Foreword

This code is developed by WISDRI Engineering & Research Incorporation Limited with participation of other relevant organizations according to the requirements of Document JIANBIAO [2012] No. 5 issued by the Ministry of Housing and Urban-Rural Development (MOHURD) of the People's Republic of China- "Notice on Printing and Distributing 'the Development and Revision Plan of National Engineering Construction Standards in 2012'".

This code is finalized by the development team through conducting extensive investigation and research during development, earnestly summarizing the practical experiences of Hydrochloric Acid Regeneration Plant Engineering According to spraying and roasting technology of iron and steel enterprises, and acquiring diversified comments with reference to the related advanced standards home and abroad.

This code consists of 12 chapters, covering: general provisions, terms, basic requirements, process design, process equipment and piping, electrical engineering and automation, plant design, construction and installation, commissioning and assessment, operation and maintenance, energy conservation and environment protection, safety and fire extinguish, etc.

The provisions printed in bold type in the Code are mandatory ones and must be implemented strictly.

This code is under the jurisdiction of the Ministry of Housing and Urban-Rural Development of China, and its mandatory provisions are interpreted by the Ministry of Housing and Urban-Rural Development of China; the detail technical specifications in the code are explained by WISDRI Engineering & Research Incorporation Limited. Any comments or recommendations during the implementation of the code should be submitted to WISDRI Engineering & Research Incorporation Limited (Address: No.33, Daxueyuan Road, Donghu Development Zone, Wuhan; Postcode: 430223) for reference in future revision.

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1 General provisions

1.0.1 The code is developed with a view to improving the technical level of Hydrochloric Acid Regeneration Plant Engineering according to spraying and roasting technology in iron and steel enterprises, and to realizing building of technically-advanced high quality projects featuring economy, feasibility and environment friendliness.

1.0.2 The code is applicable to the construction, operation, maintenance and management of green-field or revamping hydrochloric acid regeneration projects in iron and steel enterprises according to spraying and roasting technology.

1.0.3 The construction of Hydrochloric Acid Regeneration Plant Engineering According to spraying and roasting technology in iron and steel enterprises shall not only comply with this code, but also comply with the current relevant national standards.

2 Terms

2.0.1 Hydrochloric acid regeneration process

It refers to the process of treatment of waste hydrochloric acid from pickling line for producing regenerated acid which could be reused in the pickling line through a series of chemical reactions.

2.0.2 Spraying and roasting technology

It refers to the method that the waste hydrochloric acid mist is sprayed into the roaster for chemical reaction under high temperature for producing regenerated acid and ferric oxide.

2.0.3 Tank farm

It is the area where the storage tanks of fresh acid, waste acid, regenerated acid and rinse water, etc. are arranged.

2.0.4 Waste acid

It is the waste hydrochloric acid generated from pickling line.

2.0.5 Regenerated acid

It is the hydrochloric acid produced by the hydrochloric acid regeneration plant for reuse in pickling line.

2.0.6 Fresh acid

It is the outsourced hydrochloric acid.

2.0.7 Rinse water

It is the water drained from the rinse section of the pickling line after strip cleaning.

2.0.8 Ferric oxide

It is ferric oxide powder produced during spraying and roasting process.

2.0.9 Concentrated acid

It is the waste acid after heat exchange in pre-concentrator and circulating concentration.

2.0.10 Roaster

It is the equipment for producing hydrogen chloride gas and ferric oxide powder through vaporization of concentrated acid sprayed and chemical reaction under high temperature.

2.0.11 Spray boom

It is the equipment to spray the concentrated acid mist into the roaster from its top.

2.0.12 Cyclone separator

It is the equipment installed between roaster and pre-concentrator to separate the ferric oxide powder from the flue gas.

2.0.13 Preconcentrator

It is the equipment for cooling and dedusting of flue gas from the roaster as well as for concentration of waste acid.

2.0.14 Absorption column

It is the equipment which absorbs the hydrogen chloride in flue gas for acid regeneration.

2.0.15 Scrubber

It is the equipment to remove the residual hydrogen chloride and ferric oxide power in flue gas

through scrubbing.

2.0.16 Chloride remover

It is the equipment for reducing the chloride content in ferric oxide via heating.

2.0.17 Acid operation mode

It refers to such production mode as waste acid is sprayed into roaster after passing the pre-concentrator.

2.0.18 Rinse water operation mode

It refers to such production mode as rinse water is sprayed into roaster after passing the pre-concentrator.

2.0.19 Demineralized water operation mode

It refers to such production mode as demineralized water is directly sprayed into roaster.

3 Basic requirements

3.0.1 Hydrochloric acid(HCl)regeneration plant project according to spraying and roasting technology in iron and steel enterprises should be built in parallel with pickling line.

3.0.2 Advanced, well-proved and reliable technology, process and equipment shall be used in hydrochloric acid regeneration project in line with the following requirements:

1 The design capacity shall match the treatment capacity of the corresponding pickling line;

2 The process equipment and the equipment level of the automation control system shall fulfill the requirements of production process;

3 Waste gas emission index shall meet relevant requirements in the current national standard GB 28665 *Emission Standard of Air Pollutants for Steel Rolling Industry*;

4 The quality of ferric oxide powder should meet relevant requirements in the current national standard GB/T 24244 *Iron Oxide for Ferrite*;

5 Fresh acid quality shall meet relevant requirements in the current national standard GB 320 *Synthetic Hydrochloric Acid for Industrial Use*.

3.0.3 Hydrochloric acid regeneration plant should be arranged in workshop.

3.0.4 The configuration of waste acid purification device in hydrochloric acid regeneration project should be determined through techno-economic comparison based on the content of silicon and other impurities in waste acid and ferric oxide quality requirement of ferric oxide powder.

3.0.5 Indoor equipment and material selection of hydrochloric acid regeneration station shall meet the working condition and environmental requirements.

4 Process design

4.1 Process parameters

4.1.1 The designed annual working hour of the hydrochloric acid regeneration plant shall not be less than 6200h.

4.1.2 Indoor material storage capacity in the hydrochloric acid regeneration station shall fulfill the continuous operation requirement of pickling line and the hydrochloric acid regeneration plant. The storage capacity(time)shall be in compliance with Table 4.1.2.

Table 4.1.2 Storage capacity(time)of material

No.	Material	Storage time(h)
1	Fresh acid	≥24
2	Regenerated acid	≥48
3	Rinse water	≥24
4	Waste acid	≥48
5	Ferric oxide powder	≥48

4.1.3 Main composition of waste acid in the hydrochloric acid regeneration plant should be in compliance with Table 4.1.3.

Table 4.1.3 Main composition of waste acid

No.	Composition	Concentration(g/L)
1	Total HCl	≯210
2	Fe^{2+}	≯160

4.1.4 The treatment capacity of the hydrochloric acid regeneration plant may be calculated according to the following formula:

$$Q_{arp}=\frac{Q_{pl}\times S_t}{(C_{WA}-C_{RW})\times T}\times 1000 \tag{4.1.4}$$

Where: Q_{arp}–Treatment capacity of the acid regeneration plant(L/h);

Q_{pl}–Treatment capacity of pickling line(kg/a);

S_t–Iron loss of pickling line,0.35%–0.45%;

T–Annual working hour of the acid regeneration plant;

C_{WA}–Fe ion concentration in waste acid drained from pickling line(g/L);

C_{RW}–Fe ion concentration in rinse water drained from pickling line(g/L).

4.1.5 Design index of the hydrochloric acid regeneration plant should follow the requirements below:

1 Cl ion(Cl^-)recovery ratio shall not be lower than 99%;

2 The circulating pump flow of preconcentrator should be 8 times –10 times the treatment capacity of the plant;

3 The circulating pump flow of scrubber should be 8 times –10 times the treatment capacity of the plant.

4.1.6 During operation of the hydrochloric acid regeneration plant, the following requirements of

control index shall be met:

1 Roaster top pressure should be -0.15kPa - -0.45kPa;

2 Roaster top temperature shall be controlled within the range of 385℃-430℃;

3 Flue gas temperature at preconcentrator outlet shall be lower than 100℃.

4.2 Configurations

4.2.1 Main equipment of the hydrochloric acid regeneration plant should include: roaster, preconcentrator, absorption column, scrubber, waste gas fan, droplet separator, ferric oxide powder filter, acid tank, acid pump unit, combustion system, ferric oxide powder transportation and storage facilities, etc.

4.2.2 The quantity of waste acid storage tanks and regenerated acid storage tanks should not be less than 2 respectively.

4.2.3 Filter configuration shall be in accordance with the following requirements:

1 A separate working filter should be designed respectively for waste acid and rinse water before entering preconcentrator, but a standby filter can be commonly used for both. Filter accuracy should not be more than 1mm;

2 Circulation pipeline of preconcentrator shall be designed with filter;

3 Concentrated waste acid filter shall be set before waste acid entering spray boom.

4.2.4 Chloride remover should be set if the Cl ion(Cl^-) content in ferric oxide powder is no more than 0.1%.

4.2.5 The roaster shall be designed with crusher and rotary valve at its bottom. The high temperature flue gas outlet pipe of the roaster shall be designed with high temperature quick shut-off valve, and the closing time of the valve shall not be more than 8s.

4.2.6 The quantity of main burners and spray booms of the hydrochloric acid regeneration plant may be selected based on Table 4.2.6. Each main burner shall be designed with independent auto controller and flame detector.

Table 4.2.6 Quantity of main burners and spray booms

Treatment capacity(L/h)	≤4000	4000-10000	10000-15000
Spray boom quantity	2-3	3-4	4-5
Main burner quantity	2-3	3-4	4-5

4.2.7 Fuel gas main pipe shall be designed with quick shut-off valves. The closing time of the valve shall be less than 1s, and it shall be leakage free. The quantity of such valves on the main pipe shall not be less than 2.

4.2.8 The feed pumps of roaster and absorption column and waste gas conveying fan shall be designed with speed regulation function.

4.2.9 Each set of the hydrochloric acid regeneration plant should be designed with independent ferric oxide powder conveying and storage facilities. Bag type or plate type filter can be used for ferric oxide filter.

4.2.10 The acid regeneration workshop must be designed with fixed type hazardous gas leakage detection and alarm device.

4.2.11 Acid tank farm, acid pump area and roaster top area must be designed with safety shower device.

4.2.12 The following process parameters shall be measured and automatically interlocked:

1 Temperature at roaster top, flue gas pressure, temperature at middle part of roaster;

2 Flue gas temperature at outlet of preconcentrator;

3 Flue gas temperature at outlet of absorption column.

4.2.13 The hydrochloric acid regeneration plant shall be switched among the following modes manually or automatically:

1 Acid operation mode;

2 Rinse water operation mode;

3 Demineralized water operation mode.

4.2.14 The protection degree of motors in the hydrochloric acid regeneration plant shall be in accordance with the following requirements:

1 The protection degree of motors for fans and acid pumps shall not be lower than IP54;

2 The protection degree of motors for rotary valves shall not be lower than IP63;

3 The protection degree of instruments and actuation mechanism shall not be lower than IP65.

4.3 Process arrangement

4.3.1 The hydrochloric acid regeneration plant shall be safe in process arrangement, and convenient in operation, maintenance and management.

4.3.2 Tank farm shall be designed with sump pit and automatic water drainage facilities, and corresponding measures shall be taken to collect, store and drain out accumulated liquid. The liquid storage volume shall not be less than the volume of the biggest storage tank.

4.3.3 The equipment arrangement in workshop shall meet the following requirements:

1 The equipment with noise not lower than 80dB(A) during operation shall be arranged in an independent room;

2 Pump units should be arranged in a centralized way based on practical condition;

3 Bagging machine of ferric oxide should be arranged in an independent area;

4 Installation surface of preconcentrator, absorption column and scrubber, roaster top platform and emergency shower device shall be designed with floor drain and dash plate;

5 Each floor of building shall be designed with maintenance power.

4.3.4 Pipeline arrangement in building shall meet the following requirements:

1 Pipes should be laid along wall, column, pipe trench and pipe gallery. It should not be getting in the way of road, door, window & lighting, and should be convenient for maintenance;

2 Suction pipe of all acid pumps shall be designed with emptying pipe;

3 All overflow pipes shall be designed with water seal and vent facilities;

4 Storage tanks shall be designed with air inlet and air exhaust facilities;

5 Pipeline arrangement principle: non-corrosive media pipe should be arranged above corrosive media pipe; gas pipe should be arranged above liquid pipe; metallic pipe should be arranged above non-metallic pipe; thermal-insulated pipe should be arranged above non-thermal-insulated pipe.

5 Process equipment and piping

5.1 General regulations

5.1.1 Equipment and material of the hydrochloric acid regeneration plant shall be reliable, practical and durable, and shall be in accordance with the following requirements:

1 Acid resistant brick lining shall be in accordance with relevant requirements of the current national standard GB/T 8488 *Acid Resisting Bricks and Tiles*;

2 Equipment with rubber lining shall be in accordance with relevant requirements of the current relevant standards of the nation GB 18241.1 *Rubber Lining*, HG/T 20677 *Design Code for Chemical Equipment with Rubber Lining* and HG/T 20678 *Specification on Design of Steel Shell with Liner*;

3 FRP equipment shall be in accordance with relevant requirements of the current professional standard HG/T 20696 *Specification of FRP Equipment Design for Chemical Industry*;

4 PPH equipment shall be in accordance with relevant requirements of the current relevant standards of the nation GB/T 25197 *Welded Static Non-pressurized Thermoplastic Tanks* and HG 20640 *Plastic Equipment*;

5 Titanium alloy equipment shall be in accordance with relevant requirements of the current national standards GB/T 3620.1 *Designation and Composition of Titanium and Titanium Alloys* and GB/T 3620.2 *Titanium and Titanium Alloys–Permissible Variations of Chemical Composition for Wrought Product Analysis*;

6 Niobium material and its processing shall be in accordance with relevant requirements of the current professional standard YS/T 656 *Designation and Composition of Wrought Niobium and Niobium Alloy*.

5.1.2 Rust removal and anti-corrosion of steel structure shall be in accordance with the following requirements:

1 Rust removal work before paintings of steel structure and equipment shall be in accordance with relevant requirements of the current national standard GB 8923 *Rust Grades and Preparation Grades of Steel Surfaces Before Application of Paints and Related Products*;

2 Paintings of steel structure and equipment shall be in accordance with relevant requirements of the current professional standard YB/T 9256 *Specification for the Painting Work Technology of Steel Structure and Pipe*;

3 Acid-proof paint shall be used for exterior anti-corrosion work of steel structure and equipment;

4 High temperature resistant paint with corresponding temperature resistant degree shall be used for exterior anti-corrosion work of high temperature steel structure and equipment based on its maximum design temperature of the surface.

5.1.3 Heat preservation of equipment and pipe shall be in accordance with relevant requirements of the current national standard GB 50126 *Code for Construction of Industrial Equipment and Pipeline Insulation Engineering*.

5.2 Equipment

5.2.1 Acid storage tank shall be in accordance with the following requirements:

1 Carbon steel with rubber lining or FRP material should be used for acid storage tank;

2 Heated vulcanized rubber lining should be used for acid storage tank made of rubber-lined carbon steel; 2 layers of rubber plate should be used, of which the thickness should be no less than 3mm;

3 Waste acid tank and regenerated acid tank made of carbon steel with rubber lining should be laid with acid-proof bricks at its bottom and side wall, and the brick thickness should be no less than 65mm;

4 The thickness of anti-corrosion and impervious inner layer of FRP acid tank shall be no less than 4mm.

5.2.2 Carbon steel shall be used for roaster shell and its inner lining material shall meet the following requirements:

1 "Series 1" acid resistant refractory brick should be used for stack and belly of roaster; "Series 2" acid resistant refractory brick should be used for lower cone part of roaster;

2 Performance of acid resistant refractory brick, acid resistant fire clay and light castables shall meet the requirements in Table 5.2.2-1 to Table 5.2.2-3.

Table 5.2.2-1 Performance index of acid resistant refractory brick

Designation	Unit	Performance index	
		Series 1	Series 2
Volume density	g/cm^3	≥2.2	≥2.1
Fire resistance	℃	≥1710	≥1650
Apparent porosity	%	≤20	≤21
Compression strength at atmospheric temperature	MPa	≥35	≥30
Softening point under load T_a	℃	≥1430	≥1300
Acid resistance degree	%	≥99	≥99
Linear change on reheating 1300℃×3h	%	±0.1	±0.1
Al_2O_3	%	≥35	≥30
$SiO_2+Al_2O_3$	%	≥94	≥90

Table 5.2.2-2 Performance index of acid resistant fire clay

Designation	Unit	Performance index
Fire resistance	℃	≥1710
Bonding time	s	60–120
110℃×24h rupture bonding strength	MPa	≥1.2
1350℃×3h rupture bonding strength	MPa	≥5
Granularity>0.5mm	%	<1
Granularity<0.074mm	%	>65
Al_2O_3	%	≥48
$SiO_2+Al_2O_3$	%	≥90

Table 5.2.2-3 Performance index of light castables

Designation	Unit	Performance index
Volume density(110℃×16h)	g/cm^3	≤0.5
Fire resistance	℃	≥1000
Compression strength at atmospheric temperature(110℃×24h)	MPa	≥0.4
250℃±5℃ thermal conductivity (panel method)	W/(m·K)	≤0.112
600℃×3h linear change ratio	%	0–1.0
Al_2O_3	%	≥23

3 Corundum ramming material, high-aluminum light insulation brick and clay light insulation brick should be used for combustion chamber; the material performance shall meet the requirements in Table 5.2.2-4 to Table 5.2.2-6.

Table 5.2.2-4 Performance index of corundum ramming material

Designation	Unit	Performance index
Volume density	g/cm^3	≥2.9
Granularity	mm	0–6
Fire resistance	℃	≥1900
Softening temp. under 0.2MPa load T_a	℃	≥1650
Cold compression strength after 800℃×3h burning	MPa	≥40
Cold compression strength after 1500℃×3h burning	MPa	≥72
Linear thermal expansion at 400℃	%	≤0.3
Linear thermal expansion at 800℃	%	≤0.6
Linear thermal expansion at 1200℃	%	≤0.8
$Al_2O_3+TiO_2$	%	≥90
Fe_2O_3	%	≤1.5

Table 5.2.2-5 Performance index of high-aluminum light insulation brick

Designation	Unit	Performance index
Max. working temp.	℃	1530
Volume density	g/cm^3	≤1.1
Compression strength	MPa	≥5
600℃ thermal conductivity(panel method)	W/(m·K)	≤0.40
1000℃ thermal conductivity	W/(m·K)	≤0.43
Al_2O_3	%	60
Fe_2O_3	%	≤1

Table 5.2.2-6 Performance index of clay light insulation brick

Designation	Unit	Performance index
Max. working temp.	℃	1380
Volume density	g/cm^3	≤0.8
Compression strength	MPa	≥3
250℃±5℃ thermal conductivity(panel method)	W/(m·K)	≤0.29
Al_2O_3	%	≥32
Fe_2O_3	%	≤2

4 Acid resistant castables shall be used in roaster bottom discharging area, connection part between burner and roaster body, connection part between dual-cyclone ferric oxide returning pipe and roaster body as well as the area around maintenance door of roaster. Material performance shall meet the requirements in Table 5.2.2-7.

Table 5.2.2-7 Performance index of acid resistant castables

Designation	Unit	Performance index
Volume density	g/cm^3	≥2.0
Fire resistance	℃	≥1650
Compression strength after burning	MPa	≥20
Linear change ratio after 1350℃×3h burning	g/cm^3	0–1
Al_2O_3	%	≥37

5.2.3 Pre-concentrator shall be in accordance with the following requirements:

1 Carbon steel with rubber lining should be used for pre-concentrator casing; the part above

throat should be lined with acid/heat resistant brick bonded by water glass mastic cement while the part below throat with acid resistant brick bonded by furan mastic cement;

2 Niobium or titanium alloy should be used for the jet pipe of pre-concentrator;

3 The material of pre-concentrator throat shall be characterized by high temperature resistance, acid resistance and fierce erosion resistance.

5.2.4 Absorption column, scrubber, droplet separator and chimney as well as the packing shall be in accordance with the following requirements:

1 Steel with rubber lining, FRP, PPH (improved type polypropylene) or other material may be used for absorption column;

2 FRP or PPH material may be used for droplet separator, scrubber and chimney;

3 Structured packing or Pall Ring packing may be used for the packing in absorption column and scrubber; the packing material should be PPH or PVDF.

5.2.5 Waste gas exhaust fan shall be in accordance with the following requirements:

1 Carbon steel with rubber lining or titanium alloy should be used for its casing;

2 Titanium alloy should be used for impeller, and the impeller shall be designed with flushing device;

3 The fan shall be designed with vibration measuring device and shaft temperature measuring device.

5.2.6 Ferric oxide filter shall be in accordance with the following requirements:

1 Temperature resistance degree of filtering components shall be no less than 105℃;

2 Hydrogen chloride corrosion resistant material shall be used for the internal structural members.

5.2.7 Acid resistant pump shall be in accordance with the following requirements:

1 PVDF, FRP or SiC material shall be used for medium-contacting parts of circulation pump of pre-concentrator and feed pump of roaster;

2 The mechanical seal of circulation pump of pre-concentrator and feed pump of roaster shall be designed with flushing water supply.

5.2.8 Spray boom and nozzle shall be in accordance with the following requirements:

1 Niobium or titanium alloy material should be used for spray boom, and ceramics or silicon carbide material may be used for nozzle;

2 Spray boom shall be designed with built-in filter, of which the screen shall be made of PVDF.

5.2.9 Filter shall be in accordance with the following requirements:

1 PPH, steel with rubber lining or FRP material should be used for casing of waste acid filter, rinse water filter and circulated acid filter, PPH or FRP material should be used for filter element, PPH material should be used for filter screen;

2 Steel with rubber lining or titanium alloy material may be used for concentrated acid filter casing; titanium alloy or PVDF material should be used for filter element; PVDF material should be used for filter screen.

5.3 Piping

5.3.1 Pipe material in the acid regeneration station shall be in accordance with the following requirements:

1 PPH or FRP material should be used for the pipes of waste acid, regenerated acid, rinse water,

fresh acid and demineralized water as well as the breather pipe and drain pipe of acid tank;

2 PVDF material should be used for the circulating pipes and fittings of preconcentrator;

3 Steel with PVDF lining or PVDF material should be used for the acid supply pipe and fittings of roaster;

4 Carbon steel should be used for the duct of flue gas over 380℃, and PPH or FRP material should be used for the duct of flue gas less than 100℃;

5 Carbon steel should be used for combustion gas pipe, nitrogen pipe, compressed air pipe and fire-fighting water pipe for production;

6 Carbon steel pipe should be used for ferric oxide transportation; the elbow should be lined with wearing resistant material.

5.3.2 High temperature resistant expansion joint shall be designed for the pipeline from dual cyclone to preconcentrator; rubber expansion joint should be designed for the duct from exit of preconcentrator to chimney.

5.3.3 Non-metallic pipe shall be in accordance with the following requirements:

1 The PPH pipe with diameter over *DN*500 should be manufactured via extrusion and winding process;

2 Natural compensation method should be adopted for the thermal compensation of pipeline, with compensator installed if necessary; concentrated acid pipe should not be designed with corrugated expansion joint;

3 Pipe maintenance space shall be reserved during pipe arrangement.

5.4 Insulation

5.4.1 Insulation measures shall be taken for the roaster, dual cyclone, chloride remover, and the pipe between the roaster and preconcentrator.

5.4.2 Fiber blanket should be used for the insulation of roaster top and burner of chloride remover, while rock wool may be used for other parts;

5.4.3 The thickness of insulation material shall meet the requirement that the exterior surface temperature of insulation layer should not be higher than 60℃.

5.4.4 Color sheet or galvanized steel sheet may be used for external protection layer of insulation material, and the thickness should not be less than 0.4mm.

6 Electrical engineering and automation

6.1 Low voltage distribution

6.1.1 Power load of equipment in the acid regeneration station should be designed based on Grade-3 load, and the LV power supply and distribution system shall meet the requirement of such load grade.

6.1.2 Radial power supply method should be adopted. Design of LV power supply and distribution system shall be in accordance with relevant requirements in the current national standard GB 50054 *Code for Design of Low Voltage Electrical Installations*.

6.1.3 UPS shall be used for automation control system, measuring instrument and communication facilities as emergency power supply, and the backup time shall be no less than 15 minutes.

6.1.4 Special power source should be used as the lighting and maintenance power supply in the acid regeneration station.

6.2 Electrical drive

6.2.1 Full AC drive mode should be adopted for electrical drive system.

6.2.2 The speed-regulating motor should be powered by digital AC VVVF equipment, while constant-speed motor by motor control center. The constant-speed motor with large capacity should be equipped with soft starter.

6.2.3 Hydrochloric-acid-corrosion-proof material shall be used for the board of operation box in the acid regeneration station.

6.2.4 The protection degree of electrical equipment on site shall not be lower than IP54.

6.2.5 The acid regeneration area should be designed with independent electrical room.

6.2.6 Cable should be laid mainly via cable tray and partially via conduit. In anti-corrosion area, FRP or other anti-corrosion cable tray should be used, and PVC or other non-metallic pipe should be used as conduit.

6.2.7 Cable design shall be in accordance with relevant requirements in the current national standard GB 50217 *Standard for Design of Cables of Electric Power Engineering*.

6.2.8 Lighting design shall be in accordance with relevant requirements in the current national standard GB 50034 *Standard for Lighting Design of Buildings*. Electrical room and operation room shall be designed with emergency lighting and the backup time shall be no less than 30 minutes.

6.2.9 Lightning-proof design shall be in accordance with relevant requirements in the current national standard GB 50057 *Code for Design Protection of Structures against Lightning*.

6.2.10 Earthing design shall be in accordance with relevant requirements in the current national standard GB 14050 *Types and Safety Technical Requirements of System Earthing*.

6.3 Process detection and control instruments

6.3.1 Process measuring and control items shall be in accordance with the requirements in Table 6.3.1.

Table 6.3.1 Process measuring and control item setting requirements

Process system	Measuring items	Requirement
Roaster	Flow measuring and control of waste acid spray	Shall be set
	Pressure measuring and control of waste acid spray	
	Temperature measuring and control of middle part	
	Bottom temperature measuring	
	Pressure measuring of demineralized water main pipe at roaster top	
	Differential pressure measuring before and after concentrated acid filter	Should be set
Dual cyclone dust collector	Bottom temperature measuring	Shall be set
Pre-concentrator	Inlet flow measuring and control	
	Level measuring and control	
	Pressure measuring of outlet main pipe of circulating pump	
Absorption column	Inlet flow measuring and control	
	Pressure measuring of outlet main pipe of feeding pump	
	Outlet density measuring and control	Should be set
Scrubber	Level measuring and control of water collection tank	Shall set
	Pressure measuring of outlet main pipe of circulating pump	Should be set
Ferric oxide bin	Level measuring of ferric oxide bin	Shall be set
Combustion system	Combustion gas leakage detection at roaster burner area and main pipe shut-off valve area	
	Flow measuring and control of combustion gas branch pipe of each burner	
	Flow measuring and control of combustion air branch pipe of each burner	
	Pressure measuring of combustion gas main pipe	
	Pressure measuring and control of combustion air main pipe	
	Flame detection of roaster burner	
Flue gas system	Pressure measuring and control of flue gas at roaster exit	
	Temperature measuring and control of flue gas at roaster exit	
	Pressure measuring of flue gas at pre-concentrator exit	
	Temperature measuring of flue gas at pre-concentrator exit	
	Pressure measuring of flue gas at absorption column exit	
	Oxygen content measuring of flue gas at roaster exit	Should be set
	Pressure measuring of flue gas at pre-concentrator entry	
	Temperature measuring of flue gas at pre-concentrator entry	
	Temperature measuring of flue gas at absorption column exit	
	Pressure measuring of flue gas at scrubber entry	
Acid storage tank system	Level measuring of all storage tanks	Shall be set
	Pressure measuring of outlet main pipe of acid pump	
	Level measuring of sump pit	
	Pressure measuring of outlet main pipe of sump pump of sump pit	Should be set
Auxiliary media supply system	Pressure measuring at exit of demineralized water booster station	Shall be set
	Pressure measuring of compressed air main pipe	Should be set

6.3.2 Temperature measuring instrument shall meet the following requirements:

1 The graduation of RTD should be Pt100, and the graduation of thermocouple shall be selected from K, S, B based on temperature measuring range;

2 Protection tube material of temperature measuring component shall be selected based on the characteristics of measured media.

6.3.3 For the acid media with strong corrosivity, acid-resistant material shall be used for the connection part between pressure gauge and media, and flange connection shall be used for process

connection.

6.3.4 Throttling device shall meet the following requirements:

1 Throttling device should be adopted for the flow measuring of fuel gas and combustion air;

2 Temperature and pressure compensation shall be conducted for the air flow measuring of with violent fluctuation of temperature and pressure.

6.3.5 Electromagnetic flowmeter shall meet the following requirements:

1 Electromagnetic flow meter should be adopted for the flow measuring of conducting liquid medium;

2 Electromagnetic flow meter should not be used for the media containing magnetic material or magnetizable material ;

3 Stainless steel electrode should be used for the alkaline medium;platinum electrode should be used for the strong corrosive acid medium;PTFE material should be used for the inner lining;

4 Split-type electromagnetic flowmeter should be used for those places with limited maintenance space or dramatic vibration.

6.3.6 Level meter shall meet the following requirements:

1 When static pressure type or differential pressure type level meter is used for the liquid medium of which the density changes easily under normal working condition,density compensation solution shall be designed according to practical working condition;

2 Magnetic flap or magnetic float type level meter should not be used for the medium containing magnetic material or magnetizable material;

3 Anti-corrosion non-contact type level meter should be used for the level measuring of strong corrosive medium and easily-crystallized medium.

6.3.7 Analyzer shall meet the following requirements:

1 Oxygen content analyzer of flue gas of roaster should be installed in directly inserted method;

2 Vibratory type density meter should be used for online density analyzer of regenerated acid.

6.3.8 Control valve shall meet the following requirements:

1 The control valve shall be in safety position in case of emergency condition;

2 The control valve which is related with safety but not designed with bypass valve shall be provided with hand wheel;

3 The gas flow regulating valve of roaster burner shall be designed with shut off function.

6.3.9 The power supply of instrument system shall be three-phase 380V or single-phase 220V AC power.

6.3.10 Instrument air shall meet the following requirements:

1 Purified compressed air shall be used;

2 Normal pressure of supplied air should be :0.4MPa to 0.6MPa;

3 Supplied air quality shall meet the requirements of selected pneumatic instrument.

6.3.11 The installation position of instrument on site shall meet the measuring and maintenance requirements of the instrument.

6.3.12 The anti-corrosion performance of corrosive medium sampling device shall not be lower than that of its corresponding process pipe and equipment.

6.3.13 Anti-corrosion material shall be used or anti-corrosion measures shall be taken for the cable and cable laying material in strong corrosive medium area.

6.3.14 Protection measures shall be taken for the instrument like transmitter and converter, etc. installed outdoor.

6.3.15 Heating tracing and insulation measures shall be taken for the field instrument and measuring pipe in the area where the liquid medium is easily to be frozen.

6.3.16 Solenoid valve should be centrally arranged in a solenoid valve box with positive pressure protection.

6.4 Basic automation system

6.4.1 Basic automation system(L1)of the acid regeneration station shall include electrical drive control and instrument control, both of which should be integrated into one system.

6.4.2 PLC (programmable logic controller) or DCS (distributed control system) system shall be adopted for the basic automation system(L1)of the acid regeneration station.

6.4.3 The application software of basic automation system(L1)shall fulfill the requirement of process control of production process and ensure that there is no personnel injury or equipment damage caused by the intrinsic defect of the application software during commissioning and operation.

6.4.4 Human-machine interface (HMI) shall meet relevant requirements of the current national standard GB/T 4205 *Basic and Safety Principles for Man-machine Interface (MMI)*, *Marking and Identification – Actuating Principles* and also the following requirements:

1 HMI shall be of human-friendly design, and meet the requirements for marks, safe colors and safety signs in the current national standard GB 2893 *Safety Colors*;

2 Operator rooms, electrical rooms and platforms shall be designed with emergency stop button, which shall adopt the red mushroom type with mechanical retention;

3 Relevant measures shall be taken to prevent mis-operations for important operations via HMI computer and touch screen.

6.4.5 Emergency stop shall meet the following requirements:

1 Area with emergency stop function shall be divided based on the relation with production process, and those equipment which have close relation with the triggering condition shall be divided in the same area;

2 Emergency stop system shall consist of hardware electric circuits which are composed of safety relay or safety PLC;

3 The emergency stop status shall be reset manually after manual confirmation, which shall not cause automatic restart of relevant equipment.

6.4.6 The design of lightning-proof and earthing system of automation system shall be in accordance with relevant requirements in the current national standards GB 50343 *Technical Code for Protection of Building Electronic Information System against Lightning* and GB 14050 *Types and Safety Technical Requirements of System Earthing*.

6.4.7 Communication network cabling work of automation system shall be in accordance with relevant requirements in the current national standard GB 50311 *Code for Engineering Design of Generic Cabling System*.

6.5 Telecommunication facilities

6.5.1 Operator room of the acid regeneration station shall be designed with plant-wide telephone and

scheduling telephone, and electrical room and engineer room shall be designed with plant-wide telephone. IP telephone system shall be configured with QoS guarantee.

6.5.2 Electrical room, operator room and important local operation tables (boxes) of the acid regeneration station should be designed with wired intercom station.

6.5.3 Twisted shielded cable should be used for signal cable of the wired intercom system.

6.5.4 Centralized power supply method should be used for wired intercom system.

6.5.5 Wireless intercom system shall be used for the communication between crane operator and ground controller as well as operator room of the acid regeneration station.

6.5.6 Wireless intercom system shall be used for the communication between equipment maintenance, commissioning and other mobile posts as well as between the mobile posts and scheduling room and operator room.

6.5.7 The working frequency and power of the wireless intercom system shall meet current wireless management requirements of the nation.

6.5.8 Roaster top and pump house of the acid regeneration station should be designed with ITV system.

6.5.9 Maintenance platform, handrail and ladder shall be designed in case of inconvenient installation and maintenance of camera.

6.5.10 The video compression standard of video server or digital video recorder shall be the same with that of plant scheduling TV system.

6.5.11 The compression standard of IP camera shall be the same with that of plant scheduling TV. The compression standard of site monitoring camera should not be lower than MEPG4, the definition should not be lower than D1, and the real time picture transmission speed should not be lower than 25fps.

7 Plant design

7.1 General requirements

7.1.1 The acid regeneration station shall be designed as a separate building.

7.1.2 The connection pipe between acid regeneration station and pickling line for such media as waste acid, waste water and regenerated acid should be arranged in the pipe trench.

7.2 Master plan

7.2.1 The master plan of the acid regeneration station shall comply with relevant requirements in the current national standard GB 50603 *Code for Design of General Layout and Transportation of Iron & Steel Enterprises*.

7.2.2 Acid regeneration station should be arranged close to the pickling line.

7.2.3 Transportation channel for ferric oxide and fresh acid, and maintenance access for large equipment should be designed outside of the building of the acid regeneration station. Fire passage shall be designed outside of the building of the acid regeneration station.

7.3 Water supply and drainage facilities

7.3.1 Water supply and drainage facilities design for acid regeneration station shall meet relevant requirements of the current national standards GB 50721 *Code for Design of Water Supply & Drainage of Iron and Steel Enterprise* and GB 50015 *Standard for Design of Building Water Supply and Drainage*.

7.3.2 The quality and pressure of externally supplied production water, domestic water and demineralized water shall meet the requirements of HCl regeneration process.

7.4 Combustion gas facilities

7.4.1 The fuel used in acid regeneration station may be gas, natural gas and liquid petroleum gas.

7.4.2 The technical parameter of fuel shall meet the following requirements:

1 The technical parameter of gas shall meet relevant requirements in the current national standard GB 50486 *Code for Design of Industrial Furnace in Iron & Steel Works*.

2 The technical parameter of natural gas shall meet relevant requirements in the current national standard GB 17820 *Natural Gas*.

3 The technical parameter of liquid petroleum gas shall meet relevant requirements in the current national standard GB 11174 *Liqufied Petroleum Gases*.

7.4.3 The fuel gas facility design shall meet relevant requirements in the current national standards GB 50028 *Code for Design of City Gas Engineering* and GB 6222 *Safety Code for Gas of Industrial Enterprises*.

7.4.4 Nitrogen design shall meet the following requirements:

1 Technical parameter shall meet relevant requirements in the current national standard GB 50486 *Code for Design of Industrial Furnace in Iron & Steel Works*;

2 Pressure and consumption shall meet the purging requirements of fuel gas pipe;

3 Nitrogen should be supplied via plant-wide nitrogen pipe network in a centralized way.

7.5 Heating facilities

7.5.1 Compressed air design of acid regeneration station shall meet the following requirements:

1 Technical parameter of compressed air shall meet the requirements of production process and equipment;

2 Compressed air should be supplied via plant-wide compressed air pipe network in a centralized way;the compressed air header should be designed with air cleaning facility and water drainage facility.

7.5.2 Steam should be supplied via plant-wide steam pipe network in a centralized way.

7.6 Ventilation facilities

7.6.1 Heating and ventilation facilities design of acid regeneration station shall meet relevant requirements in the current national standard GB 50019 *Design Code for Heating Ventilation and Air Conditioning of Industrial Buildings*.

7.6.2 Ventilation design of acid regeneration station shall meet the following requirements:

1 Mechanical ventilation should be adopted in acid tank farm, packing area of ferric oxide and laboratory, while natural ventilation may be used in other areas;

2 Electrical room, operator room and laboratory shall be designed with air conditioner.

7.6.3 Emergency heating measure shall be envisaged for shutdown period of acid regeneration station in the areas where it is cold in winter.

7.7 Laboratory facilities

7.7.1 Laboratory facilities configuration of acid regeneration station shall meet the following requirements:

1 Acid regeneration station should be designed with an independent laboratory;

2 The inspection and test of ferric oxide should be done in the centralized laboratory of the plant.

7.7.2 Normal inspection items of acid regeneration station should meet the requirements in Table 7.7.2.

Table 7.7.2 Normal inspection items of acid regeneration station

No.	Item	Inspection frequency	Sampling point
1	Waste acid(total HCl, Fe^{2+})	Once for each shift	Outlet of waste acid tank
2	Rinse water(total HCl, Fe^{2+})	Once for each shift	Outlet of rinse water tank
3	Regenerated acid of absorption column(total HCl, Fe^{2+})	2 times for each shift	Outlet of absorption column
4	Regenerated acid of regenerated acid tank(total HCl, Fe^{2+})	2 times for each shift	Outlet of regenerated acid tank
5	Ferric oxide	At least once for each shift	Bagging machine of ferric oxide

7.7.3 Inspection and test item of ferric oxide of HCl regenerated station shall be determined based on its usage and the requirements of the current national standard GB/T 24244 *Iron Oxide for Ferrite*.

7.8 Architecture and structure

7.8.1 Architecture design shall meet the following requirements:

1 Architecture design shall follow the principle of safety, health, environment protection, energy conservation, cost effectiveness and practicability;

2 The floor design shall be determined based on the subsoil treatment and anti-frozen expansion factors, and reinforced concrete and steel fiber reinforced concrete should be used for floor base;

3 On the precondition of meeting natural ventilation and lighting requirements for window/door design, its material shall meet the fire-proof, anti-corrosion and thermal insulation requirements.

7.8.2 Structural design shall meet the following requirements:

1 Acid regeneration station should be designed with cast-in-place reinforced concrete frame structure;

2 The load value shall not only meet relevant requirements in the current national standard GB 50009 *Load Code for the Design of Building Structures*, but also be designed based on the operation and maintenance loads required by production process;

3 Structural design of buildings shall meet relevant requirements in the current national standard GB 50011 *Code for Seismic Design of Buildings*.

7.9 Anti-corrosion design

7.9.1 The anti-corrosion design of the building of the acid regeneration station shall meet relevant requirements in the current national standard GB/T 50046 *Standard for Anticorrosion Design of Industrial Constructions*.

7.9.2 The concrete structure surface of trough/trench, sump pit, pump area and acid tank area shall be designed with impervious layer, and the floor and wall (from floor to 2m high) shall be designed with acid resistant brick for anti-corrosion.

7.9.3 Acid resistant brick shall be used for the equipment foundation of all storage tanks, acid pumps and pre-concentrator for anti-corrosion; acid resistant brick should be used for the equipment foundation of absorption column, scrubber and waste gas fan.

7.9.4 The steel platform on roaster top shall be designed with anti-corrosion layer. The anti-corrosion design for other working areas shall meet the following requirements:

1 Concrete surface should be painted with acid-resistant coat for anti-corrosion;

2 Steel structure surface should be applied with acid-resistant paint.

8 Construction and installation

8.1 General requirements

8.1.1 Construction organization plan shall be prepared before commencement of construction if there are crossover works between installation of large equipment(e.g. roaster, acid storage tank, ferric oxide storage facilities)and construction of building structure of the acid regeneration station.

8.1.2 Subsequent procedure shall not be started until the previous one is accepted through inspection.

8.1.3 The following requirements shall be met during construction of anti-corrosion works:

1 Fire-prohibition area shall be set; hot work management system for the fire-prohibition area shall be established and implemented;

2 Occupational disease prevention and control system shall be established and implemented.

8.1.4 Anti-corrosion construction of the building of the acid regeneration station shall meet relevant requirements in the current national standards GB 50212 *Code for Construction of Building Anticorrosive Engineering* and GB/T 50224 *Standard for Acceptance of Construction Quality of Anticorrosive Engineering of Buildings*.

8.1.5 Construction and installation of equipment with rubber lining shall meet the following requirements:

1 Construction and installation shall meet relevant requirements in current professional standard HG/T 20677 *Design Code for Chemical Equipment with Rubber Lining*;

2 Protection measures for finished product and semi-finished product shall be established and implemented during installation;

3 Such measures as water-proof, fire-proof, anti-collision, insolation-proof, oil-proof and anti-frozen shall be taken during storage, construction, maintenance and shut down period.

8.1.6 Protection measures for finished product and semi-finished product shall be established and implemented during installation of plastic equipment.

8.1.7 Electrical equipment installation shall meet relevant requirements in the current national standards GB 50254 *Code for Construction and Acceptance of Low-Voltage Apparatus Electric Equipment Installation Engineering* and GB 50168 *Standard for Construction and Acceptance of Cable Line Electric Equipment Installation Engineering*.

8.1.8 Automation instrument installation shall meet relevant requirements in the current national standard GB 50093 *Code for Construction and Quality Acceptance of Automation Instrumentation Engineering*.

8.2 Civil construction

8.2.1 Civil construction of equipment foundation and concrete building shall meet the following requirements:

1 Relevant requirements in the current national standards GB 50204 *Code for Quality Acceptance of Concrete Structure Construction* and GB 50666 *Code for Construction of Concrete Structures* shall be followed;

2 The flatness of equipment foundation with anti-corrosion requirement shall be less than 5/1000;

3 The center position deviation of roaster ring beam shall be less than 15mm.

8.2.2 Water impoundment test shall be conducted after the construction of the floor with anti-corrosion requirement is finished.

8.2.3 Steel structure installation shall meet relevant requirements in the current national standards GB 50755 *Code for Construction of Steel Structures* and GB 50205 *Code for Acceptance of Construction Quality of Steel Structures*.

8.3 Equipment installation

8.3.1 The installation of tank body shall be carried out after the construction of its equipment foundation and anti-corrosion work has been completed and it should be carried out before the construction of upper frame structure of the building in the workshop where it is located.

8.3.2 Hot work shall not be performed on the equipment with rubber lining, FRP equipment and plastic equipment.

8.3.3 The installation accuracy of roaster, ferric oxide bin and acid storage tank shall conform to the requirements in Table 8.3.3.

Table 8.3.3 Installation accuracy of tank body

No.	Item	Allowable deviation(mm)
1	Elevation	±10
2	Traverse/longitudinal center line	±15
3	Perpendicularity	1/1000 and ≯15

8.3.4 Welding work of tank body shall meet relevant requirements in the current national standards GB 50236 *Code for Construction of Field Equipment, Industrial Pipe Welding Engineering* and GB 50683 *Code for Acceptance of Field Equipment, Industrial Pipe Welding Construction Quality*.

8.3.5 Installation of such equipment as pump and fan shall meet relevant requirements in the current national standard GB 50275 *Code for Construction and Acceptance of Fan, Compressor and Pump Installation*.

8.4 Brick lining construction

8.4.1 Brick lining of equipment shall meet the following requirements:

1 The type, specification, grade and physical and chemical parameter of refractory material and anti-corrosion material shall meet the design requirement.

2 Amorphous refractory material, binding agent and refractory ceramic fiber and its product shall be stored separately in the damp-proof and anti-pollution warehouse. Anti-freezing measures shall be taken for material with anti-freezing requirement.

3 Such material as resin, curing agent and diluents shall be stored in shady and cool, dry and ventilated warehouse; and fire-proof measures shall be taken.

4 The environment temperature for brick lining construction of acid storage tank and pre-concentrator should be 15℃ to 30℃, not lower than 10℃, and the relative humidity should be less than 80%. Heating and insulation measures shall be taken if the construction environment temperature is lower than 10℃.

5 Crossover work arrangement with other works is prohibited during the brick lining construction of acid storage tank and pre-concentrator.

6 The acid-resistant brick(plate)and acid-resistant & high temperature resistant brick(plate)shall be selected, cleaned and dried before lining; pre-arrangement of bricks should be conducted for important parts.

7 The construction of tube lining of equipment shall be completed before brick lining of equipment body; the lined tube and its surrounding daub shall not extrude the lined rubber surface of flange.

8 Brick lining of acid storage tank and pre-concentrator shall meet relevant requirements in the current national standard GB 50726 *Code for Anticorrosive Engineering Construction of Industrial Equipment and Pipeline*.

8.4.2 Bricking work of roaster shall meet the following requirements:

1 The working environment temperature shall not be lower than 5℃ during roaster bricking. Heating and insulation measures shall be taken if the construction environment temperature is lower than 5℃.

2 Combustion chamber template shall be fabricated before bricking of the combustion chamber, and the template shall be of certain rigidity and intensity to avoid displacement during ramming.

3 The holes, channels, expansion lines and insulation layers in the brickwork shall meet the design requirement.

4 The thickness of joint in brickwork of roaster shall not be larger than 2mm.

5 The allowable deviation of roaster brickwork shall meet the requirement in Table 8.4.2.

Table 8.4.2 Allowable deviation of roaster brickwork

No.	Item		Allowable deviation(mm)
1	Vertical deviation		3/1000 and≯15
2	Flatness of inner surface of roaster		5
3	Linear deviation	Inner radius deviation of round hearth: Inner dia.≥4m Inner dia.<4m	±15 ±10
		Span of arch and arch top	±10

6 Brickwork of combustion chamber shall be carried out in the direction from the burner to roaster inside, and the channel size shall meet design requirement. The center line of combustion chamber shall be aligned with that of burner.

7 Ramming material shall be stirred, rammed and cured in accordance with the construction manual. The material shall be spread evenly before ramming; the thickness of each material layer should be 80mm to 100mm. The material shall be rammed densely.

8 Besides the requirements in this code, the bricking construction of the roaster shall also meet relevant requirements in the current national standards GB 50211 *Code for Construction and Acceptance of Industrial Furnaces Building* and GB 50309 *Standard for Quality Inspection and Acceptance of Industrial Furnaces Building*.

8.4.3 Pre-concentrator bricking shall meet the following requirements:

1 Brick lining work on rubber lining layer can only start after successful spark inspection and pre-assembling; bricking work of top cover of pre-concentrator should be done after it is turned upside down

on the ground.

2 The bonding course thickness and brickwork joint width of acid-resistant & high temperature resistant brick(plate)shall meet the requirements in Table 8.4.3.

Table 8.4.3 Bonding course thickness and brickwork joint width of pre-concentrator

Type	Bonding course thickness(mm)	Brickwork joint width(mm)
Acid-resistant & high temperature resistant plate (thickness ≤ 30mm)	3–5	2–3
Acid-resistant & high temperature resistant brick (thickness > 30mm)	4–7	2–4

3 The height difference between acid-resistant & high temperature resistant brick(plate)surface and its neighboring brick(place)shall not be higher than 1mm.

4 The curing period of brick(plate)lining of water glass daub under normal temperature shall not be less than 10 days.

5 After curing of brick (plate) lining of water glass daub, sulfuric acid with 30% to 40% concentration shall be used to conduct acidification treatment for its surface.

6 During construction and curing period, the brick lining of water glass daub shall not be in contact with water or moisture.

7 Water glass daub should be used to fill the joint at the flange connections of pre-concentrator.

8.4.4 Acid storage tank bricking shall meet the following requirements:

1 Brick lining work of acid storage tank can only start after successful spark inspection of rubber lining layer.

2 The bonding course thickness and brickwork joint width of acid-resistant brick (plate) shall meet the requirements of Table 8.4.4.

Table 8.4.4 Bonding course thickness and brickwork joint width of acid storage tank

Type	Bonding course thickness(mm)	Brickwork joint width(mm)
Acid-resistant brick(thickness ≤ 30mm)	4–6	2–3
Acid-resistant brick (thickness > 30mm)	4–6	2–4

3 Protection measures shall be taken on rubber lining layer before brick lining work at bottom of acid storage tank;brick lining work should be started from tank bottom.

4 The bricking of rubber lining layer should be started after its surface is pre-coated with one course of daub and naturally solidified for no less than 24h.

5 The surface flatness and slope of acid-resistant layer shall meet the following requirements:

1)Flatness of tank bottom surface shall not be higher than 2/1000;

2)The surface height difference of adjacent bricks(plates)shall not be higher than 1mm;

3)Slope shall meet the design requirement; the allowable deviation shall be ±0.2% of the designed slope,and the maximum deviation shall not exceed 30mm.

6 The curing period of furan daub brick lining shall not be less than 7 days.

8.5 Piping installation

8.5.1 Metallic piping installation shall meet relevant requirements in the current national standards GB 50235 *Code for Construction of Industrial Metallic Piping Engineering* and GB 50184 *Code for Acceptance of Construction Quality of Industrial Metallic Piping Engineering*.

8.5.2 Non-metallic piping installation shall meet the following requirements:

1 Before installation, pipes shall be checked in accordance with design requirement; and the pipes delivered to site shall not be used until they are confirmed qualified by visual inspection;

2 Appropriate connection method and special machine and tools which are suitable for the designed pipe and construction site condition shall be used;

3 Pipe connection process documentation shall be compiled for pipe connection based on design documents and material technical documents;

4 Acceptance of non-metallic pipe construction work shall meet relevant requirements in the current national standard GB 50690 *Code for Construction Quality Acceptance of Non-metallic Piping Engineering in Petrochemical Engineering*.

9 Commissioning and assessment

9.1 General regulations

9.1.1 System commissioning shall be conducted after the construction is completed and accepted as qualified.

9.1.2 System commissioning should be divided into 4 stages: individual test, cold load test (incl. integrated test, roaster pre-heating), hot load test and trial test run. The subsequent test can only be conducted after successful test of the previous stage.

9.1.3 Commissioning program shall be prepared based on different commissioning stages for the system commissioning. The commissioning program shall include commissioning content, commissioning method, commissioning procedure commissioning equipment, personnel list of commissioning team, hazards source list and emergency response plan for accident, etc. Records shall be made for the commissioning process of each commissioning stage.

9.1.4 System performance test shall be arranged in a timely manner after the completion and acceptance of each commissioning stage and when the system is ready for operation.

9.2 Commissioning

9.2.1 During individual test, rotating direction, lubrication, temperature rise and vibration shall meet design requirement, and the continuous working time shall meet the technical requirement of equipment based on equipment characteristics.

9.2.2 Individual test shall meet the following requirements:

1 Before individual test, the installation site shall be cleared, and foreign material in the equipment shall be cleaned; warning signs shall be set and safety measures shall be taken; lubrication oil and grease of equipment shall be inspected and filled up;

2 The individual test shall be carried out in the following sequence: manual-auto, jogging-continuous working, low speed-medium speed-high speed.

9.2.3 Cold load test shall be performed after individual test, including integrated test and roaster pre-heating.

9.2.4 The following conditions shall be met for cold load test:

1 Pressure test and flushing of all pipelines shall be finished and inspected;

2 All energy media meet the system operation requirements;

3 Waste water treatment station is ready to receive waste water;

4 Such facilities as fire-fighting, fire alarm, communication, safety shower and hazardous gas detection devices in the station are in normal working condition.

9.2.5 Integrated test, as the earlier preparation stage of roaster pre-heating, shall complete the following works:

1 Preliminarily set the process operation parameters of the system;

2 Check and verify the instruments and control valves of the system;

3 Check and verify the control programs of system under cold state;

4 Check the working condition of emergency stop;

5 Check if there is enough thermal deformation space for equipment and pipes.

9.2.6 Roaster pre-heating shall meet the following requirements:

1 Roaster pre-heating shall strictly follow the pre-heating curve to ensure an even temperature rise process and a stable temperature holding period;

2 Natural ventilation method shall be employed for roaster cooling after the pre-heating is completed, and the roaster body shall not be cooled in a forced way;

3 The refractory condition in the roaster shall be checked after natural cooling of the roaster body.

9.2.7 Hot load test shall be conducted after the completion of cold load test.

9.2.8 The storage amount of waste acid and rinse water before hot load test shall be no less than 8 hours' consumption amount under acid operation mode.

9.2.9 Hot load test shall be conducted in 4 stages: roaster temperature rise, rinse water operation, waste acid operation and normal stop.

9.2.10 The following works shall be completed during the hot load test period:

1 Adjust the process operation parameters of the system to enable it to work under hot state with the set process parameters;

2 Check and verify the control programs of the system under hot state.

9.2.11 Trial test run shall be conducted after completion of hot load test.

9.2.12 The storage amount of waste acid and rinse water before trial test run shall be no less than 48 hours' consumption amount under acid operation mode.

9.2.13 The following works shall be completed during trial test run period:

1 Optimize and determine the process operation parameters of the system to enable it to achieve the most appropriate working condition and the optimal operation condition under hot state;

2 Optimize the control programs of the system under the hot state.

9.3 Assessment

9.3.1 A performance test plan shall be formulated before the test and it shall include the following contents:

1 Preconditions for performance test;

2 Test items, guarantee value and test methods;

3 Organization system and personnel;

4 Safety measures;

5 Test record list.

9.3.2 The system shall work for over 6h continuously in acid operation mode before performance test; the performance test period of process guarantee value shall not be less than 24h.

9.3.3 System performance test shall include the following contents:

1 Treatment capacity;

2 Total acid and iron ion content of regenerated acid;

3 Quality of ferric oxide;

4 Waste gas emission index.

10 Operation and maintenance

10.0.1 The operation control of the hydrochloric acid regeneration plant shall meet the following requirements:

1 Technical specification and post operation specification of the acid regeneration plant shall be established, and operation requirements and precautions for its startup, operation and stop shall be clarified;

2 Emission index of industrial waste gas generated by the plant shall meet the environment protection requirements;

3 Treatment capacity of the plant shall be controlled within 85% to 115% of the designed capacity;

4 If the plant is stopped for over 24 hours and put into production again, the system shall work under rinse water operation mode for over 4 hours before switching over to acid operation mode;

5 If the plant needs to be stopped for over 24 hours, the system shall work under rinse water mode for 3 hours and demineralized water mode for 1 hour before stop procedure is initiated;

6 During operation, the equipment operation data and site equipment working condition shall be checked and inspected every 4 hours, and corresponding records shall be made.

10.0.2 Corresponding adjustment should be made on production technical specification and post specification of the hot test based on operation condition.

10.0.3 The maintenance work of the hydrochloric acid regeneration plant shall meet the following requirements:

1 Equipment technical standards, maintenance technical standards, periodic maintenance management plan, equipment abnormity handling management and function accuracy management requirement of key equipment shall be established;

2 Regular inspection and maintenance shall be carried out for equipment in accordance with technical standards, function accuracy requirement and maintenance plan;

3 If the actual operation data fluctuation of negative pressure of roaster top exceeds the set point by ±100Pa and such fluctuation lasts for over 1 hour, the cause shall be found out, corresponding measures shall be taken and relevant equipment shall be repaired;

4 The load value of waste gas fan of the hydrochloric acid regeneration plant under working condition shall be determined. If the increased operation load of the waste gas fan reaches 10% and such condition lasts for over 1 hour, the cause shall be found out, corresponding measures shall be taken and relevant equipment shall be repaired.

11 Energy conservation and environment protection

11.0.1 Energy saving design of the hydrochloric acid regeneration plant shall meet relevant requirements in the current national standard GB/T 50632 *Standard for Design of Energy Saving of Iron and Steel Enterprise(s)*.

11.0.2 Water supply and drainage design of the acid regeneration plant shall meet relevant requirements in the current national standard GB 50506 *Code for Design of Water Saving for Iron and Steel Enterprises*.

11.0.3 Energy measuring instrument design shall meet relevant requirements in the current national standard GB 17167 *General Principle for Equipping and Managing of the Measuring Instrument of Energy in Organization of Energy Using*.

11.0.4 Relevant operation parameter of the hydrochloric acid regeneration plant shall be adjusted based on production capacity.

11.0.5 Proper air/gas ratio shall be set for the combustion system of the hydrochloric based on the gas quality.

11.0.6 Process equipment selection and auxiliary device design shall meet relevant requirements in the current national standard GB 50406 *Code for Design of Environmental Protection of Iron and Steel Industry*.

11.0.7 Waste gas emission of the hydrochloric acid regeneration plant shall meet relevant requirements in the current national standard GB 28665 *Emission Standard of Air Pollutants for Steel Rolling Industry*.

11.0.8 The waste water generated by the hydrochloric acid regeneration plant shall not be drained until it reaches the drainage standard after treatment.

12 Safety and fire extinguish

12.0.1 Safety design shall meet the following requirements:

1 Fire-proof, explosion-roof and gas safety design shall meet relevant requirements in the current national standard GB 6222 *Safety Code for Gas of Industrial Enterprises*;

2 Electrical safety design shall meet relevant requirements in the current national standards GB 50057 *Code for Design Protection of Structures against Lightning* and GB 50058 *Code for Design of Electrical Installations in Explosive Atmospheres*;

3 Seismic design of buildings and structures shall meet relevant requirements in the current national standard GB 50011 *Code for Seismic Design of Buildings*;

4 Arrangement of sidewalk, ladder, platform, protection handrail, protection panel and protection cover shall meet relevant requirements in the current national standards;

5 Safety sign arrangement shall meet relevant requirements in the current national standard GB 2894 *Safety Signs and Guideline for the Use*;

6 Safety technical measures of transportation, loading and unloading and lifting shall meet relevant requirements in the current national standard GB 6067 *Safety Rules for Lifting Appliances*.

12.0.2 Industrial sanitation design shall meet the following requirements:

1 Technical measures for dust-proof, poison-proof and asphyxia-proof shall meet relevant current national sanitation standards of industrial enterprise design. The hazards factor concentration in working places shall meet the current national requirements of contact limit value of hazards profession factor in working places.

2 Protection measures for noise and partial vibration shall meet the current national requirements of contact limit value of hazards profession factor in working places.

3 Cooling measures design for heatstroke prevention and heating measures design for cold proof shall meet relevant requirements in the current national standard GB 50019 *Design Code for Heating Ventilation and Air Conditioning of Industrial Buildings*.

4 Sanitation protection measure in the station area shall meet relevant requirements in current professional standard HG 20571 *Code for Safety and Hygiene Design of Chemical Enterprise*.

12.0.3 Building and fire-fighting facilities design of acid regeneration station shall meet relevant requirements in the current national standards GB 50016 *Code for Fire Protection Design of Buildings and Prevention* and GB 50414 *Code for Design of Fire Protection and Prevention for Iron Steel Metallurgy Enterprises*.

12.0.4 Fire extinguisher configuration shall meet relevant requirements in the current national standard GB 50140 *Code for Design of Extinguisher Distribution in Buildings*.

12.0.5 Auto fire alarm system design shall meet relevant requirements in the current national standard GB 50116 *Code for Design of Automatic Fire Alarm System*.

Explanation of wording in this code

1 Words used for different degrees of strictness are explained as follows in order to mark the differences in implementing the requirements of this code.

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation, "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation, "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation, "should not" for negation.

4) "May" is used to express the option available, sometimes with the conditional permit.

2 "Shall comply with..." or "shall meet the requirements of..." is used in this code to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

List of quoted standards

GB 50009 *Load Code for the Design of Building Structures*

GB 50011 *Code for Seismic Design of Buildings*

GB 50015 *Standard for Design of Building Water Supply and Drainage*

GB 50016 *Code for Fire Protection Design of Buildings*

GB 50019 *Design Code for Heating Ventilation and Air Conditioning of Industrial Buildings*

GB 50028 *Code for Design of City Gas Engineering*

GB 50034 *Standard for Lighting Design of Buildings*

GB/T 50046 *Standard for Anticorrosion Design of Industrial Constructions*

GB 50054 *Code for Design of Low Voltage Electrical Installations*

GB 50057 *Code for Design Protection of Structures against Lightning*

GB 50058 *Code for Design of Electrical Installations in Explosive Atmospheres*

GB 50093 *Code for Construction and Quality Acceptance of Automation Instrumentation Engineering*

GB 50116 *Code for Design of Automatic Fire Alarm System*

GB 50126 *Code for Construction of Industrial Equipment and Pipeline Insulation Engineering*

GB 50140 *Code for Design of Extinguisher Distribution in Buildings*

GB 50168 *Standard for Construction and Acceptance of Cable Line Electric Equipment Installation Engineering*

GB 50184 *Code for Acceptance of Construction Quality of Industrial Metallic Piping Engineering*

GB 50204 *Code for Quality Acceptance of Concrete Structure Construction*

GB 50205 *Code for Acceptance of Construction Quality of Steel Structures*

GB 50211 *Code for Construction and Acceptance of Industrial Furnaces Building*

GB 50212 *Code for Construction of Building Anticorrosive Engineering*

GB 50217 *Standard for Design of Cables of Electric Power Engineering*

GB/T 50224 *Standard for Acceptance of Construction Quality of Anticorrosive Engineering of Buildings*

GB 50235 *Code for Construction of Industrial Metallic Piping Engineering*

GB 50236 *Code for Construction of Field Equipment, Industrial Pipe Welding Engineering*

GB 50254 *Code for Construction and Acceptance of Low-Voltage Apparatus Electric Equipment Installation Engineering*

GB 50275 *Code for Construction and Acceptance of Fan, Compressor and Pump Installation*

GB 50309 *Standard for Quality Inspection and Acceptance of Industrial Furnaces Building*

GB 50311 *Code for Engineering Design of Generic Cabling System*

GB 50343 *Technical Code for Protection of Building Electronic Information System against Lighting*

GB 50406 *Code for Design of Environmental Protection of Iron and Steel Industry*

GB 50414 *Code for Design of Fire Protection and Prevention for Iron Steel Metallurgy Enterprises*

GB 50486 *Code for Design of Industrial Furnace in Iron & Steel Works*

GB 50506 *Code for Design of Water Saving for Iron and Steel Enterprises*

GB 50603 *Code for Design of General Layout and Transportation for Iron & Steel Enterprises*

GB/T 50632 *Standard for Design of Energy Saving of Iron and Steel Enterprise(s)*

GB 50666 *Code for Construction of Concrete Structures*

GB 50683 *Code for Acceptance of Field Equipment,Industrial Pipe Welding Construction Quality*

GB 50690 *Code for Construction Quality Acceptance of Non-metallic Piping Engineering in Petrochemical Engineering*

GB 50721 *Code for Design of Water Supply & Drainage of Iron and Steel Enterprise*

GB 50726 *Code for Anticorrosive Engineering Construction of Industrial Equipment and Pipeline*

GB 50755 *Code for Construction of Steel Structures*

GB 320 *Synthetic Hydrochloric Acid for Industrial Use*

GB 2893 *Safety Colors*

GB 2894 *Safety Signs and Guideline for the Use*

GB/T 3620.1 *Designation and Composition of Titanium and Titanium Alloys*

GB/T 3620.2 *Titanium and Titanium Alloys–Permissible Variations of Chemical Composition for Wrought Product Analysis*

GB/T 4205 *Basic and Safety Principles for Man-machine Interface (MMI), Marking and Identification-Actuating Principles*

GB 6067 *Safety Rules for Lifting Appliances*

GB 6222 *Safety Code for Gas of Industrial Enterprises*

GB/T 8488 *Acid Resisting Bricks and Tiles*

GB 8923 *Rust Grades and Preparation Grades of Steel Surfaces Before Application of Paints and Related Products*

GB 11174 *Liquefied Petroleum Gases*

GB 14050 *Types and Safety Technical Requirements of System Earthing*

GB 17167 *General Principle for Equipping and Managing of the Measuring Instrument of Energy in Organization of Energy Using*

GB 17820 *Natural Gas*

GB 18241.1 *Rubber Lining*

GB/T 24244 *Iron Oxide for Ferrite*

GB/T 25197 *Welded Static Non-pressurized Thermoplastic Tanks*

GB 28665 *Emission Standard of Air Pollutants for Steel Rolling Industry*

HG 20571 *Code for Safety and Hygiene Design of Chemical Enterprise*

HG 20640 *Plastic Equipment*

HG/T 20677 *Design Code for Chemical Equipment with Rubber Lining*

HG/T 20678 *Specification on Design of Steel Shell with Liner*

HG/T 20696 *Specification of FRP Equipment Design for Chemical Industry*

YS/T 656 *Designation and Composition of Wrought Niobium and Niobium Alloy*

YB/T 9256 *Specification for the Painting Work Technology of Steel Structure and Pipe*