ovens) with an annual output of 1 million tons of coke, along with supporting waste heat utilization facilities (including power generation) and the 1# wet quenching system, will be constructed, with provision for a 1# dry quenching facility. In Phase II, heat recovery coke ovens No. 5 to 8 (4×25 ovens) with an annual output of 1 million tons of coke, along with supporting waste heat utilization facilities (including

power generation) and the 1# and 2# dry quenching facilities, will be constructed. In Phase III, heat recovery coke ovens No. 9 to 12 (4×25 ovens) with an annual output of 1 million tons of coke, along with supporting waste heat utilization facilities (including power generation), the 3# dry quenching facility, and the 2# wet quenching system, will be constructed. Simultaneously, supporting coal preparation workshops, coke handling workshops, and public auxiliary facilities will also be built.

本工程用地面积为 580000m²。

The land area for this project is 580,000 square meters.

本工程的主要产品为冶金焦炭、蒸汽、电等。

The main products of this project are metallurgical coke, steam, electricity, etc.

本工程主要由生产设施，生产辅助设施及生产管理和生活福利设施组成，其工程主要内容见下表。

This project mainly consists of production facilities, production auxiliary facilities, production management and living welfare facilities. The main construction contents of the project are shown in the table below.

表 6-1 主要建设内容一览表
Table 6 1 List of main construction content

序号 No.	装置名称 Device name	主要建设内容 Main construction content
1	生产设施 Production facilities	
1.1	备煤装置 Coal preparation equipment	露天贮煤场、受煤坑、预粉碎机室、配煤槽、粉碎机室、煤塔、转运站及运煤带式输送机通廊等 Coal storage yard、Coal pit、Pre crusher room、Coal blending bin、Crusher room、Transfer station and Coal conveyor corridor, etc
1.2	焦处理装置 Coke processing equipment	焦台、筛焦楼、贮焦场、转运站及运焦带式输送机通廊等 Coke wharf、Coke screening station、Coke storage yard、Transfer station and Coke conveyor belt corridor, etc
1.3	炼焦装置 Coking equipment	4×25孔换热热回收焦炉、湿熄焦塔、粉焦沉淀池、干熄焦装置、迁车台、焦罐检修站等 4×25 ovens heat exchange heat recovery coke oven、quenching tower、Powder coke sedimentation tank、CDQ unit、traverser、coke bucket maintenance station, etc
2	生产辅助设施 Production auxiliary facilities	

序号 No.	装置名称 Device name	主要建设内容 Main construction content
2.1	水处理设施 Water treatment facilities	生产消防给水泵站、循环水泵站 Process & fire water pump station、pumping station for circulating water
2.2	除尘设施 Dust removal facilities	装煤除尘地面站、出焦除尘地面站、干熄焦环境除尘地面站等 coaling station for dust removal、ground station for dust removal during coke discharge、dusting system of ground environment for dry coke quenching, etc
2.3	烟气脱硫设施 Flue gas desulfurization facilities	烟气脱硫塔、旋转喷吹布袋除尘器等 Flue gas desulfurization tower, rotary blowing bag filter, etc
2.4	供电设施 Power supply facilities	132kV 开闭站、发电 10/0.4kV 变电所、干熄焦 10/0.4kV 变电所、空冷岛 10/0.4kV 变电所、焦炉 10/0.4kV 变电所、备煤 10/0.4kV 变电所、焦处理 10/0.4kV 变电所、熄焦泵房、焦台等配电室 132kV switching station、Power generation 10 / 0.4kV substation、CDQ 10 / 0.4kV substation、Air-cooled island 10 / 0.4kV substation、Coke oven 10 / 0.4kV substation、Coal preparation 10 / 0.4 kV substation、Coke processing 10 / 0.4 kV substation、Quenching pump station、coke wharf and other distribution rooms
2.5	其他 Other	干熄焦锅炉、废气余热锅炉、汽轮发电站（含除氧给水泵站及发电电气室）及空冷岛、除盐水处理站、压缩空气氮气站、液氮气化站、机修间、备品备件库、汽车衡等 CDQ boiler、waste gas and heat boiler、steam turbine power station(deaerator & feeding water pump station and Power generation electrical room)and air-cooled island、demineralized water station、compressed air and nitrogen station、liquid nitrogen vaporizing station、auto repair room、spare parts room、automobile scales, etc
3	生产管理和生活福利设施 Production management and living welfare facilities	综合办公楼、浴室、倒班宿舍、中心化验室等 Comprehensive office building、Bathroom、Shift dormitory、Central laboratory, etc

6.3.2 主要工艺流程简述 Main Process Flow Description

6.3.2.1 备煤车间 Coal Preparation Workshop

由汽车运来的原料煤在贮煤场堆放，当需要炼焦煤时，利用装载机将煤料推入受料槽内，然后经受料槽下电液动颚式闸门卸至带式输送机上，气煤、瘦煤等硬质煤由带式输送机运至预粉碎机室进行初步粉碎处理后进入配煤仓贮存，焦肥煤等易粉碎煤不经过预粉碎可通过带式输送机直接运至配煤仓内贮存。配煤仓内的各单种煤经过特定的比例混合后，由带式输送机运往粉碎机进行混合粉碎到要求细度，直接运往煤塔，并由安装在带式输送机上的固定式电动犁式卸料器卸至

煤塔内，供焦炉生产使用。

The raw coal transported by car is piled up in the coal storage yard. When coking coal is needed, it is pushed into the coal pit by the loader and then unloaded onto the belt conveyor through the electro-hydraulic jaw gate under the coal pit. Hard coal such as gas coal and lean coal are transported by belt conveyors to the pre crusher room for preliminary crushing treatment, and then stored in the coal blending bin. Coal that is easily crushed, such as coke and fat coal, can be directly transported to the coal blending bin for storage without the need for pre crushing through belt conveyors. After each type of coal in the coal blending bin is mixed in a specific proportion, it is transported by a belt conveyor to the crusher for mixing and crushing to the required fineness. It is directly transported to the coal tower and discharged into the tower through a fixed electric plow unloader installed on the belt conveyor for use in coke oven production.

6.3.2.2 炼焦车间 Coking Workshop

由备煤车间送来的能满足炼焦要求的煤装入煤塔。通过摇动给料器将煤装入装煤车的煤箱内，并将煤捣固成煤饼，装煤车按作业计划将煤饼从机侧送入炭化室内。煤饼在炭化室内经过一个结焦周期的高温干馏炼制成焦炭（焦饼中心温度 $1000\pm 50^{\circ}\text{C}$ ）。炭化室内的焦炭成熟后，由推焦机推出。

The coal that meets the coking requirements sent from the coal preparation workshop is loaded into the coal tower. By shaking the feeder, the coal is loaded into the coal box of the charging car, and the coal is compacted into coal cakes. The charging car sends the coal cakes from the pusher side into the carbonization room according to the operation plan. Coal cake undergoes a coking cycle of high-temperature dry distillation in the carbonization chamber to produce coke (with a center temperature of $1000 \pm 50^{\circ}\text{C}$). After the coke in the carbonization room matures, it is pushed out by the coke pusher.

采用干法熄焦时，焦炭经拦焦机导入焦罐车中，由电机车牵引至干熄焦区域。提升机将焦罐提升并送至干熄炉炉顶，通过带布料钟的装入装置将焦炭装入干熄炉内。在干熄炉中焦炭与惰性气体直接进行热交换，焦炭被冷却至 200°C 以下，经排焦装置卸到带式输送机上，然后送往筛贮焦系统。

When using CDQ, the coke is guided into the coke tank car through the coke blocking machine and pulled to the CDQ area by the electrical locomotive. The crane lifts the coke tank and sends it to the top of the CDQ chamber. The coke is loaded into the CDQ chamber through a loading device with a distribution bell. In the CDQ chamber, coke undergoes direct heat exchange with inert gas. The coke is cooled to below 200°C, unloaded onto a belt conveyor through a coke discharge device, and then sent to the screening and storage system.

采用湿法熄焦时，焦炭经拦焦机卸入熄焦车内。由电机车牵引至熄焦塔内进行喷水熄焦。熄焦后的焦炭卸至晾焦台上，晾置一定时间后送往筛贮焦工段。

When using wet quenching method, the coke is discharged into the quenching car through the coke blocking machine. Transported by an electric locomotive to the quenching tower for water spray quenching. After quenching, the coke is unloaded onto the coke drying platform and left to dry for a certain period of time before being sent to the coke screening and storage section.

煤在炭化室高温干馏过程中产生的荒煤气经顶部跨越孔进入燃烧室立火道，处于不同结焦时间炭化室之间的荒煤气通过煤气平衡道分配，使各炭化室的荒煤气量均匀分配。空气经换热室预热后，进入燃烧室与荒煤气分段混合燃烧。所产生的高温烟气下降进入换热室，与空气间接换热，换热后的烟气经烟道进入废气余热锅炉回收烟气余热。当废气余热锅炉检修或故障时，焦炉烟气经烟道通过烟囷排放，可保证焦炉的安全稳定生产。

The raw gas generated during the dry distillation process of coal in the high temperature carbonization chamber enters the vertical flue of the combustion chamber through the top cross holes. The raw gas between the carbonization chambers at different coking times is distributed through the gas balance channel, ensuring that the amount of raw gas in each carbonization chamber is evenly distributed. After preheating in the heat exchange chamber, the air enters the combustion chamber and mixes with the raw gas in stages for combustion. The generated high-temperature flue gas descends into the heat exchange chamber and indirectly exchanges heat with the air. After heat exchange, the flue gas enters the waste heat boiler through the flue to recover the waste heat from the flue gas. When the waste heat boiler is maintenance

or malfunctions, the coke oven flue gas is discharged through the chimney through the flue, which can ensure the safe and stable production of the coke oven.

6.3.2.3 焦处理车间 Coke Processing Workshop

从焦台或干熄炉下排出来的焦炭经带式输送机运至筛焦楼筛分为<10mm 焦粉和≥10mm 焦炭两级，其中<10mm 入仓贮存后并由装车外运至指定区域，≥10mm 焦炭即可入仓贮存后外运，也可经高架带式输送机送至贮焦场露天堆存。

The coke discharged from the coke table or dry quenching coke oven is transported by a belt conveyor to the coke screening building, which is divided into two stages:< 10mm coke powder and ≥ 10mm coke. Among them,<10mm is stored in the coke storage bunker and transported by truck to the designated area. ≥ 10mm coke can be stored and transported out of the coke storage bunker, or transported to the coke yard for outdoor coke yard by an elevated belt conveyor.

6.4 主要污染源、污染物、控制措施及符合的标准 Main Pollution Sources, Pollutants, Control Measures, and Compliance Standards

6.4.1 废气 Waste Gas

6.4.1.1 炼焦车间 Coking Workshop

炼焦系统向大气排放的污染物主要为：颗粒物、SO₂、氮氧化物等。

The pollutants emitted into the atmosphere by the coking system mainly including particulate matter, SO₂、Nitrogen oxides, etc.

a) 为了控制焦炉系统的污染，采取主要措施如下：In order to control pollution in the coke oven system, main measures taken are as follows;

炼焦过程没有无组织排放废气，捣固换热热回收焦炉为负压生产操作，避免焦炉的炉孔、炉盖、炉门、炉体泄漏烟气。

The coking process does not emit unorganized exhaust gas, and the stamping heat exchange heat recovery coke oven is a negative pressure production operation to avoid smoke leakage from the furnace ovens, covers, doors, and body of the coke oven.

换热热回收焦炉采用了空气分段燃烧和炉内燃烧控制技术，炉内温度均匀性好，火道温度低，降低了烟气中 NO_x 含量。

The heat exchange heat recovery coke oven adopts air segmented combustion and furnace combustion control technology, which has good temperature uniformity in the furnace, low flue temperature, and reduces the NO_x content in the flue gas.

经锅炉余热回收后的焦炉烟气经过 CFB 半干法脱硫塔与旋转喷吹布袋除尘器, 脱除烟气中的 SO_2 及颗粒物, 净化后废气经 45m 高烟囱排放至大气。

The coke oven flue gas after waste heat recovery by the boiler passes through a CFB semi-dry desulfurization tower and a rotary blowing bag filter to remove SO_2 and particulate matter in the flue gas. After being purified, the waste gas is discharged into the atmosphere through a 45-meter-high chimney.

采取上述污染控制措施后 SO_2 浓度 $\leq 200\text{mg}/\text{m}^3$ 、颗粒物浓度 $\leq 30\text{mg}/\text{m}^3$ 。

After taking the above pollution control measures, the total dust concentration emitted from the coke oven chimney is $\leq 80\text{mg}/\text{m}^3$, carbon monoxide concentration is $\leq 50\text{mg}/\text{m}^3$. The concentration of SO_2 is $\leq 200\text{mg}/\text{m}^3$, and the concentration of particulate matter is $\leq 30\text{mg}/\text{m}^3$.

针对焦炉装煤、出焦过程中散发出的大量烟尘和焦粉尘, 分别设置焦炉装煤除尘地面站及出焦除尘地面站。

In response to the large amount of coke dust emitted by coke oven in the process of coal loading and coke discharge, coal charging dust removal ground station and coke discharge of the coke oven are set up respectively.

装煤车走行到待装煤的炭化室定位后, 利用装煤车导烟罩将机侧炉门上方逸散的烟尘收集后导至装煤皮带密封式除尘干管, 同时向地面除尘系统发出电讯号, 通风机从低速向高速运行, 炉头烟自导烟罩吸入, 经除尘连接管道进入地面站的脉冲袋式除尘器净化后, 由通风机经烟囱排至大气。

After the coal charging car is located in the carbonization chamber where coal is to be loaded, the flue gas hood of the coal charging car is used to collect the dust escaping above the push-side coke oven door and guide it to the sealed filters main pipeline of the coal loading belt. At the same time, the signal is sent to the ground dust removal system. The fan runs from low speed to high speed, and the flue gas from the stove head is inhaled from the flue gas removal hood. After being purified by the pulse bag filter at the ground station through the dust removal connection pipeline, it is discharged into the atmosphere

through the chimney by the ventilation fan.

推焦机二次对位后，在推焦杆动作前 30s 向地面除尘系统发出电讯号，通风机由低速向高速运行。然后推焦杆进行推焦，出焦时产生的大量阵发性烟尘在烟尘热浮力及风机的作用下收入设置在拦焦机上的大型吸气罩，通过接口阀将烟尘导入除尘干管，送入蓄热冷却器冷却并粗分离，再经袋式除尘器最终净化后排入大气。出焦结束后，地面除尘系统接受电讯号，通风机转入低速运行。

After the second alignment of the coke pusher, a signal is sent to the ground dust removal system 30 seconds before the coke pusher rod is moved, and the fan runs from low speed to high speed. Then push the coke pusher rod to push the coke, and a large number of intermittent dust generated during coke discharge is collected into the large suction hood of the coke stopper under the action of the thermal buoyancy of the flue gas and dust and the fan. Through the interface valve, the dust is introduced into the dust removal main pipeline, sent into the regenerative heat exchanger for cooling and primary separation, and then finally purified into the atmosphere by the bag filters. After the coke is discharged, the ground dust removal system receives the signal, and the fan is switched to low speed operation.

采取上述污染控制措施后，装煤除尘地面站、出焦除尘地面站、干熄焦环境除尘地面站排放的总尘浓度 $\leq 30\text{mg}/\text{m}^3$ 。

After implementing the aforementioned pollution control measures, the total dust emission concentrations from the Coal Charging Dust Removal Ground Station, Coke Discharging Dust Removal Ground Station, and Dry Coke Quenching Environmental Dust Removal Ground Station are $\leq 30\text{mg}/\text{m}^3$.

b) 熄焦系统 Quenching System

干熄焦系统排放的大气污染物主要是颗粒物。产生污染物的主要污染源为干熄炉装焦口、干熄炉顶部预存室放散口、循环风机放散口、平板闸门排灰口、干熄炉底部双岔溜槽、排焦落料点处。

The main air pollutants emitted from the dry quenching coke system are particulate matter. The main pollution sources generating these pollutants, which are the coke charging port of the dry quenching furnace, the vent of the top pre-storage chamber of the dry quenching furnace, the vent of the circulating fan, the ash discharge port of the flat gate, the bottom double-slope

chute of the dry quenching furnace, and the coke discharging drop point.

为了控制干熄焦装置排出的烟尘，在设计上采取以下措施：

In order to control the smoke and dust emitted by the dry quenching device, the following measures are taken in the design:

将干熄炉顶盖装焦处、预存放散口、循环风机后放散口（备用旁路）产生的高温且含易燃易爆气体成分及火星的烟气，导入蓄热冷却器上部进行降温处理；将干熄炉底部排焦溜槽、排焦落料点等处含高浓度焦粉尘的气体导入蓄热冷却器下部与降温处理后的烟气混合，然后将温度低于 110℃ 的烟气送入脉冲袋式除尘器净化。除尘后的气体经风机、烟囱排至大气。排气筒出口粉尘浓度 $\leq 30\text{mg}/\text{Nm}^3$ 。循环风机后放散口产生的烟气属于高硫烟气，送入焦炉脱硫系统进行脱硫除尘处理，处理后经焦炉烟囱排放。

The high-temperature flue gas containing flammable and explosive gases, as well as sparks, generated at the coke charging port of the dry quenching furnace top cover, the pre-venting port, and the post-circulating fan vent port (standby bypass) is directed to the upper section of a regenerative cooler for temperature reduction. The gas containing high-concentration coke dust from the coke discharge chute and discharge drop points at the bottom of the dry quenching furnace is introduced to the lower section of the regenerative cooler, where it is mixed with the cooled flue gas. Subsequently, the flue gas with a temperature below 110℃ is sent to a pulse bag filter for purification. The purified gas is then discharged into the atmosphere via a fan and chimney, with the dust concentration at the chimney outlet not exceeding 30 mg/Nm³. The flue gas generated at the post-circulating fan vent port, classified as high-sulfur flue gas, is routed to the coke oven desulfurization system for desulfurization and dust removal treatment before being emitted through the coke oven chimney.

采取上述污染控制措施后，干熄焦环境除尘地面站排放的总尘浓度 $\leq 30\text{mg}/\text{m}^3$ 。

After taking the above pollution control measures, the total dust concentration emitted by the dust removal ground station in the CDQ environment is $\leq 30\text{mg}/\text{m}^3$.

当干熄焦装置检修，采用湿法熄焦。塔顶设有捕尘装置，可减少熄焦过程的大气污染。

When repairing the CDQ unit, wet quenching is adopted. The top of the tower is equipped with a dust catching device, which can reduce atmospheric pollution during the quenching process.

6.4.2 废水 Waste Water

本工程废水可分为两类，即生产排水和生活污水。

The wastewater from this project can be divided into two categories, namely production drainage and domestic sewage.

6.4.2.1 废水的来源 The Source of Wastewater

- a) 生产排水：来源于循环水排污水及过滤器反冲洗水、除盐水处理站排水、锅炉排污水等，其水质除水温略有升高和含有少量悬浮物外，所含其它污染物较少； Production drainage: sourced from circulating water system wastewater and filter backwash water, desalination water station wastewater, boiler wastewater, etc. The water quality contains less of other pollutants except for a slight increase in water temperature and a small amount of suspended solids;
- b) 生活污水：主要来源于厂内的卫生间排水，生活污水量较小，一般含有 COD_{Cr}、BOD₅、氨氮、悬浮物等污染物。 Domestic sewage: mainly comes from the drainage of toilets in the factory. The amount of domestic sewage is relatively small and generally contains COD_{Cr} BOD₅、Pollutants such as ammonia nitrogen and suspended solids.

6.4.2.2 废水的控制及治理措施 Control and Treatment Measures for Wastewater

本工程设分流制排水系统，分为生产排水系统、生活排水系统。为了防止水体污染，在工艺上主要采用无污染或轻污染的工艺技术、设施，对工艺过程不可避免排出的废水则采取相应的治理措施。对排放的生产废水采取清污分流的原则，尽可能提高水的重复利用率，以减少污水的外排量。采取的控制及治理措施如下：

This project is equipped with a diversion drainage system, which is divided into production drainage system and domestic drainage system. In order to prevent water pollution, the process and facilities used in the project are of non polluting or light polluting process, and corresponding treatment measures are taken for the wastewater inevitably discharged from the process. The principle of separating clean and dirty water is adopted for the discharged production

wastewater, aiming to improve the reuse rate of water as much as possible and reduce the external discharge of sewage. The control and governance measures taken are as follows:

a) 生活污水 Domestic Sewage

本工程生活污水主要含有 COD_{Cr}、BOD₅、氨氮、悬浮物等污染物，将其经化粪池初级处理后送生活污水处理装置处理后排放。

The domestic sewage in this project mainly contains pollutants such as COD_{Cr}, BOD₅, ammonia nitrogen, and suspended solids. After preliminary treatment in a septic tank, it will be sent to a domestic sewage treatment facility for further treatment before being discharged.

b) 生产排水 Production Drainage

生产排水主要含有 COD、氨氮等污染因子。对生产废水的控制及治理措施如下：

Production drainage mainly contains pollution factors such as COD and ammonia nitrogen. The control and treatment measures for production wastewater are as follows:

各车间及装置内部设置地坪；污水井、地沟、地坑及管沟设置必要的防渗结构层，防止污染地下水。

Floors are set up inside each workshop and device; Necessary anti-seepage structural layers should be installed in sewage wells, trenches, pits, and pipe trenches to prevent groundwater pollution.

6.4.3 固体废弃物 Solid Waste

本工程产生的固体废弃物主要为废渣，有如下几种：

The solid waste generated in this project is mainly waste residue, which includes the following types:

各除尘系统回收的煤粉尘和焦粉尘；烟气脱硫系统回收的脱硫废灰；厂内产生的生活垃圾等。

The coal dust and coke dust recovered by each dust removal system; The desulfurization waste ash recovered by the flue gas desulfurization system; Domestic waste generated within the factory.

为了防止固体废物造成污染，对固体废物进行综合利用，化废为宝。采取的处理措施如下：

In order to prevent pollution caused by solid waste, comprehensive utilization of solid waste is carried out to turn waste into treasure. The measures taken are as follows:

干熄焦环境除尘地面站收集的粉尘由刮板机运到灰仓贮存，再经加湿搅拌机定期外运。

The dust collected by the dry coke quenching environmental dust removal ground station is transported via scraper conveyors to ash storage silos for temporary storage, and then periodically removed off-site after treatment by dust humidifying mixers.

干熄焦工艺一、二次除尘器所收集的粉尘汇集后落入耐热刮板输送机中，再进入斗式提升机送入专用粉尘贮仓，再经加湿搅拌机加湿后采用汽车定期外运。

The dust collected by the first and second dust collectors in the CDQ process is collected and falls into the heat-resistant scraper conveyor. It then enters the bucket elevator and is sent to a dedicated dust storage bin. After being humidified by a humidification mixer, it is regularly transported by car.

焦炉装煤除尘系统及出焦除尘系统除尘器收集的粉尘由刮板机运到灰仓贮存，再经加湿搅拌机定期外运。

The dust collected by the dust collectors of the coke oven charging dedusting system and coke pushing dedusting system is transported by a scraper conveyor to an ash silo for storage, and then periodically removed and transported externally after being humidified and mixed in a mixer.

烟气脱硫系统产生的脱硫废灰收集至废灰库，可用作制砖、混凝土等原料定期外运。

The desulfurization waste ash generated by the flue gas desulfurization system is collected in the waste ash storage. It can be used as raw materials for making bricks, concrete, etc. and is transported out regularly.

各生活垃圾先倒至指定的垃圾箱，然后定期由垃圾车运至垃圾厂统一处理。

Each household waste is first dumped into the designated garbage bin, and then regularly transported by garbage trucks to the garbage factory for unified treatment.

经采取上述控制措施后，本工程一般工业固体废弃物处置满足《一般工业固体废弃物贮存和填埋污染控制标准》及其修改单要求。

After taking the above control measures, the disposal of general industrial solid waste in this project can meet the requirements of the “Pollution Control Standards for Storage and Landfill of General Industrial Solid Waste” and its amendment.

6.4.4 噪声 Noise

本工程产生的噪声为由于机械的撞击、摩擦、转动等运动而引起的机械噪声以及由于气流的起伏运动或气动力引起的空气动力性噪声，主要噪声源有：粉碎机、振动筛、轴流通风机组、空压机、干熄焦循环风机及循环气体放散口、除尘风机、脱硫引风机、流化风机、废气余热锅炉和干熄焦锅炉安全阀放散管及汽轮机本体、各蒸汽排放口和各种泵类等。一般情况下，在采取噪声控制措施前，各主要噪声源源强均大于 85dB(A)。

The noise generated in this project is caused by mechanical impact, friction, rotation and other movements, as well as aerodynamic noise caused by the fluctuation of airflow or aerodynamic forces. The main sources of noise include: crusher, vibrating screen, axial flow ventilation unit, air compressor, CDQ circulating fan and circulating gas outlet, dust removal fan, desulfurization induced draft fans, fluidized fans, waste gas and waste heat boiler, safety valve outlet pipe and turbine body of CDQ boiler, steam outlet and various pumps. In general, before taking noise control measures, the intensity of each major noise source is greater than 85dB (A).

本工程对噪声的控制主要采取控制噪声源与隔断噪声传播途径相结合的办法，尽可能选用低噪声设备，采用消声、隔振、减振等从声源上控制噪声；采用隔声、吸声、绿化等措施在传播途径上降噪，以控制噪声对厂界四邻的影响。采取的控制措施如下：

The control of noise in this project mainly adopts a combination of controlling the noise source and isolating the transmission path of noise. Low noise equipment is selected as much as possible, and noise is controlled from the sound source through methods such as noise reduction, vibration isolation, and vibration reduction; Adopting measures such as sound insulation, absorption, and greening to reduce noise in the transmission path, in order to control the impact of noise on the surrounding area of the factory boundary. The control measures taken are as follows:

a) 声源治理 Sound source control

在满足工艺设计的前提下，尽量选用低噪声型号的设备。

On the premise of meeting the process design requirements, try to choose low-noise models of equipment.

除尘风机、循环风机、脱硫引风机、流化风机、废气余热锅炉和干熄焦锅炉各放散管等设备均设置消声器。

Silencers are installed on the exhaust pipes of dust removal fans, circulating fans, desulfurization induced draft fans, fluidized fans, waste heat boilers, and CDQ boilers.

为了防止振动产生的噪声污染，预粉碎机、粉碎机、循环风机、各除尘风机、脱硫引风机、各流化风机及泵类设置单独基础达到减振作用；强振设备与管道间采取柔性连接方式。

In order to prevent noise pollution caused by vibration, independent foundations are set up for the crusher, circulating fan, each dust removal fan, desulfurization induced draft fans, fluidized fans and pump to achieve vibration reduction; Flexible connection method is adopted between the strong vibration equipment and the pipeline.

b) 传播途径的治理 Governance of transmission channels

隔声：为防止噪声的扩散与传播，以下设备均设置于室内等建筑厂房中隔声，并采用隔声的建筑材料，如：粉碎机、各除尘风机、循环水泵、汽轮发电循环水泵、汽轮发电机等。

Sound insulation: In order to prevent the spread and propagation of noise, the following equipment is installed in indoor and other building buildings for sound insulation, and soundproof building materials are used, such as: crusher, various dust removal fans, circulating water pump, steam turbine power generation circulating water pump, steam turbine generator, etc.

吸声：排焦装置、循环风机、脱硫引风机、流化风机、循环气体管道等产生高噪音的设备，采取隔音措施以降低噪音。

Sound absorption: For equipment that generates high noise such as coke removal devices, circulating fans, desulfurization induced draft fans, fluidized fans and circulating gas pipelines, sound insulation measures should be taken to reduce noise.

布局措施：在厂内总平面布置中，充分考虑地形、声源方向性及车间噪声强弱，利用建构筑物、绿化植物等对噪声的屏蔽、吸纳作用，噪声源相对集中布置，并尽量远离办公区。对强噪声单独布置，严格控制，以降低其噪声对外环境的影响。

Layout measures: In the overall layout of the factory, full consideration should be given to the terrain, directionality of sound sources, and the strength of workshop noise. The shielding and absorption effects of buildings, green plants, etc. on noise should be utilized. The noise sources should be relatively concentrated and as far away as possible from the office area. Arrange strong noise sources separately and strictly control them to reduce their noise impact on the external environment.

经采取上述措施后，本工程环境噪声强度将大幅降低，各高噪声设备产生的噪声得到控制，厂区边界噪声昼夜预计满足《工厂企业厂界环境噪声排放标准》中表 1 的 3 类标准限值，即昼间 $\leq 65\text{dB(A)}$ ，夜间 $\leq 55\text{dB(A)}$ 。

After taking the above measures, the environmental noise intensity of this project will be significantly reduced, and the noise generated by various high noise equipment will be controlled. The noise at the factory boundary is expected to meet the Class 3 standard limits in Table 1 of the "Factory Enterprise Boundary Environmental Noise Emission Standards", which is $\leq 65\text{dB (A)}$ during the day and $\leq 55\text{dB (A)}$ at night.

6.5 绿化措施 Greening Measures

绿化有利于防止污染，保护环境。在厂区各空旷地带遍植树木花草，提高绿化水平，能净化空气，调节气温，减弱噪声，美化环境，提高环境的自净能力，因而是保护环境的根本性措施之一。

Greening is beneficial to preventing pollution and protecting the environment. Planting trees, flowers and grasses in various open areas of the factory could improve the level of greening, purify air, adjust temperature, reduce noise, beautify the environment, and improve the self-purification ability. Therefore, it is one of the fundamental measures to protect the environment.

本工程根据厂区及工程的具体条件及污染特点，综合考虑排放的污染物性质和地区气候条件，选植适宜的绿化植物。并考虑绿化植物与建构筑物及地下管网的安全防护要求，统筹考虑绿化设计。

This project selects suitable green plants based on the specific conditions and pollution characteristics of the factory and the project, taking into account the nature of the pollutants emitted and the regional climate conditions. And consider the safety protection requirements of green plants, buildings, and underground pipelines, and coordinate the green design.

6.6 环境管理机构及环境监测机构 Environmental Management Agencies and environmental Monitoring Agencies

本工程环境管理机构和环境监测机构由建设单位统一安排设置，环境监测工作由建设单位统一协调解决。

The environmental management organization and environmental monitoring organization of this project are arranged and established by the construction unit, and the environmental monitoring work is coordinated and resolved by the construction unit.

a) 环境管理机构的主要任务 The main tasks of environmental management agencies

严格执行环境保护法规和标准，组织制定和修改本单位的环境保护管理规章制度，并监督执行；制定并组织实施环境保护规划和设计，领导和组织本单位的环境监测，检查本单位的环境保护设施和设备；推广和应用环境保护的先进技术及经验，组织开展本单位的环保专业技术培训，提高人员素质水平；组织开展本单位的环保科研和学术交流。

Strictly implement environmental protection regulations and standards, organize the formulation and modification of environmental protection management rules and regulations of the unit, and supervise their implementation; Develop and organize the implementation of environmental protection plans and designs, lead and organize environmental monitoring of the unit, and inspect the environmental protection facilities and equipment of the unit; Promote and apply advanced technologies and experiences in environmental protection, organize and carry out environmental protection professional technical training, and improve the quality level of personnel; Organize environmental research and academic exchanges within organizations.

b) 环境监测机构主要任务 The main tasks of environmental monitoring

agencies

建设项目环境监测是工业污染源监督管理的重要组成部分，是国家和行业管理部门了解并掌握排污状况和污染趋势的手段。监测数据是执行相关的环境保护法规、进行环境管理和污染防治的依据。因此，应建立完善建设项目的环境监测管理机构。

Environmental monitoring of construction projects is an important component of industrial pollution source supervision and management, and is a means for national and industry management departments to understand and grasp the status and trends of pollution discharge. Monitoring data is the basis for implementing relevant environmental protection regulations, conducting environmental management, and preventing and controlling pollution. Therefore, it is necessary to establish and improve environmental monitoring and management institutions for construction projects.

定期监测建设项目排放的污染物是否符合国家和地方的排放标准；分析所排污染物的变化规律，为制定污染防治措施提供依据；合理布置采样点，并严格执行国家规定的分析方法；负责污染事故的监测和报告。

Regularly monitor whether the pollutants emitted by construction projects comply with national and local emission standards; Analyze the variation patterns of discharged pollutants to provide a basis for formulating pollution prevention and control measures; Reasonably arrange sampling points and strictly implement the analysis methods specified by the state; Responsible for monitoring and reporting pollution accidents.

6.7 投资估算 Investment Estimation

本工程为环保节能项目，其中直接用于环保投资约占工程建设投资的 11.7%。

This project is an environmental and energy-saving project, with direct investment in environmental protection accounting for approximately 11.7% of the construction investment.

6.8 建议 Proposal

炼焦行业的污染源多且复杂，需抓住工艺污染源头的治理及管理，以大幅度减少末端污染源强，达到综合利用、综合治理的目的。

The pollution sources in the coking industry are numerous and complex, and it is necessary to focus on the treatment and management of process

pollution sources in order to significantly reduce the intensity of end point pollution sources and achieve the goal of comprehensive utilization and management.

对于焦电工程应加强对工程全过程的环境管理，包括施工阶段、开工试生产阶段、正常生产过程、非正常及事故状态下的环境管理、监控及应急措施，以尽可能多地减少其影响。此外，应进一步抓好环境管理与协调工作，使环保工作落到实处。最大限度地减轻本工程对环境的影响。

For coking and power engineering, it is necessary to strengthen environmental management throughout the entire process, including construction stage, trial production stage, normal production process, environmental management, monitoring, and emergency measures under abnormal and accident conditions, in order to minimize their impact. In addition, we should further strengthen environmental management and coordination work to ensure that environmental protection work is implemented effectively and mitigate the impact on environment maximum.

7 劳动安全 Work Safety

7.1 编制依据及采用的主要标准 Compilation Basis and Main Standards

7.1.1 编制依据 Compilation basis

- a) 《中华人民共和国劳动法》(1994 年 7 月 5 日第八届全国人民代表大会常务委员会第八次会议通过。2018 年 12 月 29 日第十三届全国人民代表大会常务委员会第七次会议第二次修正); Labor Law of the People's Republic of China(Approved at the 8th meeting of the Standing Committee of the 8th National People's Congress on July 5, 1994. The Second Amendment of the Seventh Meeting of the Standing Committee of the 13th National People's Congress on December 29, 2018);
- b) 《中华人民共和国防震减灾法》(1997 年 12 月 29 日, 第八届全国人民代表大会常务委员会第二十九次会议通过。2008 年 12 月 27 日中华人民共和国第十一届全国人民代表大会常务委员会第六次会议修订通过, 自 2009 年 5 月 1 日起施行); Law of the People's Republic of China on Earthquake Prevention and Disaster Reduction(On December 29, 1997, it was passed at the 29th meeting of the Standing Committee of the 8th National People's Congress. Revised and passed at the 6th meeting of the Standing Committee of the 11th National People's Congress of the People's Republic of China on December 27, 2008, implemented from May 1, 2009);
- c) 《中华人民共和国安全生产法》(2021 年 6 月 10 日, 中华人民共和国第十三届全国人民代表大会常务委员会第二十九次会议于通过《全国人民代表大会常务委员会关于修改〈中华人民共和国安全生产法〉的决定》, 自 2021 年 9 月 1 日起施行)。Work Safety Law of the People's Republic of China (On June 10, 2021, the 29th meeting of the Standing Committee of the 13th National People's Congress of the People's Republic of China passed the Decision of the Standing Committee of the National People's Congress on Amending the Work Safety Law of the People's Republic of China, implemented from September 1, 2021).

7.1.2 采用的主要标准、规范、规程 Main Standards, Specifications, and Regulations

- a) 《建筑设计防火规范(2018年版)》(GB50016-2014); Code for fire protection design of buildings(2018 edition)(GB50016-2014);
- b) 《煤化工工程设计防火标准》(GB51428-2021); Standard for fire protection design of coal chemical engineering(GB51428-2021);
- c) 《爆炸危险环境电力装置设计规范》(GB50058-2014); Code for design of electrical installations in explosive atmospheres(GB50058-2014);
- d) 《消防给水及消火栓系统技术规范》(GB50974-2014); Code of design on fire protection water supply and hydrant systems(GB50974-2014);
- e) 《建筑灭火器配置设计规范》(GB50140-2005); Code for design of extinguisher distribution in buildings(GB50140-2005);
- f) 《建筑物防雷设计规范》(GB50057-2010); Code for design protection of structures against lightning(GB50057-2010);
- g) 《建筑抗震设计标准(2024年版)》(GB/T50011-2010); Standard for seismic design of buildings(2016 edition)(GB/T50011-2010);
- h) 《构筑物抗震设计规范》(GB50191-2012); Design code for antiseismic of special structures(GB50191-2012);
- i) 《工业企业总平面设计规范》(GB50187-2012); Code for design of general layout of industrial enterprises(GB50187-2012);
- j) 《厂矿道路设计规范》(GBJ22-1987); Specifications for the design of factory and mine roads(GBJ22-1987);
- k) 《工业企业厂内铁路、道路运输安全规程》(GB4387-2008); Safety regulation for railway and road transportation in plants of industrial enterprises(GB4387-2008);
- l) 《火灾自动报警系统设计规范》(GB50116-2013); Code for design of automatic fire alarm system(GB50116-2013);
- m) 《石油化工可燃气体和有毒气体检测报警设计标准》(GB/T 50493-2019); Standard for design of combustible gas and toxic gas detection and alarm for petrochemical industry(GB/T 50493-2019);
- n) 《焦化安全规程》(GB12710-2008); Safety code for the coking plant(GB12710-2008);

- o) 《干法熄焦安全规程》(AQ7013-2018); Safety regulations for Coke Dry Quenchi(AQ7013-2018);
- p) 《生产过程安全卫生要求总则》(GB/T12801-2008); General principles for the requirements of safety and health in production process(GB/T12801-2008);
- q) 《生产设备安全卫生设计总则》(GB5083-1999); General rules for designing the production facilities in accordance with safety and health requirements(GB5083-1999);
- r) 《固定式压力容器安全技术监察规程》(TSG 21-2016); Supervision Regulation on Safety Technology for Stationary Pressure Vessel(TSG 21-2016);
- s) 《锅炉安全技术规程》(TSG11-2020); Regulation on Safety Technology for Boiler(TSG11-2020);
- t) 《工业管道的基本识别色、识别符号和安全标识》(GB7231-2003); Basic indentification colors and code indications and safety sign for industrial pipelines(GB7231-2003);
- u) 《安全色》(GB2893-2008); Safety colours(GB2893-2008);
- v) 《安全标志及其使用导则》(GB2894-2008) Safety signs and guideline for the use(GB2894-2008).

7.2 建设地区存在的自然危害因素及主要防范措施 Natural Hazard Factors and Main Prevention Measures in the Construction Area

7.2.1 自然危害因素 Natural Hazard Factors

建设地区存在的主要危害为自然危害因素形成的危害和不利影响，包括地震、不良地质、雷击、暑热、暴雨、洪水、大风等自然因素。

The main hazards in the construction area are the hazards and adverse effects caused by natural hazards, including earthquakes, unfavorable geology, lightning strikes, summer heat, rainstorm, floods, gales and other natural factors.

a) 地震 Earthquake

地震是一种能产生巨大破坏作用的自然现象，一旦发生地震会造成建（构）筑物晃动、坍塌、易燃性介质外泄，进而引发火灾甚至爆炸和人员伤亡。

Earthquake is a natural phenomenon that can cause significant damage.

Once an earthquake occurs, it can cause buildings to shake, collapse, and flammable media to leak out, leading to fires, explosions, and casualties.

b) 不良地质 Adverse geology

不良地质对建筑物的破坏作用较大，甚至影响人员安全。

Adverse geology has a significant destructive effect on buildings, even affecting personnel safety.

c) 雷击 Lightning strike

雷击能破坏建筑物和设备，并可能导致火灾和爆炸危险事故的发生，其出现的机会不大，作用时间短暂。

Lightning strikes can damage buildings and equipment, and may lead to the occurrence of fire and explosion hazards. The likelihood of their occurrence is small, and their duration of action is brief.

d) 气温 Air temperature

人体有最适宜的环境温度，当环境温度超过一定范围时，会产生不舒服感，气温过高会发生中暑。

The human body has the most suitable ambient temperature. When the ambient temperature exceeds a certain range, discomfort may occur, and excessive temperature can lead to heatstroke.

e) 其他 Other

暴雨、洪水和大风威胁工厂安全，其作用范围大，但出现的机会不多；内涝浸渍设备，影响生产，但其对人的危害性较小。大风有可能对建（构）筑物或高设备造成危害，导致建（构）筑物或高设备倒塌，从而引发其它事故。

There are not big possibilities for the occurrence of Rainstorm, flood and gale that threaten the safety of plant; The waterlogging immersion equipment can affect production, but its harm to people is relatively small. Strong winds may cause harm to buildings or high equipment, leading to their collapse and causing other accidents.

总之，自然灾害因素的发生基本是不可避免的，是自然形成的，但可以采取相应措施，以减轻对人员、设备的伤害和损失。

In short, the occurrence of natural hazards is basically inevitable and naturally formed, but corresponding measures can be taken to reduce injuries and losses to personnel and equipment.

7.2.2 主要防范措施 Main Preventive Measures

a) 抗震 Anti-seismic

在建筑设计中, 根据现行《建筑抗震设计标准》和《构筑物抗震设计规范》等国家及行业的规范、标准及规程进行地震作用计算并采取抗震措施。

In architectural design, seismic action calculations are carried out and seismic measures are taken in accordance with current national and industry norms, standards, and regulations such as the “Code for Seismic Design of Buildings” and the “Code for Seismic Design of Structures”.

废气余热锅炉、干熄焦锅炉、汽轮机等大型设备在设备采购时提出防地震等级要求。

Large equipment such as waste heat boilers, dry quenching boilers, and steam turbines seismic protection levels requirements shall be issued during equipment procurement.

在工艺设备设计中, 将有关底座加固处理, 管道采用柔性连接、选择抗震的支架形式等措施。

During the design of process equipment, reinforcement of relevant base, flexible connection method of pipelines, and anti-seismic stand shall be taken into account.

在电气设计中, 变压器滚轮拆下, 按抗震要求固定于轨道上, 防止变压器受损。

In electrical design, the transformer rollers are removed and fixed on the track according to seismic requirements to prevent damage to the transformer.

b) 不良地质 Adverse geology

为了防止或避免不良地质对建筑物的破坏, 在建筑设计中, 根据对本地区地基的承载力、变形及稳定计算, 按相应规范要求设计。

In order to prevent or avoid the damage of unfavorable geology to buildings, site bearing, deformation and stability calculation shall be taken into account during architecture design that follows relevant specifications and codes.

c) 防雷 Lightning protection

对焦炉煤塔、烟囱、干熄焦装置、烟气脱硫装置、汽轮发电站(含除氧)、循环水泵站、10米以上煤处理和焦处理系统等第三类防雷建筑物主要采用避雷

带防直击雷, 每根引下线的冲击接地电阻一般不大于 30Ω ; 放散管、风帽按规范要求采取相应的防雷措施。

For the third type of lightning protection buildings such as coke oven coal towers, chimneys, dry quenching devices, flue gas desulfurization device, steam turbine power stations (including deoxygenation), circulating water pump stations, coal processing and coke processing systems above 10 meters, lightning protection belts are mainly used to prevent direct lightning strikes. The impulse grounding resistance of each down conductor is generally not greater than 30Ω ; Take corresponding lightning protection measures for the vent pipe and wind cap according to the specifications.

对粉碎机室、筛焦楼、焦转运站等第二类防雷建筑物主要采用避雷带(独立针)防直击雷, 引下线不少于两根, 并沿建筑物四周均匀或对称布置, 其间距不大于 18m , 每根引下线的冲击接地电阻不大于 10Ω ; 防雷电感应的措施为建筑物内的设备管道构架等主要金属物就近接至防直击雷接地装置或电气设备的保护接地装置上。

For the second type of lightning protection buildings such as the crusher room, coke screening building, and coke transfer station, lightning protection strips (independent needles) are mainly used to prevent direct lightning strikes. There should be no less than two down conductors arranged evenly or symmetrically around the building, with a spacing of no more than 18m . The impact grounding resistance of each down conductor should not exceed 10Ω ; The measure to prevent lightning induction is to connect the main metal objects such as equipment pipeline structures inside the building to the nearest grounding device for direct lightning protection or the protective grounding device for electrical equipment.

在爆炸和火灾危险环境中做防静电接地设计, 属于户外装置的防静电接地装置与防雷接地装置共用, 对于建筑物内设备的防静电接地利用电气的保护接地装置。

The design of anti-static grounding in explosive and fire hazardous environments, which belongs to the shared use of anti-static grounding devices and lightning protection grounding devices for outdoor devices. For anti-static grounding of equipment inside buildings, electrical protective grounding devices

are used.

配电装置各级采用浪涌保护器以防感应雷及操作过电压。

Surge protectors are used at all levels of the distribution equipment to prevent induced lightning and overvoltage during operation.

d) 防暑 Heatstroke prevention

为了防暑热，在生产厂房内设轴流风机、自然通风帽等措施采取通风换气；在工人休息室、操作室、控制室等，设置空调等装置，进行通风换气。

In order to prevent heatstroke, measures such as axial fans and natural ventilation caps are installed in the production plant for ventilation and air exchange; Install air conditioning and other devices for ventilation and air exchange in worker lounges, operation rooms, control rooms, etc.

e) 其它 Other

为了防止内涝，及时排出雨水，避免积水，损坏设备、厂房，充分利用地形采取相应的排水、排涝措施。

Proper drainage measures for water and waterlogging is designed based on the site terrain to prevent waterlogging and rain from damaging equipment and plant.

建（构）筑物、设备在设计、施工过程中考虑合适的风载荷，避免因大风有可能对建（构）筑物或高设备造成危害，导致建（构）筑物或高设备倒塌，从而引发其它事故。

During the design and construction process of buildings and equipment, appropriate wind loads should be considered to avoid the possibility of damage caused by strong winds, which may lead to the collapse of buildings or equipment and cause other accidents.

7.3 生产过程中主要危害因素及主要防范措施 Main Hazard Factors and Prevention Measures in the Production Process

7.3.1 生产过程主要危害因素 Main Hazards in the Production Process

本工程生产过程中的主要危险、危害因素有：中毒和窒息、火灾、泄漏、物体打击、车辆伤害、机械伤害、起重伤害、触电、淹溺、灼烫、高处坠落、爆炸、其他伤害等。

The main hazards in the production process including toxic matters and

suffocation, fire, leakage, object strikes, vehicle injury, mechanical injury, lifting injury, electric shock, drowning, scalding, falling, explosion, and other injuries.

表 7-1 可能产生的危险有害因素
Table 7 1 Possible Hazardous and Harmful Factors

序号 No.	装置名称 Device Name	可能产生危险的 有害因素 Hazard factors that may cause danger	产生部位 Cause of Possible Locations
1	备煤 Coal preparation	粉尘、火灾、机械伤害、噪声 Dust, fire, mechanical injury, noise	带式输送机、转运站、粉碎机 Belt conveyor, transfer station, crusher
2	炼焦 coking	火灾、爆炸、中毒、粉尘、噪声、高温、机械伤害、起重伤害、高处坠落 Fire, explosion, poisoning, dust, noise, high temperature, mechanical injury, lifting injury, falling	焦炉、装煤车、推焦机、拦焦机、焦罐车、熄焦车、干熄炉、给料机、电机车、提升机 Coke oven, charging car, coke pusher, coke guide, coke bucket car, quenching coke car, CDQ chamber, feeder, electric locomotive, crane
3	湿熄焦系统 Wet quenching system	火灾、中毒、粉尘、噪声、高温、机械伤害 Fire, poisoning, dust, noise, high temperature, mechanical injury	熄焦泵房、熄焦塔、折流板式除尘装置、粉焦沉淀池 Quenching pump room, quenching tower, Baffled plate dust removal device, Powder coke sedimentation tank
4	热力系统 thermodynamic system	火灾、中毒、粉尘、噪声、高温、机械伤害、冻伤 Fire, poisoning, dust, noise, high temperature, mechanical injury, deep cold	废气余热锅炉、干熄焦锅炉、汽轮机、发电机、空气压缩机、液氮站 Waste gas waste heat boiler, CDQ boiler, steam turbine, generator, air compressor, Liquid nitrogen machine
5	焦处理 Coke processing	火灾、粉尘、噪声、机械伤害 Fire, dust, noise, mechanical injury	焦台、带式输送机、振动筛 Coke wharf, belt conveyor, vibrating screen
6	循环水泵站、生产消防水泵房 pumping station for circulating water、Process & fire water pump station	噪声、机械伤害、起重伤害、淹溺 Noise, mechanical injury, lifting injury, drowning	水泵、水池、起重设备 Pump, pool, lifting rig

序号 No.	装置名称 Device Name	可能产生危险的 有害因素 Hazard factors that may cause danger	产生部位 Cause of Possible Locations
7	烟气脱硫系统 Flue gas desulfurization device	粉尘、噪声、高温、机械伤害、高处坠落 Dust, noise, high temperature, mechanical injury, lifting injury, falling	输灰系统、风机、水泵、烟道、脱硫塔、除尘器 Ash conveying system, fans, water pumps, flue, desulfurization tower, dust collector

a) 火灾、爆炸 Fire and Explosion

火灾是一种燃烧现象，当燃烧失去控制时，便形成火灾事故，火灾事故能造成较大的人员及财产损失。

Fire is a burning phenomenon, and when it is out of control, it forms a fire accident, which can cause significant personnel casualties and property damage.

物质发生变化的速度不断急剧增大，并在极短时间内释放大量的能量的现象称为爆炸。爆炸也能造成较大的人员伤亡及财产损失。

The phenomenon where the speed of material change rapidly increases and releases a large amount of energy in an extremely short period of time is called an explosion. Explosions can also cause significant casualties and property damage.

b) 其他安全事故 Other accidents and incidents

物体打击、车辆伤害、机械伤害、起重伤害、触电、淹溺、灼烫、高处坠落等事故均对人体形成伤害，严重时可能造成人员的伤亡。如：装煤、出焦在操作台周围易发生高处坠落、灼烫等人身事故。

Accidents/Incidents such as object strikes, vehicle injuries, mechanical injuries, lifting injuries, electric shocks, drowning, scalding, and falling can all cause harm to the human body, and in severe cases, can result in casualties. For example, around the operation table, coal loading and coke discharge are prone to personal accidents such as falling, scalding, etc.

压力容器的事故易造成设备损坏，危及人身安全。

Accidents involving pressure vessels can easily cause equipment damage and endanger personal safety.

腐蚀易造成管道设备损坏，危及人身安全。

Corrosion can easily cause damage to pipeline equipment and endanger personal safety.

停电事故影响生产，甚至损坏设备，造成有害物外逸，危及人身安全。

Power outage accidents affect production and even damage equipment, causing harmful substances to escape and endangering personal safety.

7.3.2 主要防范措施 Main Preventive Measures

a) 有毒气体防治 Toxic gas prevention and control

炼焦车间：焦炉炉门修理站、炉顶端台及间台设置高效低噪移动轴流风机，及时排除工作区有害气体。干熄炉排焦地下室设置事故通风，以排除 CO 等有害气体，改善维修人员操作环境。

Coking workshop: The coke oven door repair station, furnace top end platform, and intermediate platform are equipped with efficient and low-noise mobile axial flow fans to timely eliminate harmful gases in the working area. Emergency ventilation is installed in the basement of the CDQ furnace grate coke to eliminate harmful gases such as CO and improve the operating environment for maintenance personnel.

公辅设施厂房设置轴流风机进行机械通风以排除余热、余湿及有害气体。

Axial flow fans are installed in the public auxiliary facility factory for mechanical ventilation to eliminate waste heat, residual humidity, and harmful gases.

采取上述措施后，降低了工作区有害气体浓度，改善了工作人员操作环境。

After taking the above measures, the concentration of harmful gases in the work area was reduced and the operating environment for workers was improved.

可燃及有毒气体检测报警系统独立设置，指示报警设备设置在焦化区域集中控制室内。

The combustible and toxic gas detection and alarm system is independently set up, and the indicator alarm equipment is set in the centralized

control room of the coking area.

在干熄焦装置等可燃/有毒气体可能泄漏的装置及单元设置固定式气体检测报警探测器，并在现场设声光报警器。

Fixed gas detection alarm detectors shall be installed in devices and units where combustible/toxic gases may leak, such as CDQ equipment ,and sound and light alarms shall be installed on site.

b) 防火、防爆 Fire and explosion prevention

平面布置原则是在满足生产工艺要求的基础上，根据交通运输、消防、安全、卫生、综合管网及施工等要求，预留发展用地等要求进行平面布置。

The principle of plain layout is to reserve development land and other requirements based on the requirements of transportation, fire protection, safety, hygiene, comprehensive pipeline network, and construction, while meeting the production process requirements.

在工艺设计中，有燃爆性粉尘产生的场所设机械除尘装置，使燃爆性粉尘浓度远低于其爆炸下限，产生燃爆性气体的厂房室内设置相应的通排风装置，使燃爆性气体的浓度低于其爆炸下限。除尘器布袋采用防静电滤料，并采取防静电接地措施，以防止静电引起火灾。在除尘器、阻火器设置安全泄爆装置，可以避免或减少事故造成的损失。

In process design, mechanical dust removal devices are installed in places where explosive dust is generated, so that the concentration of explosive dust is much lower than its lower explosive limit. Corresponding ventilation and exhaust devices are installed in the factory rooms where explosive gas is generated, so that the concentration of explosive gas is lower than its limit. The dust collector bag adopts anti-static filter material and adopts anti-static grounding measures to prevent static electricity from causing fires. Installing safety explosion relief devices in dust collectors and flame arresters can prevent or reduce losses caused by accidents.

大型除尘系统各设备之间采取可靠的联锁控制，对系统运行过程中关键设备的工作参数进行监测，并根据监测结果采取声光报警、联锁启动或停机等措施，以预防事故的发生。

Reliable interlocking control is adopted between the various equipment of the large-scale dust removal system to monitor the working parameters of key

equipment during system operation. Based on the monitoring results, measures such as sound and light alarm, interlocking start or stop are taken to prevent accidents from occurring.

本工程设置集中火灾报警系统。集中火灾报警控制器及消防联动控制器设置在控制室内。系统下设 2 台区域火灾报警控制器，设置在汽轮发电站、变配电所或值班室内。

This project is equipped with a centralized fire alarm system. The centralized fire alarm controller and fire linkage controller are installed in the control room. There are two local fire alarm controllers under the system, which are installed in the steam turbine power station, substation or duty room.

在电气室、变电所及机柜间等有火灾危险场所设置感烟、感温火灾探测器，手动报警按钮及声光报警器。火灾报警设备选用智能型总线制。

Installing smoke and temperature fire detectors, manual alarm buttons, and audible and visual alarms in areas with fire hazards such as electrical rooms, substations, and cabinet rooms. The fire alarm equipment adopts an intelligent bus system.

在转运站及通廊设置缆式线型感温火灾探测器。并参与水幕系统的消防联动。

Installing cable type linear temperature fire detectors at transfer stations and corridors. And participate in the fire linkage of the water curtain system.

本项目对生产装置、设备及其管线均做防静电接地，不允许有与地相绝缘的金属设备或金属零部件。管道的法兰连接处做好跨接。较长距离管道间距 100 米接地。将工艺管道始、末端、交叉处及间距小于 100mm 的平行管道每隔 20m 跨接一次并接地。

This project implements anti-static grounding for plant, equipment, and pipelines, which does not allow any metal equipment or components that are insulated from the ground. Ensure proper bridging at the flange connection of the pipeline. For longer pipelines, grounding shall be provided at intervals of 100 meters. Cross connect the beginning, end, intersection, and parallel pipelines with a spacing of less than 100mm every 20 meters and ground them.

本工程工作接地、保护接地、防雷接地、防静电接地共用接地网，接地电阻阻值根据最小阻值确定。

The grounding, protective grounding, lightning protection grounding, and

anti-static grounding of this project share a common grounding network, The grounding resistance value is determined based on the minimum resistance value.

在爆炸和火灾危险场所严格按照环境的危险类别或区域配置相应的电器设备和灯具。

Strictly configuring corresponding electrical equipment and lighting fixtures according to the hazardous categories or areas of the environment in areas with explosion and fire hazards.

汽轮发电站室内设明装消火栓；室外设地上式消火栓；粉碎机室、筛焦楼、运焦通廊、汽轮发电站等均按中国标准要求配置灭火器。

The turbine power station is equipped with exposed indoor fire hydrants; above-ground fire hydrants are installed outdoors; facilities such as the crusher room, coke screening building, coke conveyor gallery, and turbine power station are all provided with fire extinguishers in accordance with Chinese standard requirements.

c) 防泄漏措施 Leakage prevention measures

干熄焦装置为大型的换热系统，为防止循环气体系统因温度变化而引起的泄露，在干熄炉与一次除尘器之间以及一次除尘器与干熄焦锅炉之间设置了高温补偿器，风机后的循环气体管路上也设置了多个低温补偿器，防止因温度变化引起的伸缩造成循环气体泄漏。

The CDQ device is a large-scale heat exchange system. In order to prevent leakage caused by temperature changes in the circulating gas system, high-temperature compensators are installed between the CDQ furnace and the primary dust collector, as well as between the primary dust collector and the CDQ boiler. Multiple low-temperature compensators are also installed on the circulating gas pipeline after the fan to prevent leakage of the circulating gas caused by temperature changes.

主蒸汽管线、主给水管线、高温再热蒸汽管线、低温再热蒸汽管线按照相应规范要求管道应力分析，防止高温高压管道因管道应力增大造成开裂、疲劳、垮塌等现象，防止管道泄漏。

The main steam pipeline, main water supply pipeline, high-temperature reheated steam pipeline, and low-temperature reheated steam pipeline shall

undergo pipeline stress analysis according to corresponding specifications to prevent cracking, fatigue, collapse, and other phenomena caused by increased pipeline stress in high-temperature and high-pressure pipelines, and to prevent pipeline leakage.

d) 压力管道及压力容器安全措施 Safety measures for pressure pipelines and pressure vessels

本工程压力管道的设计、制造均按照“压力管道”的有关规定，从本质上保证压力管道的安全运行。具体措施如下：

The design and manufacturing of pressure pipelines in this project comply with the relevant regulations of "pressure pipelines", fundamentally ensuring the safe operation of pressure pipelines. The specific measures are as follows:

- 1) 正确选择压力管道材质，管配件及阀门；合理设置压力管道支吊架。严格按压力管道的规定进行分级； Correct selection of pressure pipeline materials, fittings, and valves; Reasonably set up pressure pipeline supports and hangers. Strictly classified according to the regulations of pressure pipelines;
- 2) 介质为气（汽）相的压力容器，均设计安全阀，以此保证压力容器的安全； Pressure vessels with gas (vapor) phase as the medium are designed with safety valves to ensure the safety of the pressure vessels;
- 3) 输送气体介质的压力管道，如压缩空气、蒸汽、氮气等管道与相关设备总是相连的，压力容器上的安全设施即保护了这些压力管道； Pressure pipelines for transporting gas media, such as compressed air, steam, nitrogen, etc., are always connected to related equipment, and safety facilities on pressure vessels protect these pressure pipelines;
- 4) 严格控制运行参数，对压力、温度进行自动监测及控制，超限自动报警； Strictly control operating parameters, automatically monitor and control pressure and temperature, and automatically alarm when exceeding limits;
- 5) 压力容器储罐上装有安全阀，以保证安全操作； Pressure vessel storage tanks are equipped with safety valves to ensure safe

operation;

- 6) 压力容器设置各种检测报警设施,如温度、压力、液位检测设施等,以及安全泄压设施,如安全阀、调节阀等。Pressure vessels are equipped with various detection and alarm facilities, such as temperature, pressure, and liquid level detection facilities, as well as safety relief facilities, such as safety valves and control valves.

e) 电气安全措施 Electrical safety measures

本工程大部分负荷属于一、二级负荷,因此受电电源为双重电源。每个回路皆能承担各自负荷的 100%。

Most of the loads in this project belong to the first and second grade loads, so the power supply is a duplicate supply. Each loop can bear 100% of its own load.

依据《爆炸危险环境电力装置设计规范》的规定,按照爆炸危险区域的分区,在 2 区爆炸性气体环境选用隔爆型电气设备。在 2 区爆炸性气体环境选用隔爆型或增安型电气设备。22 区爆炸性粉尘环境选用粉尘防爆型电气设备、灯具。

According to the "Design Specification for Electrical Equipment in Explosive Hazardous Environments", explosion-proof electrical equipment is selected in Zone 2 explosive gas environments according to the zoning of explosive hazardous areas. Select explosion-proof or increased safety electrical equipment in explosive gas environments in Zone 2. Dust explosion-proof electrical equipment and lighting fixtures are selected for explosive dust environments in Zone 22.

为了防止触电事故并保证检修安全,裸露滑触线高度 $>3.5\text{m}$ 。当裸露滑触线高度 $<3.5\text{m}$ 时设安全防护网;两处及多处操作的设备在机旁设事故开关;电气设备的外露导电部分应按系统的接地形式通过保护线(PE 线)或保护中性线(PEN 线)接地,有些设备必要时设置漏电保护装置。

In order to prevent electric shock accidents and ensure maintenance safety, the height of the exposed sliding contact wire is greater than 3.5m. Install safety nets when the height of the exposed sliding contact line is less than 3.5m; Equipment operated in two or more locations shall be equipped with accident switches at the machine side; The exposed conductive parts of electrical equipment should be grounded through protective wires (PE wires) or

protective neutral wires (PEN wires) according to the system grounding form. Some equipment may be equipped with leakage protection devices if necessary.

在电气室、地下通廊、封闭楼梯间等处设应急照明，消防设施构筑物应急照明电源自消防设置的专用供电回路引来。

Emergency illumination shall be installed in electrical rooms, underground corridors, enclosed stairwells, etc. The emergency illumination power supply for fire protection facilities and structures shall be introduced from the dedicated power supply circuit set up by the fire department.

焦炉机械设走行灯、铃信号，各滑触线设防止触电警牌，高度不低于安全距离，拦焦机、电机车、捣固装煤车、推焦机之间设联锁控制装置，可避免红焦落地。

The coke oven machinery is equipped with running lights and bell signals, and each sliding contact line is equipped with anti electric shock warning signs, with a height not lower than the safe distance. Interlocking control devices are installed between the coke blocking machine, electric locomotive, charging car, and coke pusher to prevent red coke from falling to the ground.

所有生产场所的带式输送机设置事故联锁停车装置，并有灯光、音响信号。

All belt conveyors in production sites are equipped with accident interlocking parking devices and light and sound signals.

备煤、运焦等系统设启动前能发出音响的启动预示信号装置，并采取逆料流的联锁措施，防止故障停车时压料。

The coal preparation, coke transportation and other systems are equipped with a start warning signal device that can emit an audio signal before starting, and interlocking measures for reverse material flow are taken to prevent material pressure during fault shutdown.

粉碎机设有电流表，电压表及盘车自动断电联锁，并在粉碎机前设有电磁除铁器。煤、焦皮带输送机及有关设施，按工艺要求集中联锁控制，并设有跑偏检测器、头尾部自动清扫装置、逆止器、紧急停车装置、纵向撕裂装置等。

The crusher is equipped with an ammeter, a voltmeter, and an automatic power off interlock for the trolley, and an electromagnetic iron remover is installed in front of the crusher. Coal and coke belt conveyors and related facilities are centrally interlocked and controlled according to process

requirements, and are equipped with deviation detectors, automatic cleaning devices for the head and tail, backstops, emergency stop devices, longitudinal tearing devices, etc.

为了防止触电事故，电气设备的外露导电部分应按系统的接地形式通过保护线（PE 线）接地，有些设备必要时设置漏电保护。

In order to prevent electric shock accidents, the exposed conductive parts of electrical equipment should be grounded through protective wires (PE wires) according to the system grounding form, and some equipment may be equipped with leakage protection if necessary.

对电磁辐射的防护措施：变压器、配电屏等设置在单独的房间内。

Protective measures against electromagnetic radiation: Transformers, distribution screens, etc. are placed in separate rooms.

变压器滚轮拆下，按防震要求固定于轨道上，避免变压器受损。

Remove the transformer roller and fix it on the track according to seismic requirements to avoid damage to the transformer.

本工程电缆桥架穿过墙、楼板采用防火隔板、堵料进行封堵。

The cable tray passes through walls and floors, which sealed with fireproof partitions and blocking materials.

f) 系统安全措施 Safety Measures of Control system

为了保障生产过程控制系统和计算机的安全，确保控制方案的顺利实施，保证控制系统及计算机系统连续运行，在控制系统设计中遵循以预防为主的原则，采取相应的安全措施，使工艺生产安全有效进行。

In order to ensure the safety of the production process control system and computer, ensure the smooth implementation of the control plan, and ensure the continuous operation of the control system and computer system, the principle of prevention is followed in the design of the control system, and corresponding safety measures are taken to ensure the safe and effective production of the process.

减少安全隐患，提高管理水平，控制室的设置和管理尽量集中；为防止电流过载造成控制设备损坏，控制室内设置系统安全接地；为防止供电故障对生产过程控制系统的影响，生产过程控制级系统均采用 UPS 供电；为提高控制系统的运行率，保障工艺流程连续正常运行，基础控制级采用性能可靠的 DCS 产品，

针对生产的主流程的控制系统均采用冗余(或热备)控制系统配置,其中控制器、电源和网卡为冗余(热备)配置;为提高控制设备的管理水平,及时发现安全隐患,监控级对所有控制系统的设备进行状态监视、诊断和报警。

Reduce safety hazards, improve management level, and concentrate the setting and management of control rooms as much as possible; To prevent damage to control equipment caused by current overload, a system safety grounding is installed in the control room; To prevent the impact of power supply failures on the production process control system, UPS power supply is used for all production process control level systems; To improve the operational efficiency of the control system and ensure the continuous and normal operation of the process flow, reliable DCS products are used for the basic control level, and redundant (or hot standby) control system configurations are used for the control systems of the main production process. The controller, power supply, and network card are configured in a redundant (hot standby) configuration; To improve the management level of control equipment and timely detect safety hazards, the monitoring level monitors, diagnoses, and alarms the status of all control system equipment.

计算机网络采取相应的防雷、防静电、防病毒、防黑客等措施。

Corresponding measures such as lightning protection, anti-static, anti virus, and anti hacker should be taken for computer networks.

g) 建构筑物安全措施 Safety measures for buildings and structures

设计中应贯彻“预防为主, 防消结合”的原则, 对所有建筑物的防火要求, 包括材料的选用、布置、构造、疏散等均按现行的建筑设计防火规范执行。

The principle of "prevention first, combined with fire prevention" should be implemented in the design, and the fire prevention requirements for all buildings, including material selection, layout, construction, evacuation, etc., should be implemented in accordance with the current building design fire prevention standards.

电气室毗邻比空气重的爆炸性气体环境 2 区时, 室内地面高出室外地面 0.6m; 其它电气室室内外高差不小于 0.3m。

When the electrical room is adjacent to Zone 2 of an explosive gas environment that is heavier than air, the indoor ground should be 0.6m higher

than the outdoor ground; The height difference between indoor and outdoor in other electrical rooms shall not be less than 0.3m.

h) 其他安全措施 Other safety measures

为了防止机械伤害及坠落事故的发生，生产场所梯子、平台及高处通道均设置安全栏杆；设备的可动部件设置必要的安全防护网、罩；地沟、水井设置盖板；有危险的吊装口、安装孔等处则设安全围栏。

In order to prevent mechanical injuries and falling accidents, safety railings are installed on ladders, platforms, and high-altitude passages in the production site; Necessary safety nets and covers should be installed on the movable parts of the equipment; Install cover plates for trenches and water wells; Safety fences shall be installed at dangerous lifting openings, installation ovens, etc.

安全标识、标志设计：按国家有关规定设置标识牌、警示牌。

Safety marking and sign design: Setting up signboard and warning signs in accordance with relevant national regulations.

i) 备用措施及应急手段 Stand-by measures and emergency measures

本工程在易发生事故的生产场所设置相应的事故应急照明设施，并建议设置必备的防尘防毒口罩、防护手套、防护服、防毒面具、呼吸器、急救药品与器械等事故应急器具。

This project will install corresponding emergency illumination facilities in production areas prone to accidents, and it is recommended to install necessary dust and gas masks, protective gloves, protective clothing, gas masks, respirators, first aid drugs and equipment, and other emergency equipment.

自动控制系统设置相应的手动装置。

The automatic control system is equipped with corresponding manual devices.

主要生产厂房拟设两个以上的安全出入口，并执行相应规定。

The main production plant is planned to have two or more safety entrances and exits, and corresponding regulations will be implemented.

通向室外主通道设事故排风的启动按钮。

Install a start button for emergency ventilation in the main outdoor passage.

7.4 劳动安全机构设置 Establishment of Work Safety Institutions

本工程为危险化学品生产装置，劳动安全防护机构由公司统一安排，应设置

专门的安全管理机构和专职安全管理人员，安全管理机构全面负责全厂的安全卫生工作，负责对全厂职工及外来相关人员进行安全卫生知识的培训和教育，进行日常安全知识的宣传，监督检查安全生产管理制度的执行情况，定期对全厂的安全工作进行检查，保证各项安全设施的正常使用，组织编制本单位事故应急预案并定期进行演练，发生事故后及时处理并上报等。

This project is a hazardous chemical production facility, and the labor safety protection organization is arranged by the company. A dedicated safety management organization and dedicated safety management personnel should be established. The safety management organization is fully responsible for the safety and health work of the entire factory, providing training and education on safety and health knowledge to all employees and external personnel, promoting daily safety knowledge, supervising and inspecting the implementation of safety production management systems, regularly inspecting the safety work of the entire factory, ensuring the normal use of various safety facilities, organizing the preparation of the unit's accident emergency plan and conducting regular drills, and promptly handling and reporting accidents.

7.5 投资估算 Investment Estimation

本工程直接用于劳动安全投资约占工程建设投资的 9.97%。

The investment directly spent on work safety accounts for approximately 9.97% of the construction investment.

7.6 预期达到的效果 Expected Result

本工程采取劳动安全防护措施后，各项安全设计符合有关要求，可以达到较好的安全生产水平。一般情况下可基本避免中毒、火灾、爆炸等各类危险事故的发生，一旦出现事故，即可采取相应的备用和应急措施，将事故造成的损失减少到最低限度。

The work safety protection measures taken in this project can meets various safety design requirements and reach good safe production level. Under normal circumstances, the measures can effectively prevent poisoning, fire, explosion and other dangerous incidence from occurring; on the other hand, when incidence occurred, spare and emergency measures will be taken to minimize damages caused by the incidence.

7.7 建议 Proposal

由于本工程规模较大，因此应格外注意施工期的安全问题，设置必要的设施及维修、保养、日常检测、检验人员。各部门协调配合，加强管理，以减少由于交叉作业而有可能造成的有害影响。

Given by the large scale of this project, special attention should be paid on safety issues during the construction period, and necessary facilities and maintenance, daily testing, and inspection personnel should be deployed. Coordinate and cooperate with various departments, strengthen management, to reduce the potential harmful effects caused by cross operations.

建议工程投产后，公司应进一步抓好安全管理与协调工作，尤其要加强操作人员的职业技术培训及安全教育工作，使安全工作落到实处。此外，还需加强安全设施及设备的维修及维护，使其充分发挥作用，始终能以最佳运行状态投入生产。

It is recommended that after the project is put into operation, the company should further focus on safety management and coordination work, especially strengthen the vocational technical training and safety education of operators, so as to ensure the implementation of safety work. In addition, it is necessary to strengthen the maintenance and repair of safety facilities and equipment, so that they can play a full role and always in top performance.

8 职业卫生 Occupational Health

8.1 编制依据及采用的规范 Compilation Basis and Adopted Specifications

8.1.1 编制依据 Compilation Basis

- a) 《中华人民共和国职业病防治法》(2001 年 10 月 27 日第九届全国人民代表大会常务委员会第二十四次会议通过。2018 年 12 月 29 日第十三届全国人民代表大会常务委员会第七次会议第四次修正)；

Occupational Disease Prevention and Control Law of the People's Republic of China (Approved at the 24th meeting of the Standing Committee of the 9th National People's Congress on October 27, 2001. The Fourth Amendment of the Seventh Meeting of the Standing Committee of the 13th National People's Congress on December 29, 2018);

- b) 《中华人民共和国劳动法》(中华人民共和国主席令第二十四号，根据 2018 年 12 月 29 日第十三届全国人民代表大会常务委员会第七次会议《关于修改<中华人民共和国劳动法>等七部法律的决定》第二次修正)；

Labor Law of the People's Republic of China (Order No. 24 of the President of the People's Republic of China, revised for the second time in accordance with the 《Decision on Amending the Labor Law and Other Seven Laws of the People's Republic of China issued at the 7th Meeting of the Standing Committee of the 13th National People's Congress on December 29, 2018);

- c) 《建设项目职业病防护设施“三同时”监督管理办法》(国家安全生产监督管理总局令第 90 号，自 2017 年 5 月 1 日起施行)。

Supervision and Management Measures for the "Three Simultaneities" of Occupational Disease Prevention Facilities in Construction Projects (Order No. 90 of the State Administration of Work Safety, implemented from May 1, 2017).

8.1.2 采用的主要标准、规范、规程 Main Standards, Specifications, and Regulations Adopted

- a) 《建筑采光设计标准》(GB50033-2013)； Standard for daylighting

- design of buildings (GB50033-2013);
- b) 《建筑照明设计标准》(GB/T50034-2024); Standard for lighting design of buildings(GB/T50034-2024);
 - c) 《工业建筑供暖通风与空气调节设计规范》(GB50019-2015); Design code for heating ventilation and air conditioning(GB50019-2015);
 - d) 《石油化工可燃气体和有毒气体检测报警设计标准》(GB/T 50493-2019); Standard for design of combustible gas and toxic gas detection and alarm for petrochemical industry(GB/T 50493-2019);
 - e) 《工业企业设计卫生标准》(GBZ1-2010); Hygienic standards for the design of industrial enterprises (GBZ1-2010);
 - f) 《工业企业噪声控制设计规范》(GB/T50087-2013); Specifications for the design of noise control system in industrial enterprises (GB/T50087-2013);
 - g) 《焦化安全规程》(GB12710-2008); Safety code for the coking plant (GB12710-2008);
 - h) 《生产过程安全卫生要求总则》(GB/T12801-2008); General principles for the requirements of safety and health in production process (GB/T12801-2008);
 - i) 《焦化行业防尘防毒技术规范》(AQ/T4219-2012); Technical specification of dust and posion control for coking industry (AQ/T4219-2012);
 - j) 《工作场所有害因素职业接触限值 第 1 部分：化学有害因素》(GBZ2.1-2019); Occupational exposure limits for hazardous agents in the workplace Part1:Chemical hazardous agents (GBZ2.1-2019);
 - k) 《工作场所有害因素职业接触限值 第 2 部分：物理因素》(GBZ2.2-2007); Occupational exposure limits for hazardous agents in the workplace Part2:Physical agents (GBZ2.2-2007);
 - l) 《用人单位劳动防护用品管理规范》安监总厅安健[2018]3 号; Management Specification for Labor Protection Equipment of Employers General Administration of Work Safety Anjian [2018] No. 3;

m) 《个体防护装备配备规范第 1 部分：总则》(GB39800.1-2020)。

Specification for the provision of personal protective equipment Part
1:General requirement (GB39800.1-2020).

8.2 建设地区存在的自然危害因素及防范措施 Natural Hazards and Prevention Measures in Construction Areas

8.2.1 自然危害因素 Natural Hazards

建设地区存在的自然危害因素主要包括暑热、日晒、风向等自然因素。

The natural hazards in the construction area mainly include heat, sunlight, wind, and other natural factors.

a) 气温 Temperature

人体有最适宜的环境温度，当环境温度超过一定范围时，会产生不舒服感，气温过高会发生中暑。

The human body has the most suitable ambient temperature. When the ambient temperature exceeds a certain range, discomfort may occur, and excessive temperature can lead to heatstroke.

b) 日晒和采光 Sunlight and daylighting

日晒和采光不足会使人的视觉产生不舒服感，且影响室内的卫生环境。可影响到工人的操作进而产生不安全因素。

Insufficient sunshine and lighting can cause visual discomfort and affect indoor hygiene. It can affect the operation of workers and generate unsafe factors.

c) 风向 Wind direction

风向对有害物质的输送作用明显，人员处于危害源的下风向极为不利。

The wind direction has a significant impact on the transportation of harmful substances, and personnel are extremely disadvantaged in the downwind direction of the hazard source.

自然危害因素的发生基本是不可避免的，是自然形成的，但可以采取相应措施，以减轻对人员、设备的伤害和损失。

The occurrence of natural hazards is basically inevitable and naturally formed, but corresponding measures can be taken to reduce injuries and losses to personnel and equipment.

8.2.2 主要防范措施 Main Preventive Measures

a) 采光、通风及日晒 Daylighting, ventilation, and sun exposure

主要建筑物尽量采用南北朝向，避免西晒，若有东西向的采取遮阳措施，并组织好自然通风，以提供高质量的采光条件，保证工作人员的视觉需求得到满足。合理的日照时数保证各岗位室内的卫生环境及职工的用眼卫生。建筑物设计应满足《建筑采光设计标准》、《建筑照明设计标准》中的有关规定。

The main buildings should be oriented from north to south as much as possible to avoid being exposed to the sun. If there is an east-west orientation, shading measures should be taken, and natural ventilation should be organized to provide high-quality lighting conditions to ensure that the visual needs of the staff are met. Reasonable sunshine hours ensure the indoor hygiene environment of each position and the eye hygiene of employees. The design of buildings should comply with the relevant provisions of the "Building Daylighting Design Standards" and the "Building Lighting Design Standards".

b) 风向 Wind direction

风向及风速对有害尘毒的传输作用十分明显，其对噪声的传输作用也十分显著。

The transmission effect of wind direction and speed on harmful dust and toxins is very obvious, and their transmission effect on noise is also very significant.

8.3 生产过程中主要职业病危害因素及防范措施 Main Occupational Hazards and Prevention Measures during the Production Process

本工程生产过程中的主要职业病危害因素有尘毒危害、高温辐射、电磁辐射、振动、噪声、化学试剂危害等。

The main occupational hazards in the production process of this project include dust and toxin hazards, high-temperature radiation, electromagnetic radiation, vibration, noise, chemical reagent hazards, etc.

8.3.1 生产过程主要职业病危害因素分析 Analysis of Main Occupational Disease Hazards in the Production Process

a) 尘毒危害物 Dust and toxic hazards

粉尘分为两类，直径 $>10\mu\text{m}$ 者，称为降尘；直径 $\leq 10\mu\text{m}$ 者，称为飘尘；直

径在 $0.5\mu\text{m}\sim 5\mu\text{m}$ 之间者, 对人体危害最大。尤其是粉尘表面尚有催化作用以及附着的有害物之间的协同作用, 由此而形成新的危害物, 其毒性远胜于各个单体危害性的综合, 可以形成多种疾病。

Dust can be divided into two categories, with a diameter greater than $10\mu\text{m}$, which is called dust fall; A diameter $\leq 10\mu\text{m}$ is called floating dust; Those with a diameter between $0.5\mu\text{m}$ and $5\mu\text{m}$ pose the greatest harm to human health. Especially on the surface of dust, there is still a catalytic effect and a synergistic effect between attached harmful substances, which forms new harmful substances. Their toxicity far exceeds the combined harmfulness of various monomers, and can form various diseases.

CO 是一种无色、无味、无臭的气体, 比重为 0.967, 燃烧时呈浅兰色火焰, 主要来源于煤气系统的泄漏和燃料的不完全燃烧。人体吸入 CO 后, 即与血红蛋白结合, 生成碳氧血红蛋白(COHb), 阻碍血液输氧, 造成人体缺氧中毒。空气中浓度达到 $1.2\text{g}/\text{m}^3$ 时, 短时间可致人死亡。

CO is a colorless, odorless, and odorless gas with a specific gravity of 0.967. It forms a light blue flame during combustion, mainly due to gas system leaks and incomplete combustion of fuel. After inhaling CO, the human body combines with hemoglobin to produce carboxyhemoglobin (COHb), which hinders blood oxygen delivery and causes hypoxia and poisoning in the human body. When the concentration in the air reaches $1.2\text{g}/\text{m}^3$, it can cause death in a short period of time.

SO₂ 是无色、不燃、有恶臭, 并具有辛辣味的窒息性气体, 比重 1.434, 它主要来源于燃料的燃烧。其对人体的危害表现为对结膜及上呼吸道粘膜具有强刺激性, 可引起喉部不适, 甚至窒息, 并可导致支气管炎、肺炎和呼吸麻痹。大气中的 SO₂ 易形成酸雾或酸雨, 其对人体影响远胜于 SO₂, 空气中酸雾达 $0.8\text{mg}/\text{l}$ 时, 人体即有不适感。

SO₂ is a colorless, non-flammable, odor and spicy suffocating gas with a specific gravity of 1.434. It mainly comes from the combustion of fuel. Its harm to the human body is characterised by strong irritation to the conjunctiva and upper respiratory tract mucosa, which can cause throat discomfort, even suffocation, and can lead to bronchitis, pneumonia and respiratory paralysis. SO₂ in the atmosphere is easy to form acid fog or acid rain, which has a much

more impact on the human body than SO₂. When the acid fog in the air reaches 0.8mg/l, the human body will feel uncomfortable.

NO_x: 通常以此来表示 NO 与 NO₂ 的总和。NO 为无色无臭的气体, 比重为 1.0367。NO₂ 为红棕色有毒的恶臭气体, 与水反应生成 HNO₃ 及 NO。主要来源于燃料燃烧系统如焦炉烟囱等, 对人的眼睛和呼吸道器官有强烈刺激。在空气中可形成“光化学烟雾”, 使晴朗天空烟雾弥漫, 严重影响人体健康。

NO_x: Usually used to represent the sum of NO and NO₂. NO is a colorless and odorless gas with a specific gravity of 1.0367. NO₂ is a toxic, reddish brown odor gas that reacts with water to produce HNO₃ and NO. Mainly derived from fuel combustion systems such as coke oven chimneys, it can cause strong irritation to human eyes and respiratory organs. Photochemical smoke can form in the air, causing clear skies to be filled with smoke and seriously affecting human health.

b) 高温辐射 High temperature radiation

当工作场所的高温辐射强度大于 4.2J/cm².min 时, 可使人体过热, 产生一系列生理功能变化: 体温调节失去平衡; 水盐代谢出现紊乱; 消化及神经系统受到影响。

When the high temperature radiation intensity in the workplace exceeds 4.2J/cm².min, it can cause the human body to overheat, resulting in a series of physiological changes: loss of balance in temperature regulation; Disordered water and salt metabolism; The digestive and nervous systems are affected.

c) 冻伤 Frostbite

深冷危害主要产生在液氮气化站。

The harm of cryogetic mainly occurs in liquid nitrogen ga stations.

液氮温度≤-196℃, 皮肤接触液氮可冻伤。如在常压下气化产生的氮气过量, 可使空气中氧分压下降, 引起缺氧窒息。

Liquid nitrogen temperature ≤ -196℃, skin contact with liquid nitrogen can cause frostbite. If there is an excess of nitrogen produced during gasification at atmospheric pressure, it can cause a decrease in oxygen partial pressure in the air, leading to hypoxia and suffocation.

d) 电磁辐射 Electromagnetic radiation

振荡的电荷或电流系统以及任意加速运动的带电粒子向外辐射电磁波的过程叫电磁辐射。本工程中变压器、配电盘产生的辐射电磁波长时间会对人体造成伤害。电磁辐射是造成孕妇流产、不育、畸胎等病变的诱发因素。

Electromagnetic radiation refers to a reaction that an oscillating charge or current system or any accelerating charged particles radiate electromagnetic waves. In this project, the radiation electromagnetic wave irradiated by transformers and distribution panels can cause harm to human body if human being is under the irradiation for a long time. The electromagnetic wave irradiation can cause abortion, infertility, and malformations of fetus.

e) 噪声及振动 Noise and vibration

噪声除损害听觉器官外，对神经系统、心血管系统亦有不良影响。

Noise not only damages the auditory organs, but also has adverse effects on the nervous and cardiovascular systems.

振动可导致人体患发振动病，主要表现为足的损害，还可有神经衰弱症候群及植物神经功能紊乱。

Vibration can cause vibration disease in the human body, mainly manifested as foot damage, as well as neurasthenia syndrome and autonomic dysfunction.

8.3.2 主要防范措施 The Main Preventive Measures

a) 尘毒防治 Prevention and control of dust poison

炼焦车间：焦炉炉门修理站、炉顶端台及间台、熄焦泵房、锅炉间台设置高效低噪移动轴流风机，及时排除工作区有害气体。干熄炉排焦地下室设置事故通风，以排除 CO 等有害气体，改善维修人员操作环境。

Coking workshop: The coke oven door repair station, furnace top end platform, and intermediate platform, quenching pump house and boiler room and platform are equipped with efficient and low-noise mobile axial flow fans to timely eliminate harmful gases in the working area. Emergency ventilation is installed in the basement of the CDQ furnace grate coke to eliminate harmful gases such as CO and improve the operating environment for maintenance personnel.

公辅设施厂房设置轴流风机进行机械通风以排除余热、余湿及有害气体。

Axial flow fans are installed in the public auxiliary facility factory for

mechanical ventilation to eliminate waste heat, residual humidity, and harmful gases.

采取上述措施后，降低了工作区有害气体浓度，改善了工作人员操作环境。

After taking the above measures, the concentration of harmful gases in the work area was reduced and the operating environment for workers was improved.

有毒气体检测报警系统独立设置，指示报警设备设置在焦电区域集中控制室内。

The toxic gas detection and alarm system is independently set up, and the indicating alarm equipment is set up in the centralized control room of the pyroelectric region.

在干熄焦装置等可燃/有毒气体可能泄漏的装置及单元设置固定式气体检测报警探测器，并在现场设声光报警器。

Fixed gas detection alarm detectors shall be installed in devices and units where combustible/toxic gases may leak, such as CDQ equipment, and sound and light alarms shall be installed on site.

b) 热辐射防护 Thermal radiation protection

干熄焦本体地下部分、地下通廊、地下转运站以及有关操作室处设机械通风或空调，减轻高温辐射对人体造成的危害。

Mechanical ventilation or air conditioning should be installed in the underground parts, underground corridors, underground transfer stations, and related operating rooms of the CDQ body to reduce the harm of high temperature radiation to human health.

焦炉的拦焦机、电机车、装煤车及推焦机之间采用可靠的联锁装置，可避免红焦落地。

Reliable interlocking devices are used between the coke guiding machine, electric locomotive, charging car, and pushing machine of the coke oven to avoid the landing of red coke.

焦罐四周设置隔热陶瓷纤维布，提升时顶部加装焦罐盖，干熄炉及一次除尘器的外墙为隔热砖及耐热浇注料等，以减少红热焦炭的高温辐射。

Thermal insulation ceramic fiber cloth is installed around the coke tank, and a coke tank cover is added at the top when lifting. The outer walls of the

CDQ furnace and primary dust collector are made of thermal insulation bricks and heat-resistant casting materials to reduce the high-temperature radiation of red hot coke.

对高温设备及管道均设置隔热防烫保护措施，保证其外表温度小于 60℃，以减少热辐射、防止接触烫伤。主蒸汽管道等高温管道采用导热系数小的保温材料，保护层采用铝合金板。

Install insulation and anti scalding protection measures for high-temperature equipment and pipelines to ensure that their external temperature is less than 60 °C, in order to reduce thermal radiation and prevent contact burns. High temperature pipelines such as the main steam pipeline use insulation materials with low thermal conductivity, and the protective layer is made of aluminum alloy plate.

对在温度较高的工作场所操作人员采取必要的个体防护与保健措施。

Take necessary personal protective and health measures for operators in workplaces with high temperatures.

c) 电磁辐射防护 Electromagnetic radiation protection

为防止电磁辐射，将变压器、配电盘等设置在单独的房间内。

To prevent electromagnetic radiation, transformers, distribution panels, etc. are placed in separate rooms.

d) 降噪与减振 Noise reduction and vibration reduction

在满足工艺要求的前提下，对高噪音设备如通风机、除尘风机、各种泵类等尽量选用低噪声的产品。

On the premise of meeting the process requirements, low-noise products should be selected as much as possible for high noise equipment such as ventilation fans, dust removal fans, various pumps, etc.

各种高噪声设备如粉碎机、振动筛、除尘风机等均设置于室内等建筑厂房中隔声，厂房采用隔声的建筑材料，可防止噪声的扩散与传播。

Various high noise equipment such as crushers, vibrating screens, dust removal fans, etc. are installed indoors in building buildings for sound insulation. The buildings use soundproof building materials to prevent the spread and propagation of noise.

为了防止振动产生的噪声污染，汽轮发电机、各除尘风机、脱硫引风机、流化风机及泵类等设置单独基础；强振设备与管道间采取柔性连接方式，以防止振动产生噪音。

In order to prevent noise pollution caused by vibration, separate foundations are set up for steam turbine generators, various dust removal fans, desulfurization induced draft fans, fluidized fans and pumps; Flexible connection is adopted between the strong vibration equipment and the pipeline to prevent vibration from generating noise.

除尘地面站的除尘风机外壳及前后管道设隔声装置，所有除尘风机、流化风机的进出口均采用软连接，风机出口均设消声器。

The shell and front and rear pipelines of the dust removal fans at each dust removal ground station are equipped with sound insulation devices. Soft connections are installed at the inlets and outlets of all dust removal fans and fluidizing fans, and silencers are equipped at the fan outlets. .

废气余热锅炉、干熄焦锅炉各放散管均设消声器。

Silencers are installed on the exhaust pipes of waste heat boilers and CDQ boilers.

干熄焦循环风机及循环气体管道等处均采取隔声措施。

Sound insulation measures are taken at the CDQ circulating fan and circulating gas pipeline.

在厂区内总平面设计中，充分考虑地形、声源方向性及车间噪声强弱，利用建构筑物、绿化植物等对噪声的屏蔽、吸纳作用，进行合理布局，以起到降低噪声影响的作用。

In the overall layout design of the factory area, full consideration is given to the terrain, directionality of sound sources, and the strength of workshop noise. The shielding and absorption effects of buildings, green plants, etc. are utilized to make a reasonable layout and reduce the impact of noise.

经采取措施后，对于操作人员每天接触噪声 8 小时的场所，噪声级均可低于 85dB(A)；控制室、操作室等室内噪声级均小于 70dB(A)；其它生活卫生用室内噪声则低于 55dB(A)；对于操作工人每天接触噪声不足 8 小时的场所及其它作业地点的噪声均满足《工业企业噪声控制设计规范》中的标准要求。

After taking measures, for places where operators are exposed to noise

for 8 hours a day, the noise level can be below 85dB (A); The indoor noise level in control rooms, operation rooms, etc. is less than 70dB (A); The indoor noise of other living and sanitation rooms is less than 55dB (A); The noise in places where operators are exposed to noise for less than 8 hours a day and other work locations meets the standard requirements of the “Design Specification for Noise Control in Industrial Enterprises”.

8.4 其他防范措施 Other Preventive Measures

8.4.1 生产过程中设自动控制系统和紧急停机、事故处理设施 Install Automatic Control Systems and Emergency Shutdown and Accident Handling Facilities during the Production Process

备煤、焦处理等系统设启动前能发出音响的启动预示信号装置，并采取逆料流的联锁措施，防止故障停车时压料。

The coal preparation, coke processing and other systems are equipped with a start warning signal device that can emit an audio signal before starting, and interlocking measures are taken to reverse the material flow to prevent material pressure during fault shutdown.

废气余热锅炉紧急停炉保护：紧急停炉时主蒸汽切断阀（电动）关闭，放散电动排汽阀开启；引风机停运。引风机与废气余热锅炉水位设有联锁装置。干熄焦锅炉紧急停炉保护：紧急停炉时主蒸汽切断阀（电动）关闭，放散电动排汽阀开启；循环风机停运。循环风机与干熄焦锅炉水位设有联锁装置。

Emergency shutdown protection of waste gas waste heat boiler: the main steam cut-off valve (electric) is closed during emergency shutdown, and the discharge electric exhaust valve is opened; The induced draft fan is down. An interlocking device is provided for the water level of the induced draft fan and waste gas and heat boiler. Emergency shutdown protection of CDQ boiler: the main steam cut-off valve (electric) is closed during emergency shutdown, and the discharge electric exhaust valve is opened; The circulating fan fails. An interlocking device is provided for the circulating fan and the CDQ boiler water level.

8.4.2 事故的抢救和疏散、事故应急措施 Emergency Rescue and Evacuation, Measures

a) 中暑的应急措施 Emergency measures for heatstroke.

中暑一般多发生在高温作业场所，发现有人中暑后，迅速将患者移到阴凉安静的地方平卧休息，解松或脱去衣服，用冷水擦洗全身，用风扇向患者吹风帮助散热，同时立即通过电话或其它形式与医务室联系，进行现场急救处理，对严重的中暑患者急救后立即送医院治疗。

Heat stroke generally occurs in high-temperature workplaces. If someone experiences heat stroke, they should be quickly moved to a cool and quiet place to lie down and rest, loosen or take off their clothes, wash their entire body with cold water, use a fan to blow air to help dissipate heat, and immediately contact the medical room via phone or other means for on-site emergency treatment. For severe heat stroke patients, they should be immediately sent to the hospital for treatment.

b) 事故的疏散 Evacuation of accidents

生产区域必须设安全通道，安全通道净宽不得小于 1m，仅通向一个操作点或设备的不得小于 0.8m。

A safety passage must be set up in the production area, and the net width of the safety passage must not be less than 1m. The passage that only leads to one operating point or equipment must not be less than 0.8m.

电梯设置安全出口，供紧急情况下人员撤离。

Elevators are equipped with safety exits for emergency evacuation of personnel.

c) 事故的应急措施 Emergency measures for accidents

本工程设置专用消防电话，消防电话主机设置在焦电区域集中控制室内。

This project is equipped with a dedicated firefighting telephone, and the firefighting telephone is located in the centralized control room of the coking and generation regions.

在电气室、操作室等人员密集的火灾危险场所设置消防应急广播扬声器，消防应急广播主机设置在焦电区域集中控制室内。

Fire emergency broadcast speakers are set up in densely populated fire danger places such as the electrical room and operation room, and the fire emergency broadcast principle equipment is set up in the centralized control room in the coking area.

本工程在备煤、筛焦、变配电所等处易发生事故的生产场所设置相应的事故

应急照明设施，消防设施构筑物应急照明电源自消防设施专用供电回路引来。

In this project, the corresponding emergency lighting facilities are set up in the production sites prone to accidents such as coal preparation, coke screening, power transformation and distribution stations. The emergency lighting power of fire fighting facilities is drawn from the dedicated power supply circuit of fire extinguishing facilities.

设置必备的防尘防毒口罩、防护手套、防护服、防毒面具、呼吸器、急救药品与器械等事故应急器具。

Prepare necessary emergency equipment such as dust and gas masks, protective gloves, protective clothing, gas masks, respirators, first-aid drugs and instruments.

操作人员配备一些防噪声的个人防护设施，如防噪声耳塞、耳罩、防护服等，以及一些头部防护设施，如安全帽等。

Operators are equipped with some anti-noise personal protective facilities, such as anti-noise earplugs, ear mugs, protective clothing, etc., as well as some head protective facilities, such as hard hats.

此外，在通向室外主通道处设事故排风的启动按钮。

In addition, a start button for emergency exhaust air is provided at the main passage leading to the outdoor.

8.5 职业卫生机构 Occupational Health Organization

本工程职业卫生机构由公司统一安排，应设置职业卫生管理机构，并在车间、班组设置兼职的职业卫生管理人员，职业卫生管理机构的职责主要有制定各级人员的职业病危害防治责任制度、职业卫生管理制度、岗位职业健康操作规程等各项制度，定期对职工进行职业健康宣传培训教育，建立职业病危害事故应急救援预案，根据需要及时发放劳动防护用品，每年定期对职工进行职业健康体检，定期对职业危害岗位进行职业病危害因素的检测、监测，对可能产生职业病危害的建设项目按照《建设项目职业病危害分类管理办法》向监督管理部门进行申报等。

The occupational health organization of the project shall be uniformly arranged by the company, and an occupational health management organization shall be set up, and part-time occupational health management personnel shall be assigned in the workshop and team. The main responsibility of the occupational health management organization shall be to formulate the

occupational disease hazard prevention responsibility system, occupational health management system, occupational health operation rules and other systems for personnel at all levels. Carry out regular publicity, training and education on occupational health for employees, establish emergency rescue plans for occupational-disease-inductive accidents, issue labor protection articles in a timely manner according to needs, conduct regular annual occupational health examination for employees, and regularly test and monitor occupational-disease-inductive factors in occupational hazard positions. The construction project that may cause occupational disease hazards shall be reported to the supervision and administration department in accordance with “Management Measures for Classification of Occupational Disease Hazards in Construction Projects”.

8.6 投资估算 Investment Estimation

本工程直接用于职业卫生投资约占工程建设投资的 10.54%。

The direct investment spent on occupational health accounts for 10.54% of the construction investment.

8.7 预期达到的效果 Expected Results

本工程职业卫生设施完善，经采取措施后，本工程操作场所及岗位空气中尘毒等有害物浓度将低于《工作场所有害因素职业接触限值第一部分 化学有害因素》中相应的允许浓度；工作场所室内温度满足《工业企业设计卫生标准》及《工业建筑供暖通风与空气调节设计规范》的相应规定；工作场所及岗位的噪声级满足《工业企业噪声控制设计规范》及《工作场所有害因素职业接触限值第二部分 物理因素》中的相应标准。

The occupational health facilities of the project are sound, and after taking measures, the concentration of dust, poison and other harmful substances in the air of the operation site and work positions of the project will be lower than the corresponding allowable concentration in the “Occupational Exposure Limit of Hazardous Factors in the Workplace Part I Chemical Hazardous Factors”; The indoor temperature of the workplace meets the corresponding provisions of the “Design Hygiene Standard for Industrial Enterprises ”and the “Design Code for Heating, Ventilation and Air Conditioning of Industrial Buildings”; The noise levels of the workplace and posts meet the corresponding standards in

the “Design Code for Noise Control of Industrial Enterprises ”and the “Occupational Exposure Limits for Harmful Factors in the Workplace Part II Physical Factors”.

8.8 建议 Proposal

本工程职业卫生的特点主要以尘毒为主，因焦化行业属于易燃易爆类行业，希望加强管理，加强操作人员的培训。施工过程中使用的作业机具及设备数量与种类均比较多，因此应格外注意施工期的职业卫生问题，加强施工部门的协调配合，以减少施工过程中的职业卫生事故。

The characteristics of occupational health of this project are mainly dust and poison, because the coking industry is flammable and explosive industry, it is hoped to strengthen management and strengthen the training of operators. The number and types of operating machines and equipment used in the construction process are relatively large, so special attention should be paid to occupational health problems during the construction period, and the coordination and cooperation of construction departments should be strengthened to reduce occupational health accidents during the construction process.

建议工程投产后，公司除进一步抓好职业卫生管理与绿化等环节外，应进一步抓好职业卫生管理与协调工作，尤其要加强操作人员的职业技术培训及职业卫生教育工作，使职业卫生工作落到实处；加强职业卫生设施及设备的维修及维护，使其充分发挥作用，始终能以最佳运行状态投入生产。

It is recommended that after the project is put into operation, in addition to further focusing on occupational health management and greening, the company should also further strengthen occupational health management and coordination work, especially strengthening the vocational technical training and occupational health education of operators, so as to ensure the implementation of occupational health work; Strengthen the maintenance and upkeep of occupational health facilities and equipment, so that they can fully play their role and always be put into production in the best operating condition.

9 消防 Firefighting

9.1 编制依据及采用的规范 Compiled Basis and Specifications

9.1.1 编制依据 Compiled Basis

- a) 《中华人民共和国消防法》(中华人民共和国主席令第 29 号, 2021 年 4 月 29 日第十三届全国人民代表大会常务委员会第二十八次会议通过《全国人民代表大会常务委员会关于修改〈中华人民共和国道路交通安全法〉等八部法律的决定》第三次修正); Fire Protection Law of the People's Republic of China Order No. 29 of the President of the People's Republic of China, passed at the 28th meeting of the Standing Committee of the 13th National People's Congress on April 29, 2021. The 《Decision of the Standing Committee of the National People's Congress on Amending Eight Laws, including the Road Traffic Safety Law of the People's Republic of China, was revised for the third time.);
- b) 《建设工程消防设计审查验收管理暂行规定》(中华人民共和国住房和城乡建设部令第 51 号, 2020 年 6 月 1 日起施行); Interim Provisions on the Management of Fire Protection Design Review and Acceptance in Construction Projects Order No. 51 of the Ministry of Housing and Urban Rural Development of the People's Republic of China, effective from June 1, 2020);
- c) 《建设工程消防设计审查验收工作细则》(建科规[2020]5 号)。Detailed Rules for Review and Acceptance of Fire Protection Design in Construction Projects(Jian Ke Gui [2020] No. 5).

9.1.2 采用的主要标准 The Main Standards Adopted

- a) 《建筑设计防火规范》(GB50016-2014, 2018 年版); Code for fire protection design of buildings(GB50016-2014, 2018 edition);
- b) 《煤化工工程设计防火标准》(GB51428-2021); Standard for fire protection design of coal chemical engineering(GB51428-2021);
- c) 《干熄焦工程设计标准》(GB51363-2019); Standard for design of coke dry quenching engineering(GB51363-2019);
- d) 《建筑内部装修设计防火规范》(GB50222-2017); Code for fire prevention in design of interior decoration of buildings(GB50222-2017);

- e) 《爆炸危险环境电力装置设计规范》(GB50058-2014); Code for design of electrical installations in explosive atmospheres(GB50058-2014);
- f) 《火灾自动报警系统设计规范》(GB50116-2013); Code for design of automatic fire alarm system(GB50116-2013);
- g) 《石油化工可燃气体和有毒气体检测报警设计标准》(GB/T50493-2019); Standard for design of combustible gas and toxic gas detection and alarm for petrochemical industry(GB/T50493-2019);
- h) 《建筑物防雷设计规范》(GB50057-2010); Code for design protection of structures against lightning(GB50057-2010);
- i) 《消防给水及消火栓系统技术规范》(GB50974-2014); Code of design on fire protection water supply and hydrant systems(GB50974-2014);
- j) 《建筑灭火器配置设计规范》(GB50140-2005); Code for design of extinguisher distribution in buildings(GB50140-2005);
- k) 《工业企业总平面设计规范》(GB50187-2012); Code for design of general layout of industrial enterprises(GB50187-2012);
- l) 《焦化安全规程》(GB12710-2008); Safety code for the coking plan(GB12710-2008);
- m) 《干法熄焦安全规程》(AQ7013-2018); Safety regulations for Coke Dry Quenching AQ7013-2018;
- n) 《安全色》(GB2893-2008); Safety colours(GB2893-2008);
- o) 《安全标志及其使用导则》(GB2894-2008); Safety signs and guideline for the use(GB2894-2008);
- p) 《消防安全标志设置要求》(GB15630-1995); Requirements for the placement of fire safety signs(GB15630-1995);
- q) 《消防安全标志 第一部分:标志》(GB13495.1-2015); Fire safety signs—Part 1:Signs(GB13495.1-2015);
- r) 《图形符号 安全色和安全标志 第1部分:安全标志和安全标记的设计原则》(GB/T2893.1-2013)。Graphical symbols—Safety colours and safety signs—Part 1:Design principles for safety signs and safety markings(GB/T2893.1-2013).

9.2 工程的火灾危险性分析 Fire Hazard Analysis of the Project

本工程生产过程中原料及产品多为可燃、易燃、易爆物品,具有一定火灾危险性,火灾危险性及危害性的与危险物质的多少及生产性质、操作管理水平、环境等有直接关系。火灾危险因素可分为以下几种:

The raw materials and products in the production process of this project are mostly combustible, flammable and explosive materials, which have a certain fire risk, and the size of the fire risk and harm are directly related to the number of dangerous substances, production nature, operation management level, environment, etc. Fire risk factors can be divided into the following categories:

- a) 室内易燃易爆粉尘气体浓度达到爆炸浓度极限后遇火花引起爆炸,酿成火灾; When the concentration of flammable and explosive dust gas in the room reaches the limit of explosion concentration, sparks will cause explosion, resulting in fire;
- b) 明火、雷电及静电能引起爆炸和火灾。 Open flames, lightning and static electricity can cause explosions and fires.

9.2.1 主要火灾爆炸危险物品特征 Characteristics of Main Fire and Explosion Hazardous Materials

a) 煤 Coal

煤为可燃物质,丙类火灾危险品,粉尘具燃爆性,着火点在 300°C~500°C之间,爆炸下限浓度 34g/m³~47g/m³(粉尘平均粒径: 5μm~10μm)。高温表面堆积粉尘(5mm 厚)的引燃温度:225°C~285°C,云状粉尘的引燃温度 580°C~610°C。此外煤长期堆积可使煤料氧化、煤温升高甚至引起自燃。

Coal is a combustible substance and a Class C fire hazard. Dust has an explosive nature, with an ignition point between 300°C and 500°C, and an explosive lower limit concentration of 34g/m³ to 47g/m³(average particle size of dust: 5μm to 10μm). The ignition temperature of high-temperature surface accumulated dust (5mm thick) is 225°C~285°C, and the ignition temperature of cloud like dust is 580°C~610°C. In addition, long-term accumulation of coal can cause coal oxidation, increase coal temperature, and even lead to spontaneous combustion.

b) 焦炭 Coke

焦炭为可燃物质，丙类火灾危险品，粉尘具燃爆性，爆炸下限 $37\text{g/m}^3 \sim 50\text{mg/m}^3$ (粉尘平均粒径: $4\mu\text{m} \sim 5\mu\text{m}$)，焦化厂一般达不到该下限。高温表面堆积粉尘(5mm 厚)的引燃温度: 430°C ，云状粉尘的引燃温度 $>750^\circ\text{C}$ 。

Coke is a combustible substance, classified as a Class C fire hazard, with explosive dust and a lower explosive limit of $37\text{g/m}^3 \sim 50\text{mg/m}^3$ (average particle size of dust: $4\mu\text{m} \sim 5\mu\text{m}$). Coking plants generally cannot reach this lower limit. The ignition temperature of high-temperature surface accumulated dust (5mm thick) is 430°C , and the ignition temperature of cloud like dust is greater than 750°C .

c) 润滑油 Lubricating oil

润滑油为可燃性液体，闪点为 211°C ，自燃点为 255°C 。

Lubricating oil is a flammable liquid with a flash point of 211°C and a spontaneous ignition point of 255°C .

d) 干熄焦循环气体 Dry quenching cycle gas

含可燃气体 H_2 和 CO , H_2 的爆炸极限范围为 $4.0\% \sim 75.6\%$, 自燃点为 560°C ; CO 的爆炸极限范围为 $12.5\% \sim 74.0\%$, 自燃点为 605°C 。

The explosion limit range of H_2 is $4.0\% \sim 75.6\%$, and the spontaneous combustion point is 560°C . The explosion limit range of CO is $12.5\% \sim 74.0\%$, and the spontaneous combustion point is 605°C .

9.2.2 主要生产场所及装置的火灾危险性分析 Fire Risk Analysis of Primary Production Sites and Installations

本工程可能出现的环境分为爆炸性气体环境、爆炸性粉尘环境及火灾危险环境，其中爆炸性气体有煤气等易燃气体；爆炸性粉尘有煤尘、焦尘等粉尘；火灾危险有煤及焦炭等物质。根据《焦化安全规程》及《爆炸危险环境电力装置设计规范》等有关规定，焦化厂主要生产场所及装置的火灾爆炸危险性分类如下表：

The environments with possible fire risks in this project could be divided

into 3 environments that are explosive dust environment, fire risk environment, and explosive gas environment. Coal gas is contained in explosive gas environment; coal powder and coke dust are contained in explosive dust environment; and the fire risk environment includes coal and cokes. In accordance with “Coking Safety Procedures” and “Specifications of design for electrical device installed in explosive environments”, the fire and explosion risks of coke plant primary plant and installations are classified as follows:

表 9-1 主要生产场所或装置的火灾爆炸危险性
Table 9 1 Fire and explosion risk of major production sites or installations

序号 No.	场所或装置 Place or device	生产类别 Production category	爆炸危险区 域等级 Explosion hazard zone level	介质 Medium	备注 Remarks
一、备煤系统 Coal preparation system					
1	预粉碎机室 pre crusher room	丙 C	22 区 zone	煤尘 coal dust	
2	粉碎机室 crusher room	丙 C	22 区 zone	煤尘 coal dust	
3	煤塔 coal bunker	丙 C		煤尘 coal dust	
4	带式输送机通廊 belt conveyor corridor	丙 C		固体状可燃物-煤 solid combustible material - coal	
5	煤转运站 coal transfer station	丙 C		煤尘 coal dust	
二、运焦系统 Coke transportation system					
1	焦台 coke wharf			焦炭 coke	
2	运焦通廊 coke transfer corridor	丙 C	22 区 zone	焦尘 coke dust	
3	焦转运站 transfer station	丙 C	22 区 zone	焦尘 coke dust	
4	筛焦楼 coke screening station	丙 C	22 区 zone	焦尘 coke dust	
三、干熄焦系统 CDQ system					
1	除尘地面站 dust removal ground station	丁 D	22 区 zone	焦尘 coke dust	
2	汽轮发电站 Steam turbine power station	丁 D		润滑油 lubricating oil	

9.3 消防站的依托 Reliance on Fire Stations

本工程不自建消防站，消防事宜由建设单位统一考虑。

This project does not build a fire station, and fire control matters are considered by the contractor

9.4 消防设计的初步方案 Preliminary Plan for Fire Fighting

本工程在正常生产情况下，一般不易发生火灾，只有在操作失误、违反规程、管理不当及其它非正常生产情况或意外事故状态下，才可能由各种因素导致火灾发生。因此，为了防止火灾的发生，或减少火灾发生造成的损失，本工程在设计上采取相应的防范措施。

Under normal production conditions, this project is generally not prone to fires. Only in cases of operational errors, violations of regulations, improper management, and other abnormal production or accidental situations can cause fires. Therefore, in order to prevent the occurrence of fires or reduce the losses caused by fires, corresponding preventive measures are taken in the design of this project.

9.4.1 工艺 Workmanship

各处煤料贮存按规定时间进行，均不超过贮存期限，防止煤料存放时间过长，发生氧化自燃。焦处理系统带式输送机采用耐热胶带。干熄炉下带式输送机采用耐热胶带，防止胶带受热燃烧。

All the coal storage shall be carried out according to specific time and not be exceed the prescribed time period to prevent oxidation spontaneous combustion. Belt conveyor of coke transfer system shall use heat resistance tape. The heat resistance tape shall be also used on the belt conveyor under CDQ furnace to avoid burning caused by heat.

焦炉机械设走行灯、铃信号，各滑触线设防止触电警示牌，高度不低于安全距离。焦炉机械设有自动识别炉号和对位装置，并设有连锁控制装置。

The coke oven machinery is equipped with running lights and bell signals, and each sliding contact line is equipped with warning signs to prevent electric shock, with a height not lower than the safe distance. The coke oven machinery is equipped with an automatic identification furnace number and alignment device, as well as an interlocking control device.

控制惰性气体中可燃成份（CO 和 H₂）的浓度是保证干熄焦装置安全运行的重要措施。循环气体中的可燃成份是由焦炭的残余挥发份及干熄炉内冷却段高温部分发生的焦炭烧损所产生的可燃气体形成的。在气体循环系统中设置了连续、自动的气体分析装置，并向系统中不断补充空气或 N₂，将可燃成份的浓度控制在安全范围内，再将多余气体放散。此外，在干熄焦装置及气体循环系统中，还设有多处防爆及紧急放散设施等。

Controlling the concentration of combustible components (CO and H₂) in inert gases is an important measure to ensure the safe operation of CDQ equipment. The combustible components in the circulating gas are formed by the residual volatiles of coke and the combustible gases generated by the burning of coke in the high-temperature part of the cooling section of the CDQ furnace. A continuous and automatic gas analysis device is installed in the gas circulation system, and air or N₂ is continuously added to the system to control the concentration of combustible components within a safe range before releasing excess gas. In addition, there are multiple explosion-proof and emergency release facilities in the CDQ device and gas circulation system.

在火灾危险性较大的场所设置安全标志及信号装置；对各类介质的管道涂刷相应的识别色，并按照《安全色》及《安全标志及其使用导则》等规定进行。

Safety signs and signal devices shall be set up in places with high fire hazards; Apply corresponding identification colors to pipelines of various media, and follow the regulations of "Safety Colors" and "Safety Signs and their Use Guidelines".

9.4.2 总图运输 General Layout Drawing and Transportation

在总平面布置中，各生产区域、装置及建筑物间均设置足够的防火间距，道路则根据消防车对通道的要求进行设计与布置。

In the general layout, sufficient fire separation distances are set between each production area, device, and building, and roads are designed and arranged according to the requirements of fire trucks for access.

本工程各种设施按其功能、生产性质以及火灾危险性的大小，结合厂区自然条件全面地、因地制宜地分类分区布置，各小区之间采用道路相隔，并按要求设置防火间距，以防止一旦发生火灾造成火势扩大、蔓延。

The various facilities in this project are classified and arranged according to their functions, production properties, and fire hazards, taking into account the natural conditions of the factory area. Roads are used to separate each community, and fire separation distances are set according to requirements to prevent the expansion and spread of fires in the event of a fire.

考虑到生产、消防、检修等需要，厂内道路呈环形和尽头两种布置形式，根据道路用途和车流量的大小，设置道路。道路宽度为 12.0m、9.0m，在有物料装

卸的灰仓等处，设置回车场。

Considering the needs of production, fire protection, maintenance, etc., the roads inside the factory are arranged in two forms: circular and terminal. Roads are set up according to the purpose of the roads and the size of traffic flow. The road widths are 12.0 meters and 9.0 meters. Turning areas are provided at locations such as ash silos where material loading/unloading occurs.

工程用地范围内道路至相邻建构筑物的最小净距满足相关规范对厂区道路的距离要求。

The minimum clear distance between roads within the scope of engineering land and adjacent buildings meets the distance requirements of relevant regulations for factory roads.

对进入厂内的运行车辆要求进行年检、小中大修和日常保养维护，对有安全隐患的车辆和有扬尘、滴漏（包括罐车）的车辆不得上路运行。车辆必须进入有防火要求的区域，在车辆排气管消音器处装设阻火器。车辆的行驶与装卸、车辆驾驶员的管理要求符合相关规范的要求。

Vehicles entering the factory are required to undergo annual inspections, minor and major repairs, and daily maintenance. Vehicles with safety hazards and those with dust and leaks (including tankers) are not allowed to operate on the road. Vehicles must enter areas with fire safety requirements and install flame arresters at the muffler of the vehicle's exhaust pipe. The driving and loading/unloading of vehicles, as well as the management requirements of vehicle drivers, comply with relevant regulations.

9.4.3 建筑 Building

计中应贯彻“预防为主，防消结合”的原则，对所有建筑物的防火要求，包括材料的选用、布置、构造、疏散等均按现行的建筑设计防火规范执行。

The principle of "prevention first, combined with fire prevention" should be implemented in the plan, and the fire prevention requirements for all buildings, including material selection, layout, construction, evacuation, etc., should be implemented in accordance with the current building design fire prevention standards.

建筑物、转运站与通廊连接处的门洞均设置防火隔断措施。

Fireproof partition measures are installed at the door openings connecting

buildings, transfer stations, and corridors.

易燃与可燃性物质生产厂房或库房的门窗应向外开。

The doors and windows of factories or warehouses for the production of flammable and combustible substances should open outward.

生产区域必须设安全通道，安全通道净宽不得小于 1m，仅通向一个操作点或设备的不得小于 0.8m。

The safety channel must be set up in the production area. The clear width of the safety channel shall not be less than 1m, and the one leading to only one operating point or equipment shall not be less than 0.8m.

9.4.4 电力、电信 Electricity, Telecommunications

本工程新建一座 132 kV 开闭站，分三期建设，最终满足 360 万吨焦炉及整个工业园区供配电要求。132 kV 开闭站一期、二期、三期公共的用电设备及设施在一期建设中一次建成。两路 132kV 电源由上级变电所提供，每路电源皆能承担本工程 100% 的负荷，业主负责送至升压站。

一期、二期、三期焦炉系统余热锅炉各配置一座汽轮发电站，每座汽轮发电站安装 2 台 10kV、65MW 汽轮发电机组。每台发电机通过升压变到 132kV，各经一路 132kV 电缆联络线并网至升压站 132kV 不同母线上。

This project will construct a new 132 kV switching station in three phases, ultimately meeting the power supply and distribution requirements for a 3.6 million ton coke oven and the entire industrial park. The public electrical equipment and facilities for the first, second, and third phases of the 132 kV switching station will be built in one go during the construction of the first phase. Two 132kV power sources are provided by the superior substation, Each power supply can bear 100% of the load of this project, and the owner is responsible for delivering them to the booster station.

The waste heat boilers of the first, the second, the third coke oven systems are each equipped with a steam turbine power station, each steam turbine power station and two 10kV and 65MW steam turbine generator sets are installed. Each generator is converted to 132kV through the boost voltage, and each 132kV cable connection line is connected to the grid to the different 132kV bus of the boost station.

消防设施用电采用单独的回路供电，消防设施用的配电线路采用耐火电缆，

明敷时置于配线桥架内或直接埋地敷设，当发生火灾切断生产、生活用电时，仍能保证消防用电。

The power supply for firefighting facilities is provided through a separate circuit, and the distribution lines for firefighting facilities are made of fire-resistant cables. When exposed, they are placed in wiring trays or directly buried. In the event of a fire cutting off production and domestic electricity, firefighting electricity can still be guaranteed.

在电气室、封闭楼梯间等处设应急照明，消防设施构筑物应急照明电源自消防设施的专用供电回路引来。

Emergency lighting should be installed in electrical rooms, enclosed stairwells, and other areas. The emergency lighting power supply for firefighting facilities and structures should be introduced from the dedicated power supply circuit of the fire-fighting facilities.

在爆炸和火灾危险场所严格按照环境的危险类别或区域配置相应的电气设备和灯具，避免电气火花引起火灾。主要火灾爆炸危险场所选用的防爆电气见下表。

Strictly configure corresponding electrical equipment and lighting fixtures according to the hazardous categories or areas of the environment in explosion and fire hazard areas to avoid electrical sparks causing fires. The explosion-proof electrical equipment selected for the main fire and explosion hazardous areas is shown in the table below.

对焦炉煤塔、干熄焦装置、汽轮发电站、除氧水泵站、循环水泵站、10 米以上煤处理和焦处理系统等第三类防雷建筑物主要采用避雷带防直击雷，每根引下线的冲击接地电阻一般不大于 30Ω ；放散管、风帽按规范要求采取相应的防雷措施。

For the third type of lightning protection buildings such as coke oven coal towers, CDQ devices, steam turbine power stations, deoxygenation water pump stations, circulating water pump stations, coal processing and coke processing systems above 10 meters, lightning protection belts are mainly used to prevent direct lightning strikes. The impact grounding resistance of each down conductor is generally not greater than $30\ \Omega$; Take corresponding lightning protection measures for the vent pipe and wind cap according to the specifications.

对筛焦楼、焦转运站等第二类防雷建筑物主要采用避雷带（独立针）防直击雷，引下线不少于两根，并沿建筑物四周均匀或对称布置，其间距不大于 18m，每根引下线的冲击接地电阻不大于 10Ω ；防雷电感应的措施为建筑物内的设备管道构架等主要金属物就近接至防直击雷接地装置或电气设备的保护接地装置上。

For the second type of lightning protection buildings such as coke screening buildings and coke transfer stations, lightning protection strips (independent rod) are mainly used to prevent direct lightning strikes. There should be no less than two down conductors arranged evenly or symmetrically around the building, with a spacing of no more than 18m. The impact grounding resistance of each down conductor should not exceed $10\ \Omega$; The measure to prevent lightning induction is to connect the main metal objects such as equipment pipeline structures inside the building to the nearest grounding device for direct lightning protection or the protective grounding device for electrical equipment.

在爆炸和火灾危险环境中做防静电接地设计，属于户外装置的防静电接地装置与防雷接地装置共用，对于建筑物内设备的防静电接地利用电气的保护接地装置。

Design anti-static grounding in explosive and fire hazardous environments, which belongs to the shared use of anti-static grounding devices and lightning

protection grounding devices for outdoor devices. For anti-static grounding of equipment inside buildings, electrical protective grounding devices are used.

电缆桥架穿过墙、楼板需采用防火隔板、堵料进行封堵。配电室、电缆夹层、地下室、电缆隧道等耐火等级为二级。

Cable trays passing through walls and floors need to be sealed with fireproof partitions and blocking materials. The fire resistance rating of the distribution room, cable interlayer, basement, cable tunnel, etc. is level 2.

配电装置采用浪涌保护器以防感应雷及操作过电压。

The distribution device adopts surge protectors to prevent induced lightning and overvoltage during operation.

本工程设置集中火灾报警系统。集中火灾报警控制器及消防联动控制器设置在控制室内。系统下设 2 台区域火灾报警控制器，设置在汽轮发电站、变配电所或值班室内。

This project is equipped with a centralized fire alarm system. The centralized fire alarm controller and fire linkage controller are installed in the control room. There are two regional fire alarm controllers under the system, which are installed in the steam turbine power station, substation or duty room.

在电气室、变电所及机柜间等有火灾危险场所设置感烟、感温火灾探测器，手动报警按钮及声光报警器。火灾报警设备选用智能型总线制。

Smoke and temperature fire detectors, manual alarm buttons and sound and light alarms shall be installed in fire danger places such as electrical room, substation and cabinet. Intelligent bus system is used for fire alarm equipment.

在转运站及通廊设置缆式线型感温火灾探测器。并参与水幕系统的消防联动。

Cable type linear thermal fire detectors are installed in the transfer station and corridors. And participate in the fire protection linkage of water curtain system.

消防专用电话网络为独立的消防通信系统，消防电话主机设置在焦电区域集中控制室内。

The fire special telephone network is an independent fire communication system, and the fire telephone host is set in the centralized control room in the pyroelectric region.

在电气室、操作室等人员密集的火灾危险场所设置消防应急广播扬声器，消

防应急广播主机设置在焦电区域集中控制室内。

Fire emergency broadcast speakers are set up in densely populated fire danger places such as the electrical room and operation room, and the fire emergency broadcast host is set up in the centralized control room in the pyroelectric region.

9.4.5 消防给水设施 Firefighting Water Supply Facilities

a) 消防给水系统 Fire water supply system

本工程消防按同时发生一次火灾考虑,室内消火栓系统消防用水量为 10L/s, 室外消火栓系统消防用水量为 15L/s, 室外最大消防用水量为 30L/s。

Considering the simultaneous occurrence of a fire, the water consumption of indoor fire hydrant system is 10L/s, that of outdoor fire hydrant system is 15L/s, The maximum outdoor fire water demand is 30L/s.

室内、外按中国现行《建筑设计防火规范》、《消防给水及消火栓系统技术规范》、《干法熄焦安全规程》及《钢铁冶金企业设计防火标准》的要求设置消火栓。消防给水管道接自消防给水系统。

Fire hydrants are set up in accordance with the requirements of China's current "Code for fire protection design of buildings", "Code of design on fire protection water supply and hydrant systems", "Safety regulations for Coke Dry Quenching" and "Standard for fire protection design of iron and steel metallurgy enterprises". The fire water supply pipe is connected with the fire water supply system.

各厂房、工艺装置消防设施配置如下:

The fire protection facilities for each factory building and process unit are configured as follows:

- 1) 按国家现行的《建筑设计防火规范》及《消防给水及消火栓系统技术规范》要求设置室内外消火栓。生产厂房设施室内设明装消火栓。室外设地上式消火栓,消火栓沿道路布置,按间距不大于 120m, 保护半径不大于 120m 布置; Install indoor and outdoor fire hydrants in accordance with the current national "Code for fire protection design of buildings" and "Code of design on fire protection water supply and hydrant systems". The production plant facilities are equipped with exposed fire hydrants indoors. Install Above-ground

fire hydrants outdoors, arranged along the road with a spacing of no more than 120m and a protection radius of no more than 120m;

b) 灭火器的设置 Fire extinguisher setup

所有建筑物室内，均按《建筑灭火器配置设计规范》要求配置灭火器。现场备有足够数量的灭火器材，灭火器设置在明显和便于取用的地点，且不影响安全疏散。灭火器设置稳固，其铭牌朝外。灭火器均放置在灭火器箱内。设置在室外的灭火器，有保护措施。

All buildings are equipped with fire extinguishers in accordance with the requirements of "Code for design of extinguisher distribution in buildings". An adequate quantity of fire extinguishing equipment is provided on site, and fire extinguishers are located in an obvious and easily accessible location that does not affect safe evacuation. Fire extinguisher set securely with nameplate facing outwards. Fire extinguishers are placed in the fire extinguisher box. Fire extinguisher installed outside, protected.

9.4.6 通风及除尘 Ventilation and Dust Removal

在产生燃爆性气体和粉尘的厂房内设通风除尘装置，以降低爆炸性物质浓度，使其低于燃爆下限。

Ventilation and dust removal devices are installed in the workshop where explosive gases and dust are generated to reduce the concentration of explosive substances and make them lower than the lower limit of the explosion.

通风设施均采用难燃或不燃材料；在主要车间厂房及辅助用室内部采取相应的通风换气措施。

Ventilation facilities are made of flame-retardant or non combustible materials; Take corresponding ventilation measures in the main workshop and auxiliary rooms.

本项目设置多个除尘系统，各除尘系统的净化设备均选用脉冲袋式除尘器，除尘效率高，除尘器滤料采用防静电材质，除尘器设安全泄爆装置，除尘系统设防静电接地装置。

This project incorporates multiple dust removal systems. The purification equipment of each dust removal system adopts a pulse bag dust collector with high dust removal efficiency. The filter material of the dust collector is made of anti-static materials, and the dust collector is equipped with a safety explosion

relief device. The dust removal system is equipped with an anti-static grounding device.

大型除尘系统各设备之间采取可靠的联锁控制，对系统运行过程中关键设备的工作参数进行监测，并根据监测结果采取声光报警、联锁启动或停机等措施，以预防事故的发生。

Reliable interlocking control is adopted between the various equipment of the large-scale dust removal system to monitor the working parameters of key equipment during system operation. Based on the monitoring results, measures such as sound and light alarm, interlocking start or stop are taken to prevent accidents from occurring.

9.5 投资估算 Investment Estimation

本工程直接用于消防投资约占工程建设投资的 8.25%。

The direct firefighting investment of this project accounts for about 8.25% of the project construction investment.

9.6 预期达到的效果 The Expected Result

本工程消防设施完善，经采取措施后，形成了完整的防火与消防体系，体现了“预防为主，防消结合”的原则。本工程可基本避免火灾、爆炸等危险事故的发生，一旦出现事故，即可采取相应的备用和应急措施，将事故造成的损失减少到最低限度。

The firefighting facilities of this project are sound, and after taking measures, a complete fire prevention and control system has been formed, reflecting the principle of "prevention first, combining prevention and control". This project can basically avoid the occurrence of dangerous accidents such as fires and explosions. Once an accident occurs, corresponding backup and emergency measures can be taken to minimize the losses caused by the accident.

9.7 建议 Proposal

从炼焦行业的火灾事故特点来看，在正常生产情况下，一般不易发生火灾，只有在操作失误、违反规程、管理不当及其它非正常生产情况或意外事故状态下，才可能由各种因素导致火灾发生。

Given by the characteristics of fire accidents in the coking industry, it is

generally not easy for fires to occur under normal production conditions. Only in cases of operational errors, violations of regulations, improper management, and other abnormal production or accidental situations can cause fires.

根据以往经验,加强管理对减少火灾事故具有显著的作用。建议工程投产后,公司除加强消防设施和设备的维修和维护工作外,要进一步抓好消防管理与协调工作,尤其要加强对工作人员的消防安全培训及职业技术教育工作,使消防工作落到实处。

Based on previous experience, strengthening management has a significant role in reducing fire accidents. It is recommended that after the project is put into operation, the company should not only strengthen the maintenance and repair of fire-fighting facilities and equipment, but also further focus on fire management and coordination, especially strengthening the fire safety training and vocational technical education for staff, so as to implement fire protection work effectively.

10 节能 Energy-saving

10.1 节能编制依据 Basis of Energy-saving

本项目节能编制遵循中国国家有关的法律、法规和标准，具体如下：

This chapter is compiled according to laws, regulations, and standards of China, as follows:

- a) 《中华人民共和国节约能源法》；
“Energy-saving Law of the People's Republic of China”;
- b) 《中国节能技术政策大纲》（国家发改委、科技部 2006 年 12 月）；
“Outline of China's Energy-saving Technology Policy ”(December 2006, National Development and Reform Commission and Ministry of Science and Technology);
- c) 《国务院关于加强节能工作的决定》（国发[2006]28 号）2006.8.6
“Decision of the State Council on Strengthening Energy-saving Work” (the National Development and Reform Commission [2006] No. 28) on August 6, 2006;
- d) 《国务院关于印发“十四五”节能减排综合工作方案的通知》（国发[2021]33 号）2022.1.24；
“Notice of the State Council on Issuing the Comprehensive Work Plan for Energy-saving and Emission Reduction during ‘the 14th Five Year Plan period’ ” (the National Development and Reform Commission [2021] No. 33) on January 24, 2022;
- e) 《产业结构调整指导目录（2025 年本）》（国发[2024]7 号）2024.2.1；
“Guiding Catalogue for Industrial Structure Adjustment (2024 Edition) ”(the National Development and Reform Commission [2024] No. 7) on February 1, 2024;
- f) 《清洁生产标准—炼焦行业》HJ/T126-2003；
HJ/T126-2003, Clean Production Standard - Coking Industry;
- g) 《焦炭单位产品能源消耗限额》GB21342-2013；
GB21342-2013, The Energy Consumption Limit per Unit Product of Coke;

h) 《企业节能计算方法》(GB/T13234-2018);

GB/T13234-2018, Calculation Method for Energy Conservation of Enterprises

i) 《综合能耗计算通则》(GB/T2589-2020)。

GB/T2589-2020, General Rules for Calculation of Comprehensive Energy Consumption.

10.2 能源构成 Energy Mix

焦电生产是一个能源转换过程。投入的一次能源为炼焦用洗精煤, 产出的二次能源有焦炭、蒸汽、电等。生产过程中消耗的能源及耗能工质有生产用新水、循环水、除盐水、电、蒸汽、压缩空气、氮气等, 耗能工质的消耗以及能源转换过程中的损失构成了焦电生产过程的工序能耗。

Coking production is a process of energy conversion. The primary energy input is washed coke for coking, and the secondary energy output includes coal, steam, electricity, etc. The energy and Energy-consumed medium in the production process include production water, recirculating cooling water, demineralized water, electricity, steam, compressed air, nitrogen, etc. The consumption of energy consuming working fluids and losses during energy conversion constitute the energy consumption of the coke production process.

10.3 能耗计算 Energy consumption calculation

10.3.1 能耗计算范围 Scope of energy consumption calculation

工序能耗计算范围包括备煤车间、炼焦车间、筛运焦系统、干熄焦装置及配套辅助生产设施。

The scope of process energy consumption calculation includes coal preparation unit, coking unit, screening and transportation unit, C.D.Q, and supporting auxiliary production unit.

10.3.2 折标系数 Conversion coefficient

能源及耗能工质的折算(折标准煤)系数如下:

The conversion coefficients for energy and Energy-consumed medium (converted to standard coal) are as follows:

洗精煤 Washed coal	1.0088tce/t
焦炭 Coke	0.9714tce/t

电 Electric power	0.1229tce/10 ³ kWh
生产用水 Production water	0.0414tce/10 ³ m ³
除盐水 Demineralized water	0.189tce/10 ³ m ³
循环水 Recirculating cooling water	0.143tce/10 ³ m ³
氮气 Nitrogen	0.0169tce/10 ³ m ³
压缩空气 Compressed air	0.0152tce/10 ³ m ³
蒸汽 Steam (0.4-0.6MPa)	0.0978tce/t

10.3.3 能耗计算 Calculation of Energy-consumption

本工程三期共投入能源 4358451.80 吨标准煤，产出二次能源为 3105784.17 吨标准煤，能源转换差为 1252667.63 吨标准煤。动力消耗为 185216.84 吨标准煤，回收能源为 1259869.00 吨标准煤，总工序能耗 178015.47 吨标准煤，单位工序能耗为 55.68 kgce/t，符合中国标准(GB21342—2013)《焦炭单位产品能源消耗限额》。能耗计算详见下表：

The total input energy for this project is 4382214.18 tons of standard coal (tce), and The total output energy for this project is 3105784.17 tons of standard coal (tce). The energy conversion difference is 1252667.63 tons of standard coal. The power consumption is 185216.84 tons of standard coal, the recovered energy is 1259869.00 tons of standard coal, the total process energy consumption is 178015.47 tons of standard coal, and the unit process energy consumption is 55.68 kgce/t, which is lower than the Chinese standard GB21342-2013) "Energy Consumption Limit per Unit Product of Coke".The energy consumption calculation is detailed in the table below:

表 10-1 能耗计算表
Table 10-1 Energy consumption calculation table

序号 No.	项目名称 Name	折标系数 Conversion coefficient	单位 Unit	实物量 Quantity	折标准煤(tce) Convert to standard coal(tce)
1	投入 Input				4358451.80
1.1	洗精煤 Washed coal	1.0088	t/t	4320432	4358451.80
2	产出 Output				3105784.17
2.1	全焦 Fule	0.9714	t/t	3197224.8	3105784.17

序号 No.	项目名称 Name	折标系数 Conversion coefficient	单位 Unit	实物量 Quantity	折标准煤(tce) Convert to standard coal(tce)
3	能源转换差 Margin energy- conversion				1252667.63
4	动力消耗 Power consumption				185216.84
4.1	生产用水 Production water	0.0414	t/10 ³ m ³	25.20	1.04
4.2	循环水 Recirculating water	0.143	t/10 ³ m ³	1134.00	162.16
4.4	电 Electric Power	0.1229	t/10 ³ kWh	236046	29010.05
4.5	除盐水 Demineralized water	0.189	t/10 ³ m ³	669.06	126.45
4.6	蒸汽 Steam	0.0978	t/t	1266696.0 0	123882.87
4.7	压缩空气 Compressed air	0.0152	t/10 ³ m ³	136848.96	2080.10
4.8	氮气 Nitrogen	0.0169	t/10 ³ m ³	5292.00	89.43
4.9	焦炭烧损 Coke burning loss	0.9714	t/t	30744.00	29864.72
5	回收能源 Recycling energy				1259869.00
5.1	干熄焦锅炉年产 蒸汽折标煤 Annual steam production of C.D.Q boiler converted to standard coal		t/t		215449

序号 No.	项目名称 Name	折标系数 Conversion coefficient	单位 Unit	实物量 Quantity	折标准煤(tce) Convert to standard coal(tce)
5.2	焦炉废气余热锅炉年产蒸汽折标煤 Annual steam production of coke oven waste heat recovery boiler converted to standard coal		t/t		1044420
6	总能耗 Total energy consumption		t		178015.47
7	单位能耗 Unit energy consumption		kg		55.68

10.4 节能分析 Energy-saving analyss

《焦炭单位产品能源消耗限额》(GB21342—2013)是国家标准委在充分借鉴和参考美国、欧盟、日本等国家先进技术成果的基础上，结合中国相关产品的节能技术的实际，经过大量的试验验证的基础上制定的，本工程设计指标满足标准要求。

GB21342-2013 “The Energy Consumption Limit per Unit Product of Coke” is formulated by the National Standards Commission on the basis of fully drawing on and referring to advanced technological achievements of countries such as the United States, the European Union, and Japan, combined with the actual Energy-saving technology of relevant products in China, and based on extensive experimental verification. The design indicators of this project meet standard requirements.

10.5 节能措施 Energy-saving measures

10.5.1 备煤及筛运焦系统的节能措施 Energy-saving measures for coal preparation and coke screening and transportation systems

- a) 定量给料机及焦台下的刮板放焦机等采用变频调速电动机，可根据给料量调节输出功率，节省电力消耗；The quantitative feeder and scraper coke discharge machine under the coke table adopt variable frequency speed regulation motors, which can adjust the output power according to the feeding amount, saving power consumption;
- b) 备煤和焦处理系统均采用 PLC 联锁自动控制，并采用计算机进行科学管理，其操作更准确、合理、效率更高。The coal preparation and coke processing systems both adopt PLC interlocking automatic control, and are scientifically managed by computers, making their operations more accurate, reasonable, and efficient.

10.5.2 炼焦系统的节能措施 Energy-saving measures for coking systems

- a) 换热热回收焦炉取消了蓄热室及换向设施，采用换热室预热空气，增加了换热效率；The heat exchange heat recovery coke oven has eliminated the storage chamber and reversing facilities, and adopted a heat exchange chamber to preheat air, increasing heat exchange efficiency;
- b) 焦炉的空气道在立火道隔墙中，高向分段供气。保证了焦炉高向加热的均匀，提高了焦炉的热工效率；The air duct of the coke oven is located in the vertical flue partition wall, supplying gas in high sections. Ensuring uniform high directional heating of the coke oven, and improving the thermal efficiency of the coke oven;
- c) 焦炉为负压操作，在装煤和结焦过程中，炉内的烟尘和荒煤气都不易向炉外逸散；The coke oven operates under negative pressure, and during the coal loading and coking process, the smoke, dust, and raw gas inside the furnace are not easily dispersed outside the furnace;
- d) 炉门采用敲打刀边炉门，敲打刀边炉门密封效果好，防止炉门冒烟冒火，减少了散热及荒煤气的外逸；The furnace door adopts a striking knife edge furnace door, and the sealing effect of the striking knife edge furnace door is good, preventing smoke and fire from the furnace door, reducing heat dissipation and the escape of raw gas;
- e) 换热室外表面用隔热砖密封保护，使焦炉本体的散热量减少到最小，

有效的提高了焦炉热工效率，节约了能源；The outdoor surface of the heat exchange room is sealed and protected with insulation bricks, which minimizes the heat dissipation of the coke oven body, effectively improves the thermal efficiency of the coke oven, and saves energy;

- f) 在炉顶区采用高效隔热砖和高强隔热砖，确保炉顶表面层平整、严密，降低了炉顶面温度，降低了焦炉耗热量；The use of high-efficiency insulation bricks and high-strength insulation bricks in the furnace top area ensures that the surface layer of the furnace top is flat and tight, reduces the temperature of the furnace top surface, and reduces the heat consumption of the coke oven;
- g) 焦炉下部多分烟道，合理分配烟气流量，减少系统阻力，利于生产运行的调节与稳定。The lower part of the coke oven is divided into multiple flues, which can reasonably distribute the flue gas flow rate, reduce system resistance, and facilitate the regulation and stability of production operation.

10.5.3 热力专业的节能措施 Energy-saving measures for the thermal engineering profession

- a) 采用干法熄焦技术，与 3 套干熄焦装置配套，设置 3 台干熄焦锅炉。干熄焦锅炉主要作用是降低干熄焦系统惰性循环气体的温度并吸收其热量，产生蒸汽用以供热或发电，以达到使惰性循环气体的热量得到有效利用，节省能源的目的，干熄焦年节标煤量为 215449t/a，干熄焦蒸汽回收量折标煤为 70.27kgce/t 焦；Adopting C.D.Q technology, paired with two sets of C.D.Q unit, two C.D.Q boilers are installed. The main function of a C.D.Q boiler is to lower the temperature of the inert circulating gas in the C.D.Q system and absorb its heat, generating steam for heating or power generation, in order to effectively utilize the heat of the inert circulating gas and save energy. The annual standard coal consumption for C.D.Q is 215449t/a; The steam recovery amount of C.D.Q is 70.27kgce/t coke equivalent to standard coal;
- b) 干熄焦锅炉热力系统设置连续排污扩容器，其产生的二次蒸汽，予以

回收利用，用于除氧器除氧给水加热。回收蒸汽量约为：89880t/a;

The thermal system of the C.D.Q boiler is equipped with a continuous discharge flash tank, and the secondary steam generated by it is recycled and used for heating the deoxygenated feedwater of the deaerator. The amount of steam recovered is approximately 89880t/a;

- c) 干熄焦锅炉为充分利用锅炉排污水，节省水资源，在干熄焦锅炉排污井处设置 1 台长轴液下泵，对排污水进行回收，干熄焦锅炉排污水用于干熄焦装入装置水封槽用水。回收水量为：15876t/a; In order to fully utilize the waste water discharged from the C.D.Q boiler and save water resources, a long axis submerged pump is installed at the discharge well of the C.D.Q boiler to recover the waste water. The waste water discharged from the C.D.Q boiler is used for the water seal tank of the C.D.Q loading unit. The recovered water volume is 15876t/a;

- d) 将除氧器放散蒸汽进行回收，回收至除盐水箱，供干熄焦锅炉循环利用; The steam released from the deaerator is recovered and sent to the desalination water tank for circulation by the C.D.Q boiler.
- e) 焦炉废气余热锅炉与 12 座焦炉配套，设置 6 台锅炉。焦炉废气余热锅炉主要作用是降低焦炉废气的温度并吸收其热量，产生蒸汽用以供热或发电，以达到热量得到有效利用，节省能源的目的，年节标煤量为：1083919t/a; The coke oven waste heat recovery boiler is matched with coke ovens and equipped with 6 boilers. The main function of the coke oven waste heat recovery boiler is to reduce the temperature of the coke oven waste gas and absorb its heat, generating steam for heating or power generation, in order to achieve effective utilization of heat and save energy. The annual standard coal consumption is 1083919t/a;

- f) 本项目干熄焦锅炉及焦炉废气余热锅炉所产高温高压蒸汽用于新建汽轮发电站发电。保证了干熄焦及焦炉废气余热锅炉热力系统所回收热能的合理利用; The high-temperature and high-pressure steam

produced by the C.D.Q boiler and the coke oven waste heat recovery boiler of the coke oven in this project is used for power generation in the newly built steam turbine power station. Ensure the reasonable utilization of heat energy recovered by the thermal system of C.D.Q coke and coke oven waste heat recovery boiler;

- g) 汽轮发电站疏水采用疏水扩容器收集，汽封和阀杆漏气通过轴封加热器回收并加热凝结水，回收的凝结水重新利用，节约水资源、降低能耗，凝结水回收量约为：92485tt/a; The drainage of the steam turbine power station is collected by a drainage expansion container. The leakage of the steam seal and valve stem is recovered and heated by the shaft seal heater, and the recovered condensate is reused to save water resources and reduce energy consumption. The recovery amount of condensate is about 92485tt/a;
- h) 除盐水处理站设计规模为：3×60t/h，根据《钢铁企业节水设计规范》和国家发展改革委等组织制订的《中国节水技术政策大纲》中“提高用水效率和效益，促进水资源的可持续利用”的有关要求，本工程采用二级反渗透+EDI 工艺；The design scale of the desalination water station is 3 × 60t/h. In accordance with the requirements of "improving water efficiency and efficiency, promoting sustainable utilization of water resources" in the "Water saving Design Specification for Steel Enterprises" and the "China Water Saving Technology Policy Outline" formulated by the National Development and Reform Commission and other organizations, this project adopts a two-stage reverse osmosis+EDI process;
- i) 本项目蒸汽管道采取有效保温措施，降低热损失（管道散热损失小于5%）、节省能耗；The steam pipeline of this project adopts effective insulation measures to reduce heat loss (pipeline heat dissipation loss is less than 5%) and save energy;
- j) 余热锅炉布置在间台，减少高温烟道散热。The coke oven waste heat recovery boiler is arranged on the intermediate platform to reduce the heat dissipation of the high-temperature flue.

10.5.4 除尘通风专业的节能措施 Energy saving measures for dust removal and ventilation profession

- a) 本工程破碎机房、粉碎机房、D101 转运站、C103 转运站除尘系统分别设置在厂房屋面上, 风机均不调速; 1 座干熄焦除尘地面站, 风机变频调速。当干熄炉装焦满负荷时, 干熄焦除尘风机高速(100%)运转, 其它时间风机中速(70%)运行; This project Crusher room, crushing room D101 transfer station The dust removal systems of C103 transfer station are respectively installed on the roof of the factory building, and the fans are not regulated; 1 C.D.Q dust removal ground station, with variable frequency speed regulation of the fan. When the C.D.Q furnace is fully loaded with coke, the dust removal fan in the C.D.Q environment runs at high speed (100%), and the fan runs at medium speed (70%) at other times;
- b) 除尘管道布置减少不必要的转弯、变径, 以降低除尘系统阻力; The arrangement of dust removal pipelines reduces unnecessary turning and diameter changes to reduce the resistance of the dust removal system;
- c) 选用低阻除尘器, 可降低阻力, 节约电能。除尘器采用针刺毡覆膜滤料, 可降低阻力, 节约电能; Choosing a low resistance dust collector can reduce resistance and save electricity. The dust collector adopts needle punched felt covered membrane filter material, which can reduce resistance and save electricity;
- d) 优先采用自然通风, 可大大节省能耗; Prioritizing natural ventilation can greatly save energy consumption;
- e) 柜式或壁挂式空调机的室外机尽量布置在建筑物的南侧; 柜式或壁挂式空调机的室外机采取遮阳措施; 空调机的制冷剂管路系统采取保温措施 (保温护套厚度>15mm); 空调连接管道尽量短。The outdoor units of cabinet or wall mounted air conditioning units should be arranged on the south side of the building as much as possible; Take shading measures for outdoor units of cabinet or wall mounted air conditioners; The refrigerant pipeline system of the air conditioner adopts insulation measures (insulation sheath thickness>15mm); The

air conditioning connection pipeline should be as short as possible.

10.5.5 给排水专业的节能措施 Energy saving measures for water supply and drainage profession

- a) 为降低新水用量，本工程中给水系统尽量采用循环给水方式；In order to reduce the amount of new water used, the water supply system in this project adopt a recirculating cooling water supply method;
- b) 为提高工艺冷却设备的传热效率，防止循环水系统的管道和设备结垢，从而达到降低能耗的目的，在循环水泵站内设有全自动浅层过滤器、水质稳定加药装置，向循环水系统投加缓蚀阻垢剂、杀菌灭藻剂。In order to improve the heat transfer efficiency of process cooling equipment, prevent scaling of pipelines and equipment in the recirculating cooling water system, and achieve the goal of reducing energy consumption, fully automatic shallow filters and water quality stabilization dosing units are installed in the recirculating cooling water pump station to add corrosion and scale inhibitors, bacteria and algae killing agents to the recirculating cooling water system.

10.5.6 电力专业的节能措施 Energy saving measures for the power industry

- a) 选用国家公布的节能机电产品（例如节能型变压器）及在规范要求的各级供电回路上加设电能计量装置；Select Energy-saving electromechanical products announced by the state (such as Energy-saving transformers) and install energy metering units on the power supply circuits at all levels required by regulations;
- b) 正确设计供配电系统，变电所靠近负荷中心，降低变压器损耗，降低输电线路损耗，优化配电线路，使供电设备经济运行。在 10kV 配电室、380V 变电所安装无功补偿装置，提高系统功率因数，节约能源；Correctly design the power supply and distribution system, close the substation to the load center, reduce transformer losses, reduce transmission and distribution line losses, optimize distribution lines, and ensure the economic operation of power supply and distribution equipment. Install reactive power compensation units in 10kV distribution rooms and 380V substations to improve system power factor and save energy;

- c) 全厂照明灯具采用节能型 LED 照明灯具, 合理选择照明方式, 合理设计照明线路控制方式, 设置全厂照明管理控制系统, 根据时间及现场使用情况实现远程控制, 从而达到节能目的; The entire factory adopts Energy-saving LED lighting fixtures, selects lighting methods reasonably, designs lighting circuit control methods reasonably, sets up a lighting management and control system for the entire factory, and realizes remote control based on time and on-site usage to achieve Energy-saving goals;
- d) 根据工艺生产需要, 对风机、泵类负荷采用变频调速装置。According to the production process requirements, variable frequency speed regulation units are used for the loads of fans and pumps.

10.5.7 总图道路专业的节能措施 Energy saving measures for the Overall layout major

- a) 各车间变电所靠近其负荷中心布置, 减少电能的损耗; Each unit substation is arranged near its load center to reduce energy loss;
- b) 各除尘地面站靠近其负荷中心布置, 使除尘管道短捷, 减少沿程损失, 降低风机压头, 从而减少电能的消耗。Each dust removal ground station is arranged close to its load center to shorten the dust removal pipeline, reduce the loss along the way, lower the pressure head of the fan, and thus reduce the consumption of electric power.

10.6 节能结论 Energy-saving conclusion

综上所述, 本项目使用的主要能源种类合理, 能源供应有保障, 建设符合国家产业政策、企业发展方向, 建设规模合理, 工艺技术可靠, 设备选型先进、建设条件良好, 具有显著的经济效益和社会效益。因此, 项目是可行的。

In summary, the main types of energy used in this project are reasonable, the energy supply is guaranteed, the construction conforms to national industrial policies and enterprise development directions, the construction scale is reasonable, the process technology is reliable, the equipment selection is advanced, and the construction conditions are good, which has significant economic and social benefits. Therefore, the project is feasible.

11 职工定员及技术经济指标 Employee quota and technical and economic indicators

11.1 职工定员 Staff Quota

11.1.1 编制依据 Compilation basis

本工程职工定员参照中华人民共和国劳动和劳动安全行业标准《冶金劳动定员定额（冶金生产）》之有关规定进行编制。

The staffing quota for this project is formulated in accordance with the relevant provisions of the Labor and Labor Safety Industry Standard of the People's Republic of China, Metallurgical Labor Quota (Metallurgical Production).

11.1.2 编制范围 Scope of Preparation

编制范围为备煤车间、炼焦车间、筛运焦系统、干熄焦系统、辅助生产设施等生产人员及管理和服务人员。

The scope of staffing includes production personnel, management and service personnel in coal preparation unit, coking unit, Screening and coke transportation system, C.D.Q system, auxiliary production facilities, etc.

11.1.3 组织机构及管理体制 Organizational structure and management system

本工程的装置和相应的公用辅助设施均隶属于南非，其生产、人事等均由公司现有的组织机构进行管理，现有的组织机构和管理体制保持不变。

The equipment and corresponding public auxiliary facilities of this project belong to Zimbabwe, and their production, personnel, and other aspects are managed by the company's existing organizational structure. The existing organizational structure and management system remain unchanged.

11.1.4 生产班制 Production shift system

连续生产岗位按四班制配备、两班制操作。补缺勤人员按生产人员总数的4%。

Continuous production positions are equipped with a four shift system and operated on a two shift system. 4% of the total production personnel will be compensated for absenteeism.

11.1.5 编制结果 Preparation results

一期工程所需职工定员 358 人，其中生产人员 315 人，管理及服务人员 43 人。

The first phase of the project requires a workforce of 358 people, including 315 production personnel and 43 management and service personnel.

二期工程新增职工定员 256 人，其中生产人员 225 人，管理及服务人员 31 人。

The second phase of the project has added 256 new employees, including 225 production personnel and 31 management and service personnel.

三期工程新增职工定员 260 人，其中生产人员 229 人，管理及服务人员 31 人。

The second phase of the project has added 260 new employees, including 229 production personnel and 31 management and service personnel.

详见表 11-1 一期职工定员、表 11-2 二期职工定员表、表 11-3 三期职工定员表。

Please refer to Table 12-1 for the first phase staff quota, Table 12-2 for the second phase staff quota, and Table 12-3 for the third phase staff quota.

表 11-1 一期职工定员表
Table 11-1 Staffing Table for Phase I Employees

序号 No.	名称 Name	人数 Number	备注 Remarks
1	生产设施人员 Production facility personnel		
1.1	备煤车间 Coal preparation unit	40	
1.2	炼焦车间 Coking unit		
1.2.1	炼焦系统 Coking system	127	
1.2.2	筛运焦系统 Screening and coke transportation system	20	
1.2.3	烟气脱硫装置 fgd	32	
1.2.4	干熄焦系统 Dry quenching system	16	
1.3	公辅车间 Public auxiliary unit	68	
	生产人员小小计 Subtotal	303	
	补缺勤 Make up for absenteeism	12	

序号 No.	名称 Name	人数 Number	备注 Remarks
	生产人员合计 Total	315	
2	管理及服务人员 Management and service personnel	43	
3	职工总数 Total	358	

备注：未包含厂前区辅助人员。

Note: Auxiliary personnel in the front area of the factory are not included.

表 11-2 二期职工定员表
Table 11-2 Staffing Table for Phase II Employees

序号 No.	名称 Name	人数 Number	备注 Remarks
1	生产设施人员 Production facility personnel		
1.1	备煤车间 Coal preparation unit	4	
1.2	炼焦车间 Coking unit		
1.2.1	炼焦系统 Coking system	127	
1.2.2	烟气脱硫装置 fgd	32	
1.2.3	干熄焦系统 Dry quenching system	16	
1.3	公辅车间 Public auxiliary unit	37	
	生产人员小小计 Subtotal	216	
	补缺勤 Make up for absenteeism	9	
	生产人员合计 Total	225	
2	管理及服务人员 Management and service personnel	31	
3	职工总数 Total	256	

备注：未包含厂前区辅助人员。

Note: Auxiliary personnel in the front area of the factory are not included.

表 11-3 三期职工定员表
Table 11-3 Staffing Table for Phase III Employees

序号 No.	名称 Name	人数 Number	备注 Remarks
1	生产设施人员 Production facility personnel		
1.1	备煤车间 Coal preparation unit	4	
1.2	炼焦车间 Coking unit		
1.2.1	炼焦系统 Coking system	127	
1.2.2	筛运焦系统 Screening and coke transportation system	4	
1.2.3	烟气脱硫装置 fgd	32	
1.2.4	干熄焦系统 Dry quenching system	16	
1.3	公辅车间 Public auxiliary unit	37	
	生产人员小小计 Subtotal	220	
	补缺勤 Make up for absenteeism	9	
	生产人员合计 Total	229	
2	管理及服务人员 Management and service personnel	31	
3	职工总数 Total	260	

备注：未包含厂前区辅助人员。

Note: Auxiliary personnel in the front area of the factory are not included.

11.1.6 人员培训 Personnel training

11.1.6.1 管理人员培训 Management personnel training

管理人员要求具有大专以上学历和助理工程师以上技术职称。生产、技术、设备、经营、自动控制等部门的管理人员送到中国国内已投产的同类企业进行现场培训。

Management personnel are required to have a college degree or above and a technical title of assistant engineer or above. Management personnel from departments such as production, technology, equipment, operation, and

automatic control will be sent to similar domestic enterprises that have already been put into operation for on-site training.

11.1.6.2 生产技术骨干的培训 Training for production technology backbone

生产人员要求具有高中文化程度。对生产、维修、自动控制等生产技术骨干到国内已投产的同类企业进行培训，需专门培训 2~3 个月。以上人员上岗进行技术考核，凭合格证上岗。

Production personnel are required to have a high school education level. Training for production, maintenance, automatic control and other production technology backbone to similar domestic enterprises that have already been put into operation requires specialized training for 2-3 months. The above personnel are required to undergo technical assessment before taking up their positions with a certificate of qualification.

11.2 技术经济指标 Technical and Economic Indicators

表 11-4 一期主要经济技术指标表
Table 11-4 Main economic and technical indicators of the first phase

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
1	装置能力 Unit capability			
1.1	焦炭产量 Coke production	10 ⁴ t/a	100	
1.2	焦炉炉型 Coke oven type		热回收焦炉 heat recovery coke oven	
1.3	焦炉孔数 Number of coke oven holes	孔 holes	4×25	
1.4	干法熄焦装置能力 Capacity of dry quenching device	t/h	1×140	
1.5	干法熄焦锅炉 (P=13.8MPa,t=570℃)	t/h	1×63	最大 73 Maximum 73
1.6	焦炉烟气余热锅炉 Coke oven flue gas coke oven waste heat recovery boiler (P=13.8MPa,t=570℃)	t/h	2×152	
1.7	汽轮发电站 Steam turbine power station (P1=13.2MPa (绝), t1=566℃)	MW	2×65	
2	产品产量 Product output			
2.1	干全焦 Dry total focus	t/a	1065742	
2.2	焦炭（干基） Coke (dry basis)	t/a	1030724	
	>30mm	t/a	979188	
	<30mm	t/a	51536	
2.3	沉淀池粉焦（干基） Sedimentation tank powder coke (dry basis)	t/a	745	
2.4	干熄焦粉焦 Dry quenching powder coke	t/a	24024	
2.5	发电量 Power generation	10 ³ kWh/a	1027600	
	其中：外供 Among them: external supply	10 ³ kWh/a	929300	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
3	原材料消耗量 Raw material consumption			
3.1	炼焦用洗精煤(干) Clean coal for coking (dry)	t/a	1440144	
3.2	磷酸三钠 Trisodium Phosphate	t/a	7.763	
3.3	PH 调节剂 PH regulator	t/a	48.26	
3.5	复合药剂 complex reagent	t/a	5.28	
3.6	氧化杀菌灭藻剂 Oxidative fungicide and algacide	t/a	0.17	
3.7	非氧化杀菌灭藻剂 Non oxidizing bactericidal and algicidal agents	t/a	0.05	
3.11	盐酸: HCL (30%) Hydrochloric acid: HCL (30%)	t/a	0.208	
3.8	烧碱: NaOH (40%) Caustic soda: NaOH (40%)	t/a	2.025	
3.11	絮凝剂 Flocculant	t/a	3.67	
3.8	杀菌剂 bactericide	t/a	6.716	
3.9	还原剂 reducing agent	t/a	1.113	
3.10	阻垢剂 Scale inhibitor	t/a	1.113	
3.12	反渗透膜 reverse osmosis membrane	万元/a 10000 yuan/a	14	
3.13	超滤膜 ultrafiltration membrane	万元/a 10000 yuan/a	6	
3.14	反渗透保安过滤膜 Reverse osmosis security filter membrane	万元/a 10000 yuan/a	1.2	
3.15	超滤膜保安过滤膜 Ultrafiltration membrane security filter membrane	万元/a 10000 yuan/a	0.6	
3.16	焦炭烧损 Coke burning loss	t/a	10248	
3.17	生石灰 Quicklime	t/a	7464	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
4	动力消耗 Power consumption			
4.1	水 Water			
	生产用水 Production water	10 ³ m ³ /a	1237.74	
	焦炉循环水 Coke oven recirculating cooling water	m ³ /h	39	自供 Self supply
	汽轮发电循环水 Recirculating cooling water for steam turbine power generation	m ³ /h	45	自供 Self supply
	空氮站循环水 Compressed air nitrogen station circulating water		2374	自供 Self supply
	生活用水 Domestic water	m ³ /d	19.58	
4.2	电 Electric power			
	有功功率 Active power	kW	17874	
	视在功率 Apparent power	kVA	19428	
	年耗电量 Annual power consumption	10 ³ kWh/a	98300	自供 Self supply
4.3	蒸汽 Steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	4	开工用 Starting work
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	0.2	焦炉用 Used for coke oven
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	8	脱硫用 For desulfurization purposes
4.5	压缩空气 compressed air	m ³ /min	15.33	新建空压站供 New air compressor station for supply
4.6	净化压缩空气 Purifying compressed air	m ³ /min	77.1	新建空压站供 New air compressor station for supply
4.7	除尘用 Use for dust remove	m ³ /min	13.5	新建空压站供 New air compressor station for supply
4.8	仪表用净化空气 Purified air for	m ³ /min	3.5	新建空压站供 New air compressor

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	instruments			station for supply
4.8	干熄焦烘炉用天然气 Natural gas for dry quenching oven	10 ³ m ³ /a	132	一年用 10 天（以热值约 36420kJ/Nm ³ 计算） 10 days per year (calculated based on a calorific value of approximately 36420kJ/Nm ³)
4.9	除盐水 Demineralized water	t/h	26.55	新建除盐水处理站供 Newly built desalination water station for supply
5	投资 Investment			
5.1	建设投资 Construction investment	万元 10 ⁴ yuan	154099.02	
5.2	建设期利息 Interest during construction period	万元 10 ⁴ yuan	9275.53	
5.3	流动资金 Working capital	万元 10 ⁴ yuan	11437.30	
6	财务预测指标 Financial forecast indicators			
6.1	营业收入 Operating income	万元/a 10 ⁴ yuan/a	298421.95	达产年 Production year
6.3	增值税 value added tax	万元/a 10 ⁴ yuan/a	17887.48	达产年 Production year
6.4	原料费用 Raw material costs	万元/a 10 ⁴ yuan/a	161001.05	达产年 Production year
6.5	动力费用 Power cost	万元/a 10 ⁴ yuan/a	283.53	达产年 Production year
6.6	总成本费用 Total cost expenses	万元/a 10 ⁴ yuan/a	176507.42	经营期平均 Average operating period
6.7	利润总额 Total profit	万元/a 10 ⁴ yuan/a	101290.12	经营期平均 Average operating period
6.8	所得税 Income tax	万元/a 10 ⁴ yuan/a	33425.74	经营期平均 Average operating period
6.9	税后利润 After tax profit	万元/a 10 ⁴ yuan/a	67864.38	经营期平均 Average operating period
6.10	项目投资财务内部收益率（税前） Project investment financial internal rate of return (pre tax)	%	58.59	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
6.11	项目投资财务内部收益率（税后） Financial internal rate of return on project investment (after tax)	%	42.46	
6.12	资本金财务内部收益率 Capital Financial Internal Rate of Return	%	59.57	
6.13	项目投资回收期（税前） Project investment payback period (pre tax)	年 Years	3.19	含建设期 Including construction period
6.14	项目投资回收期（税后） Project investment payback period (after tax)	年 Years	3.82	含建设期 Including construction period
6.15	资本金投资回收期 Capital investment payback period	年 Years	4.06	含建设期 Including construction period
6.16	项目投资净现值（ic=12%，税前） Net present value of project investment (ic=12%, pre tax)	万元 10 ⁴ yuan	551063.17	
6.17	项目投资净现值（ic=12%，税后） Net present value of project investment (ic=12%, after tax)	万元 10 ⁴ yuan	341710.59	
6.18	资本金净现值（ic=12%） Net present value of capital (ic=12%)	万元 10 ⁴ yuan	1391219.83	
6.19	总投资收益率 Total investment return rate	%	58.88	
6.20	项目资本金净利润率 Net profit margin of project capital	%	102.49	
7	其他指标 Other indicators			
7.1	职工定员 Employee quota	人 Person	358	
	其中：生产人员 Among them: Production personnel	人 Person	315	
	管理和服务人员 Management and service personnel	人 Person	43	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
7.2	总图及运输 Overall plan and transportation			
7.2.1	工程用地面积 Engineering land area	m ²	428700	一期用地面积 Phase I land area
7.2.2	道路工程 road engineering	m ²	66350	全部三期道路 All three phases of roads
7.2.3	绿化用地率 Green land utilization rate	%	15	
7.2.4	绿化用地面积 Green land area	m ²	64305	全部三期绿化 All three phases of greening

表 11-5 二期主要经济技术指标表

Table 11-5 Technical and Economic Indicators for Phase II

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
1	装置能力 Unit capability			
1.1	焦炭产量 Coke production	10 ⁴ t/a	100	
1.2	焦炉炉型 Coke oven type		热回收焦炉 heat recovery coke oven	
1.3	焦炉孔数 Number of coke oven holes	孔 holes	4×25	
1.4	干法熄焦装置能力 Capacity of dry quenching device	t/h	1×140	
1.5	干法熄焦锅炉 (P=13.8MPa,t=570℃)	t/h	1×63	最大 73 Maximum 73
1.6	焦炉烟气余热锅炉 Coke oven flue gas coke oven waste heat recovery boiler (P=13.8MPa,t=570℃)	t/h	2×152	
1.7	汽轮发电站 Steam turbine power station (P1=13.2MPa (绝), t1=566℃)	MW	2×65	
2	产品产量 Product output			
2.1	干全焦 Dry total focus	t/a	1065742	
2.2	焦炭（干基） Coke (dry basis)	t/a	1030724	
	>30mm	t/a	979188	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	<30mm	t/a	51536	
2.3	沉淀池粉焦 (干基) Sedimentation tank powder coke (dry basis)	t/a	745	
2.4	干熄焦粉焦 Dry quenching powder coke	t/a	24024	
2.5	发电量 Power generation	10 ³ kWh/a	1027600	
	其中: 外供 Among them: external supply	10 ³ kWh/a	929300	
3	原材料消耗量 Raw material consumption			
3.1	炼焦用洗精煤(干) Clean coal for coking (dry)	t/a	1440144	
3.2	磷酸三钠 Trisodium Phosphate	t/a	7.763	
3.3	PH 调节剂 PH regulator	t/a	48.26	
3.5	复合药剂 complex reagent	t/a	5.28	
3.6	氧化杀菌灭藻剂 Oxidative fungicide and algacide	t/a	0.17	
3.7	非氧化杀菌灭藻剂 Non oxidizing bactericidal and algicidal agents	t/a	0.05	
3.11	盐酸: HCl(30%) Hydrochloric acid: HCl(30%)	t/a	0.208	
3.8	烧碱: NaOH(40%) Caustic soda: NaOH(40%)	t/a	2.025	
3.11	絮凝剂 Flocculant	t/a	3.67	
3.8	杀菌剂 bactericide	t/a	6.716	
3.9	还原剂 reducing agent	t/a	1.113	
3.10	阻垢剂 Scale inhibitor	t/a	1.113	
3.12	反渗透膜 reverse osmosis membrane	万元/a 10000 yuan/a	14	
3.13	超滤膜 ultrafiltration	万元/a 10000	6	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	membrane	yuan/a		
3.14	反渗透保安过滤膜 Reverse osmosis security filter membrane	万元/a 10000 yuan/a	1.2	
3.15	超滤膜保安过滤膜 Ultrafiltration membrane security filter membrane	万元/a 10000 yuan/a	0.6	
3.16	焦炭烧损 Coke burning loss	t/a	10248	
3.17	生石灰 Quicklime	t/a	7464	
4	动力消耗 Power consumption			
4.1	水 Water			
	生产用水 Production water	10 ³ m ³ /a	1237.74	
	焦炉循环水 Coke oven recirculating cooling water	m ³ /h	39	自供 Self supply
	汽轮发电循环水 Recirculating cooling water for steam turbine power generation	m ³ /h	45	自供 Self supply
	空氮站循环水 Compressed air nitrogen station circulating water		2374	自供 Self supply
	生活用水 Domestic water	m ³ /d	19.58	
4.2	电 Electric power			
	有功功率 Active power	kW	13007	
	视在功率 Apparent power	kVA	14138	
	年耗电量 Annual power consumption	10 ³ kWh/a	71539	自供 Self supply
4.3	蒸汽 Steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	4	开工用 Starting work
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	0.2	焦炉用 Used for coke oven

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	8	脱硫用 For desulfurization purposes
4.5	压缩空气 compressed air	m ³ /min	15.33	新建空压站供 New air compressor station for supply
4.6	净化压缩空气 Purifying compressed air	m ³ /min	54.1	新建空压站供 New air compressor station for supply
4.7	除尘用 Use for dust remove	m ³ /min	13	新建空压站供 New air compressor station for supply
4.8	仪表用净化空气 Purified air for instruments	m ³ /min	3.5	新建空压站供 New air compressor station for supply
4.8	干熄焦烘炉用天然气 Natural gas for dry quenching oven	10 ³ m ³ /a	132	一年用 10 天（以热值约 36420kJ/Nm ³ 计算） 10 days per year (calculated based on a calorific value of approximately 36420kJ/Nm ³)
4.9	除盐水 Demineralized water	t/h	26.55	新建除盐水处理站供 Newly built desalination water station for supply
5	投资 Investment			
5.1	建设投资 Construction investment	万元 10 ⁴ yuan	127263.29	
5.2	建设期利息 Interest during construction period	万元 10 ⁴ yuan	7660.24	
5.3	流动资金 Working capital	万元 10 ⁴ yuan	10804.14	
6	财务预测指标 Financial forecast indicators			
6.1	营业收入 Operating income	万元/a 10 ⁴ yuan/a	299813.52	达产年 Production year
6.3	增值税 value added tax	万元/a 10 ⁴ yuan/a	18070.33	达产年 Production year
6.4	原料费用 Raw material costs	万元/a 10 ⁴ yuan/a	161001.05	达产年 Production year
6.5	动力费用 Power cost	万元/a 10 ⁴ yuan/a	273.29	达产年 Production year
6.6	总成本费用 Total cost expenses	万元/a 10 ⁴ yuan/a	173206.15	经营期平均 Average operating period

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
6.7	利润总额 Total profit	万元/a 10 ⁴ yuan/a	105788.33	经营期平均 Average operating period
6.8	所得税 Income tax	万元/a 10 ⁴ yuan/a	34910.15	经营期平均 Average operating period
6.9	税后利润 After tax profit	万元/a 10 ⁴ yuan/a	70878.18	经营期平均 Average operating period
6.10	项目投资财务内部收益率（税前） Project investment financial internal rate of return (pre tax)	%	70.82	
6.11	项目投资财务内部收益率（税后） Financial internal rate of return on project investment (after tax)	%	51.13	
6.12	资本金财务内部收益率 Capital Financial Internal Rate of Return	%	74.41	
6.13	项目投资回收期（税前） Project investment payback period (pre tax)	年 Years	2.91	含建设期 Including construction period
6.14	项目投资回收期（税后） Project investment payback period (after tax)	年 Years	3.44	含建设期 Including construction period
6.15	资本金投资回收期 Capital investment payback period	年 Years	3.46	含建设期 Including construction period
6.16	项目投资净现值（ic=12%，税前） Net present value of project investment (ic=12%, pre tax)	万元 10 ⁴ yuan	592461.07	
6.17	项目投资净现值（ic=12%，税后） Net present value of project investment (ic=12%, after tax)	万元 10 ⁴ yuan	373938.12	
6.18	资本金净现值（ic=12%） Net present value of capital (ic=12%)	万元 10 ⁴ yuan	1453002.68	
6.19	总投资收益率 Total investment return rate	%	73.50	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
6.20	项目资本金净利润率 Net profit margin of project capital	%	128.34	
7	其他指标 Other indicators			
7.1	职工定员 Employee quota	人 Person	256	
	其中：生产人员 Among them: Production personnel	人 Person	225	
	管理和服务人员 Management and service personnel	人 Person	31	
7.2	总图及运输 Overall plan and transportation			
7.2.1	工程用地面积 Engineering land area	m ²	87480	二期用地面积 Phase II land area

表 11-6 三期技术经济指标表

Table 11-6 Technical and Economic Indicators for Phase III

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
1	装置能力 Unit capability			
1.1	焦炭产量 Coke production	10 ⁴ t/a	100	
1.2	焦炉炉型 Coke oven type		热回收焦炉 heat recovery coke oven	
1.3	焦炉孔数 Number of coke oven holes	孔 holes	4×25	
1.4	干法熄焦装置能力 Capacity of dry quenching device	t/h	1×140	
1.5	干法熄焦锅炉 (P=13.8MPa,t=570℃)	t/h	1×63	最大 73 Maximum 73
1.6	焦炉烟气余热锅炉 Coke oven flue gas coke oven waste heat recovery boiler (P=13.8MPa,t=570℃)	t/h	2×152	
1.7	汽轮发电站 Steam turbine power station (P1=13.2MPa (绝), t1=566℃)	MW	2×65	
2	产品产量 Product output			
2.1	干全焦 Dry total focus	t/a	1065742	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
2.2	焦炭（干基） Coke (dry basis)	t/a	1030724	
	>30mm	t/a	979188	
	<30mm	t/a	51536	
2.3	沉淀池粉焦（干基） Sedimentation tank powder coke (dry basis)	t/a	745	
2.4	干熄焦粉焦 Dry quenching powder coke	t/a	24024	
2.5	发电量 Power generation	10 ³ kWh/a	1027600	
	其中：外供 Among them: external supply	10 ³ kWh/a	929300	
3	原材料消耗量 Raw material consumption			
3.1	炼焦用洗精煤(干) Clean coal for coking (dry)	t/a	1440144	
3.2	磷酸三钠 Trisodium Phosphate	t/a	7.763	
3.3	PH 调节剂 PH regulator	t/a	48.26	
3.5	复合药剂 complex reagent	t/a	5.28	
3.6	氧化杀菌灭藻剂 Oxidative fungicide and algacide	t/a	0.17	
3.7	非氧化杀菌灭藻剂 Non oxidizing bactericidal and algicidal agents	t/a	0.05	
3.11	盐酸： HCL (30%) Hydrochloric acid: HCL (30%)	t/a	0.208	
3.8	烧碱： NaOH (40%) Caustic soda: NaOH (40%)	t/a	2.025	
3.11	絮凝剂 Flocculant	t/a	3.67	
3.8	杀菌剂 bactericide	t/a	6.716	
3.9	还原剂 reducing agent	t/a	1.113	
3.10	阻垢剂 Scale inhibitor	t/a	1.113	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
3.12	反渗透膜 reverse osmosis membrane	万元/a 10000 yuan/a	14	
3.13	超滤膜 ultrafiltration membrane	万元/a 10000 yuan/a	6	
3.14	反渗透保安过滤膜 Reverse osmosis security filter membrane	万元/a 10000 yuan/a	1.2	
3.15	超滤膜保安过滤膜 Ultrafiltration membrane security filter membrane	万元/a 10000 yuan/a	0.6	
3.16	焦炭烧损 Coke burning loss	t/a	10248	
3.17	生石灰 Quicklime	t/a	7464	
4	动力消耗 Power consumption			
4.1	水 Water			
	生产用水 Production water	10 ³ m ³ /a	1237.74	
	焦炉循环水 Coke oven recirculating cooling water	m ³ /h	39	自供 Self supply
	汽轮发电循环水 Recirculating cooling water for steam turbine power generation	m ³ /h	45	自供 Self supply
	空氮站循环水 Compressed air nitrogen station circulating water		2374	自供 Self supply
	生活用水 Domestic water	m ³ /d	19.58	
4.2	电 Electric power			
	有功功率 Active power	kW	12038	
	视在功率 Apparent power	kVA	13084	
	年耗电量 Annual power consumption	10 ³ kWh/a	66207	自供 Self supply
4.3	蒸汽 Steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated	t/a	4	开工用 Starting work

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	steam			
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	0.2	焦炉用 Used for coke oven
	0.6MPa 饱和蒸汽 0.6MPa saturated steam	t/h	8	脱硫用 For desulfurization purposes
4.5	压缩空气 compressed air	m ³ /min	15.33	新建空压站供 New air compressor station for supply
4.6	净化压缩空气 Purifying compressed air	m ³ /min	48.1	新建空压站供 New air compressor station for supply
4.7	除尘用 Use for dust remove	m ³ /min	12	新建空压站供 New air compressor station for supply
4.8	仪表用净化空气 Purified air for instruments	m ³ /min	3.5	新建空压站供 New air compressor station for supply
4.8	干熄焦烘炉用天然气 Natural gas for dry quenching oven	10 ³ m ³ /a	132	一年用 10 天 (以热值约 36420kJ/Nm ³ 计算) 10 days per year (calculated based on a calorific value of approximately 36420kJ/Nm ³)
4.9	除盐水 Demineralized water	t/h	26.55	新建除盐水站供 Newly built desalination water station for supply
5	投资 Investment			
5.1	建设投资 Construction investment	万元 10 ⁴ yuan	131209.62	
5.2	建设期利息 Interest during construction period	万元 10 ⁴ yuan	7897.77	
5.3	流动资金 Working capital	万元 10 ⁴ yuan	10853.37	
6	财务预测指标 Financial forecast indicators			
6.1	营业收入 Operating income	万元/a 10 ⁴ yuan/a	300090.79	达产年 Production year
6.2	增值税 value added tax	万元/a 10 ⁴ yuan/a	18106.49	达产年 Production year
6.3	原料费用 Raw material costs	万元/a 10 ⁴ yuan/a	161001.05	达产年 Production year

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
6.4	动力费用 Power cost	万元/a 10 ⁴ yuan/a	273.29	达产年 Production year
6.5	总成本费用 Total cost expenses	万元/a 10 ⁴ yuan/a	173599.40	经营期平均 Average operating period
6.6	利润总额 Total profit	万元/a 10 ⁴ yuan/a	105633.83	经营期平均 Average operating period
6.7	所得税 Income tax	万元/a 10 ⁴ yuan/a	34859.16	经营期平均 Average operating period
6.8	税后利润 After tax profit	万元/a 10 ⁴ yuan/a	70774.67	经营期平均 Average operating period
6.9	项目投资财务内部收益率（税前） Project investment financial internal rate of return (pre tax)	%	69.03	
6.10	项目投资财务内部收益率（税后） Financial internal rate of return on project investment (after tax)	%	49.86	
6.11	资本金财务内部收益率 Capital Financial Internal Rate of Return	%	72.23	
6.12	项目投资回收期（税前） Project investment payback period (pre tax)	年 Years	2.94	含建设期 Including construction period
6.13	项目投资回收期（税后） Project investment payback period (after tax)	年 Years	3.49	含建设期 Including construction period
6.14	资本金投资回收期 Capital investment payback period	年 Years	3.51	含建设期 Including construction period
6.15	项目投资净现值（ic=12%，税前） Net present value of project investment (ic=12%, pre tax)	万元 10 ⁴ yuan	589551.62	
6.16	项目投资净现值（ic=12%，税后） Net present value of project investment (ic=12%, after tax)	万元 10 ⁴ yuan	371336.78	
6.17	资本金净现值（ic=12%）	万元 10 ⁴ yuan	1450880.65	

序号 No.	指标名称 Name	单位 Units	指标 Indicators	备注 Remarks
	Net present value of capital (ic=12%)			
6.18	总投资收益率 Total investment return rate	%	71.35	
6.19	项目资本金净利润率 Net profit margin of project capital	%	124.55	
7	其他指标 Other indicators			
7.1	职工定员 Employee quota	人 Person	260	
	其中：生产人员 Among them: Production personnel	人 Person	229	
	管理和服务人员 Management and service personnel	人 Person	31	
7.2	总图及运输 Overall plan and transportation			
7.2.1	工程用地面积 Engineering land area	m ²	63820	三期用地面积 Phase III land area

12 附图（见附件） Attached Figures (See attachment)

13 财评附表（见附件） Financial Evaluation Appendix (See attachment)