



2016 Version

Shanghai Electric Power Generation Service Production

Air Pollutant Emission Control

WWW.SHANGHAI-ELECTRIC.COM

Shanghai 
Electric



Create Our Future **TOGETHER**



▶ Introduction of
Shanghai-Electric

01

▶ Introduction of
Service Production

03

▶ Flue Gas Denitrification
Technology

07





▶ ESP - High Efficiency
ESP Technology

13

▶ ESP - Low Low Temperature
ESP Technology

15

▶ ESP - Wet Esp
Technology

16

▶ Flue Gas Desulphurization
Technology

17

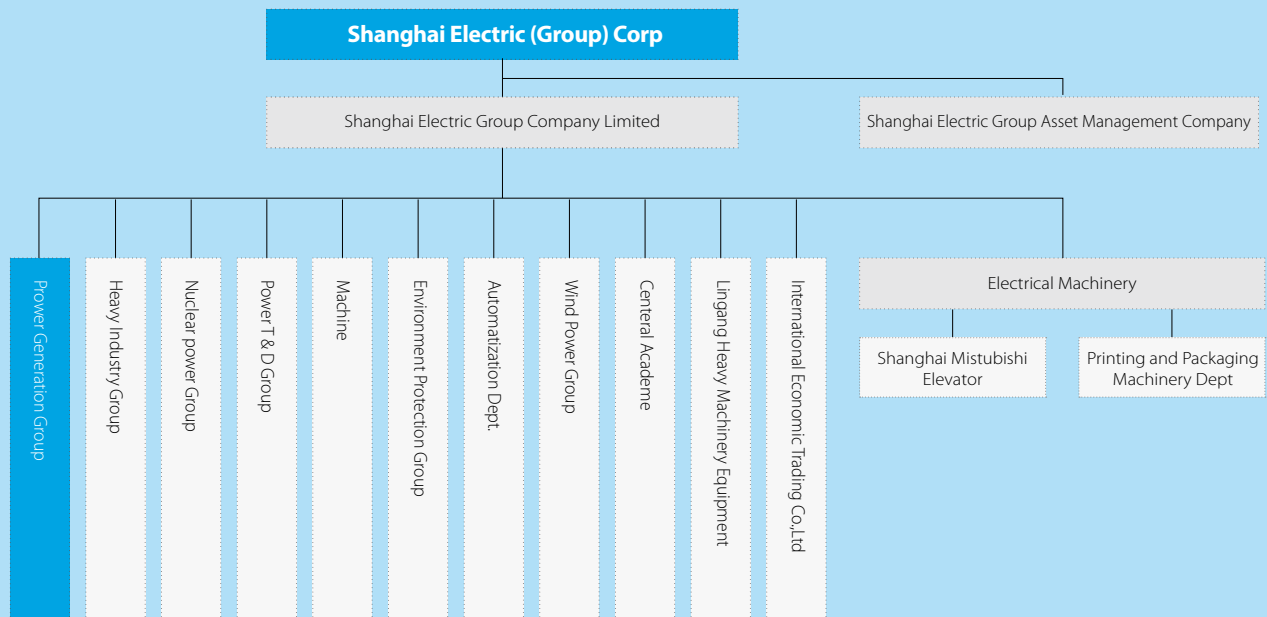
Introduction of Shanghai Electric

Shanghai Electric Group Company Limited as one of the largest equipment manufacturing conglomerates in China, possesses key advantages in the comprehensive provision of modern equipment, complete equipment sets, and engineering works contracting. Since the 1990s, Shanghai Electric's sales revenues have ranked top 3 in the Chinese equipment manufacturing industry.

Shanghai Electric Power Generation Group as one of core business area of Shanghai Electric, is mainly engaged in manufacturing power equipments, construction of power plants and after-sale services.



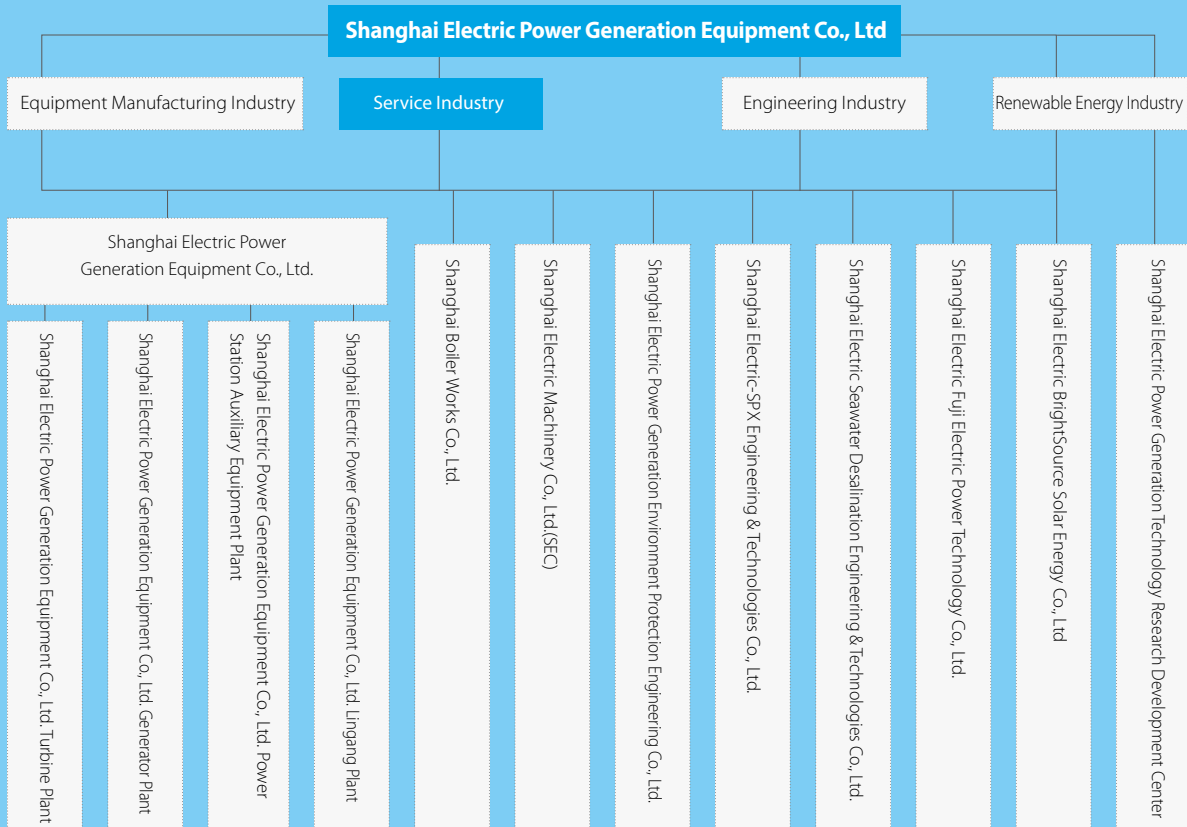
SEC Industry Structure



Shanghai Electric Power Generation Service Company

Was established on October 1, 2011 and operates independently. It is the sole window which engages in after-sale service of power station equipments and one of the three business sectors of Shanghai Electric Power Generation Group. The company mainly engages in Long Term Service Agreement, Retrofit & Upgrade Service Package, Operation & Maintenance, Overhaul Service, Spare Parts Service, Technical Service, Equipment Retrofit & Upgrade, Equipment Subcontracting, Relocation Service, other services. Shanghai Electric Power Generation Service Company takes full advantage of group's integration and provides the best service to the customers through six service models which mainly include service subcontracting model, direct sales service model, engineering service model, network service model, agency service model and other service model. Serviced units include 125MW (or below), 300MW, 600MW and 1000MW coal-fired units (including CFB), combined-cycle gas units, IGCC units, nuclear power units, environmental protection device and such electrical equipment products.

Shanghai Electric Power Generation Service Company devoted to providing the whole life cycle services of the unit's operation and creating the greatest benefits and value for the customer.



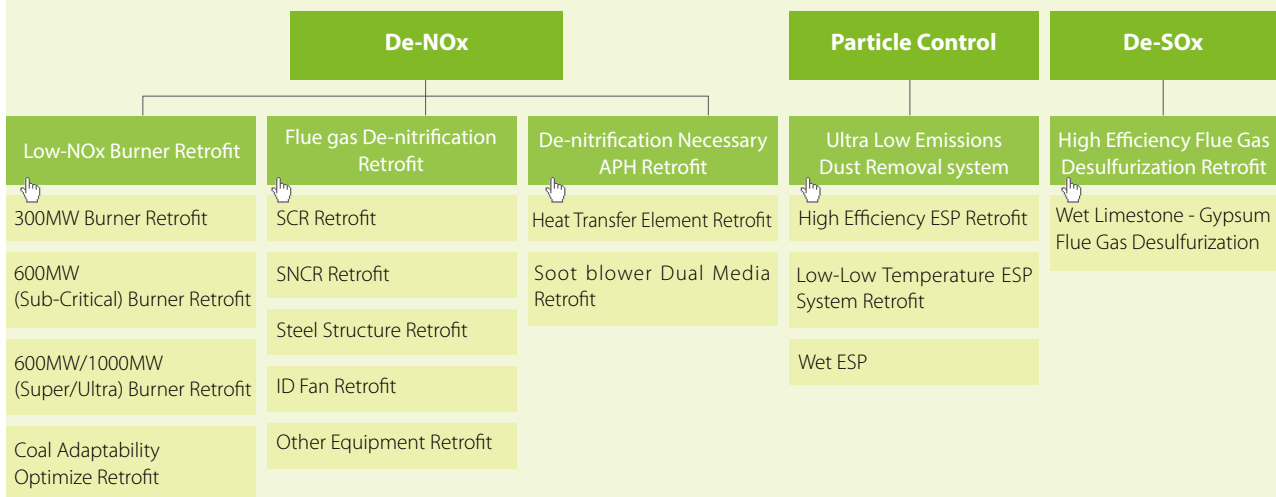
Introduction of Service Production -- Completed Pollutant Control Island Retrofit Program

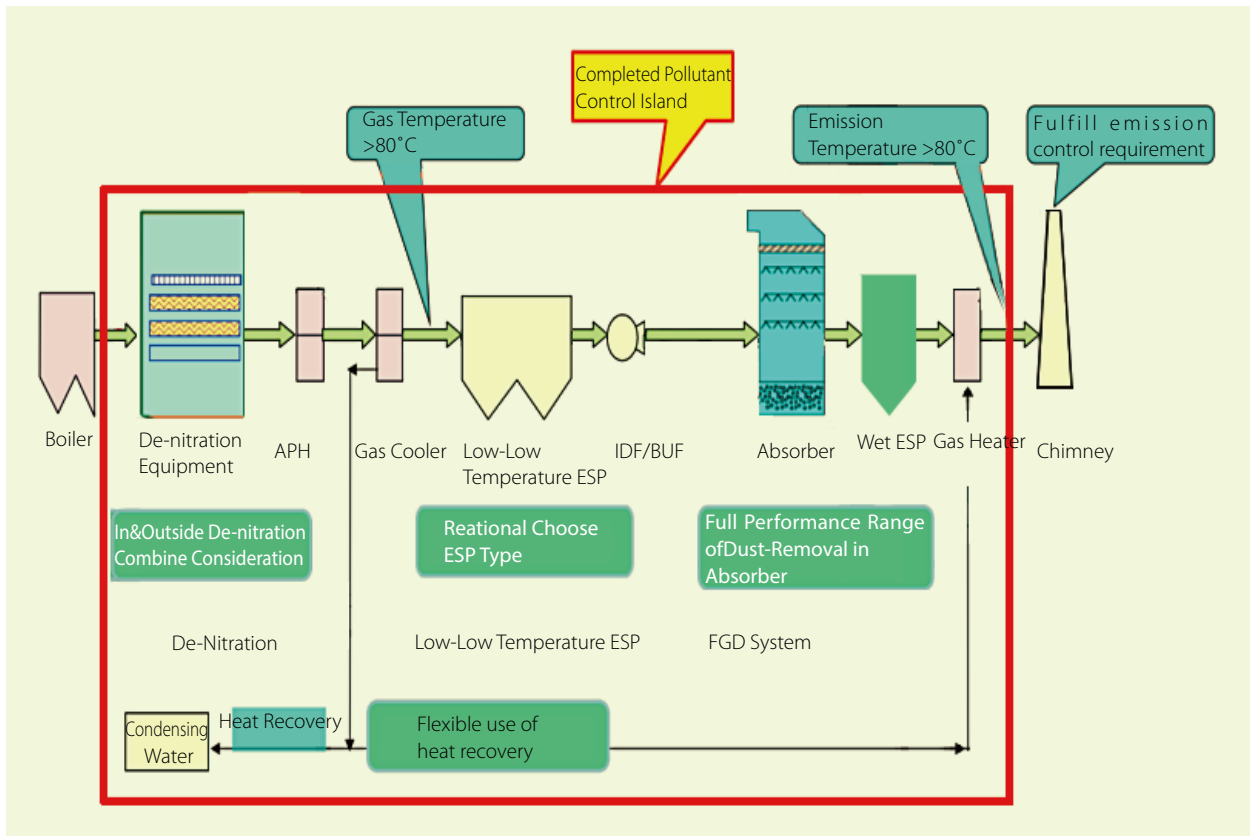
SECPG Service Company has the most leading Air Pollutant Emission Control Technology in both Domestic and International Market. Engaging on Engineering, Manufacturing, Construction & Installation furthermore offers Completed Pollutant Control Island EPC Retrofit Program, Effectively reduce unit emissions, ensure safe and reliable operation.

Coal fire units can achieve the gas-turbine emission level on NOx, SOx, Dust (PM) and other pollutant by our completed island optimizing and retrofit.

Menu of Completed Pollutant Control Island Retrofit Program

(Sequenced with Flue Gas Direction)





Advantages of Completed Pollutant Control Island Retrofit Program

1. Optimize Performance of Emission Control Equipment

Arrangement of whole system and various of equipment is overall considered to ensure environmental protection device to operate at the most reasonable conditions.

2. Optimize Design Margin

Design margin of whole system on each device is overall considered, to optimize the output of whole unit, under the premise of enough design margin and strict emission requirement.

3. Minimize Energy Consumption

Optimize the design of emission control system to recover waste heat of flue gas, furthermore to make whole system achieve the lowest energy consumption.

4. Minimize the footprint

Rationally arrange devices according to island's site situation for optimizing connection structure and minimizing the space usage.

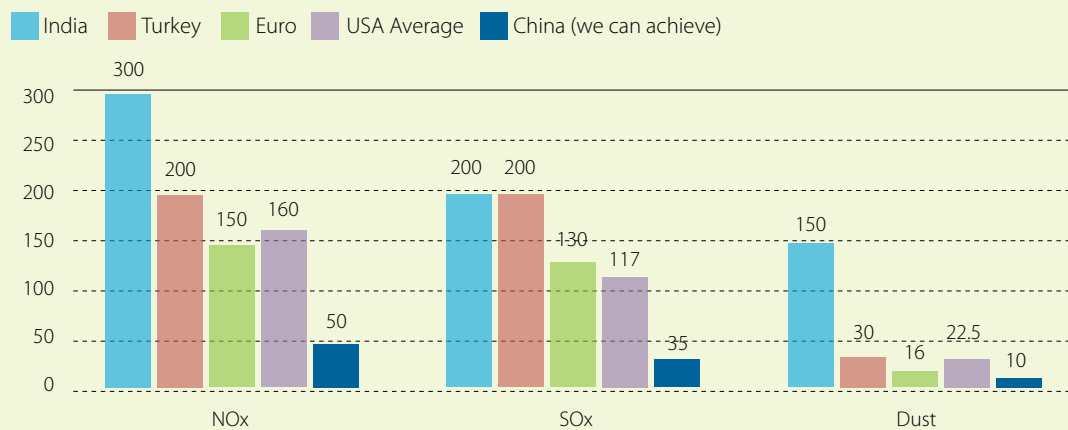
The Latest Emission Limitation

Emission control requirement of China is world's leading level, which in key industrial areas is "**Near Zero Emission**", with Shanghai Electric Completed Pollutant Control Island Retrofit Program, we can make emission of thermal power plant to achieve of which gas turbine is.

This means our emission control level CAN FULFILL the requirements ALL OVER the world.

For Countries which presently have easy emission control requirements, we can reach advance steps to offset future legal and political stringent trend.

World Wide Emission Standard mg/Nm³



We fulfill the Most Strict Emission Control requirement

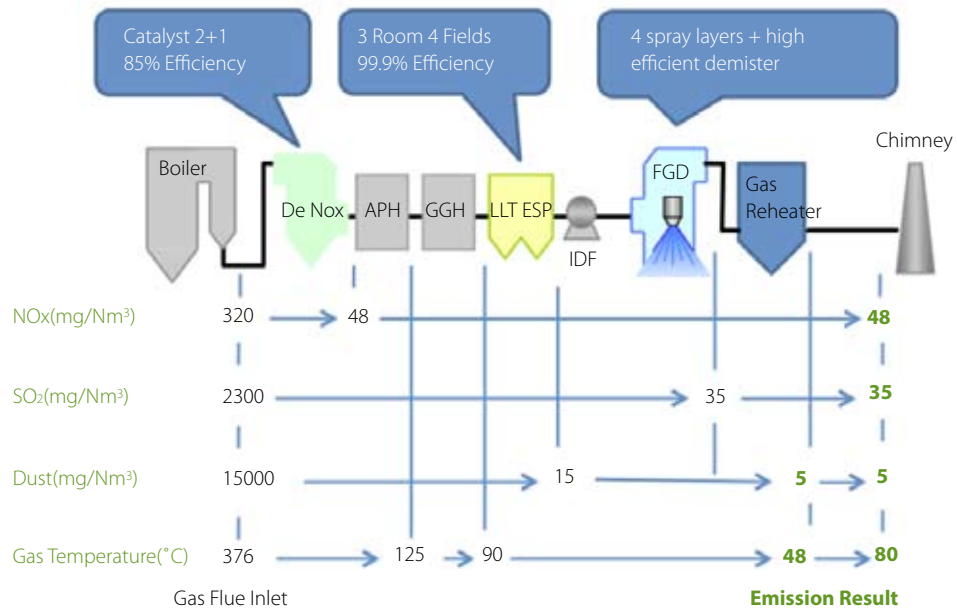
*Note: The Emission Standard is the requirement for retrofit above 300MW Existing Unit

**Note: Due to different among states of USA the chart shows the average requirement level.

***Note: For India market, SOx requirement in this Figure is of above 500MW unit. For 300MW to 500MW unit, SOx emission requirement is 600mg/Nm³.



Real Sample Project with Actual Emission Result



** Actual Results May Vary

Real Sample Project (Shen Energy Wai Gaoqiao No. 2 Pant 2x900MW)



Denitrification Technology

Denitrification Technology

The Company's main denitration technologies include: low-NO_x combustion, SNCR, SCR, and combine optimization of above. Reference Project undertaken ranges from 7MW unit capacity to 1000MW.

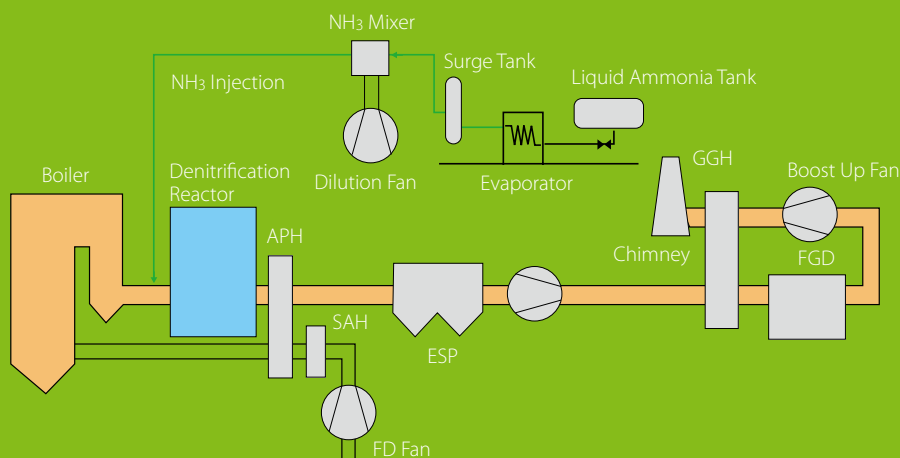


SCR Overview and Features

Selective Catalyst Reduction (SCR) is the world's most widely used method of denitration, with following advantages:

- High denitration efficiency;
- Simple process and compact structure of the reactor;
- Easy Operation, maintenance, high reliability;
- No by-products, no secondary pollution;
- Varieties designs of catalysts and reactors meet different flue gas condition.

▼ Coal-fired SCR Basic Flowchart



Note: The ammonia area offers liquid ammonia, urea and aqueous ammonia

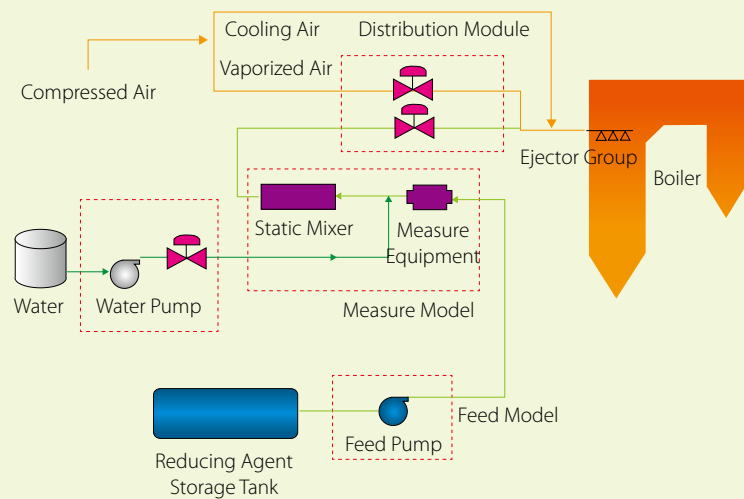
SNCR Overview and Features

For different conditions, SNCR is more suitable for certain unit, boiler furnace is used as reactor, no need catalyst and separate reactor.

- Small footprint
- Without catalyst
- Lower investment & operating costs
- Not sensitive to different coal types
- Short construction period, simple construction process (modular structure).
- No need to replace the induced draft fan
- Lower denitration efficiency than SCR
- Higher ammonia slip rate than SCR



▼ SNCR system flow chart

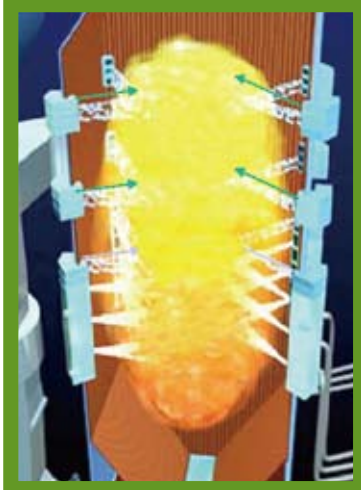


Low NOx Burner Retrofit

Retrofit Technology

Based on decades experience of design and manufacture of Boilers, Shanghai Electric independently researches and develops Advanced Composite Air Staged Low NOx Combustion System, NOx emissions can reach a minimum value of about 100 ~ 120mg/Nm³ (O₂=6%) or below.

This latest low NOx combustion technology is applied to Burner Retrofit projects of 300MW, 600MW subcritical and 1000MW ultra-supercritical units.



Development of Burning Technology

Phase	Technical Description	Burning bituminous coal lowest NOx emission mg/Nm ³ (O ₂ =6%)
1st Generation	Quadrangular Concentric Tangential Firing System	250
2nd Generation	Introducing low-NOx tangential firing system	145
3rd Generation	Advanced Composite Air Staged Low NOx combustion system	120

3MW Multifunction Coal Combustion Thermal Test Platform

The platform is China's first large-scale, full functional, sound system-ed multi-function megawatt coal combustion hot experimental system, for the study of characteristics of coal combustion, and coal-fired atmospheric pollutant emission in a variety of burning ways with different coal in Tangentially, Opposed Wall and W flame etc. The project is mainly to solve the problem of low NOx combustion, furthermore rational regulating best combustion ratio.

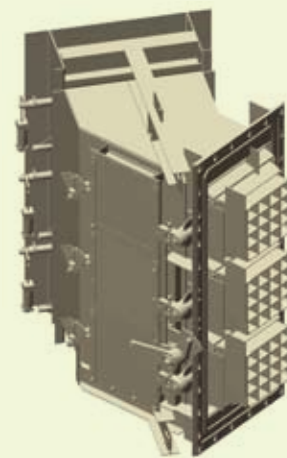
Which provides basic experimental data and technical support for the low-NOx combustion zoom-in experimental research and industrial demonstration.

Composite Air Staged Low NOx Combustion System has following characteristics

1. Technology is very mature, with successful operation references of new construction and retrofit job, so far in worldwide, it applied to more than 200 units, with a total installed capacity more than 62,000MW.
2. In order to reduce NOx emissions, we focus on improving the capacity of boiler combustion stability without oil inject at low load and combustion efficiency
3. Also, it has significant effect in prevention of slagging and high temperature corrosion, and in reducing flue gas temperature deviation etc. at furnace exit.

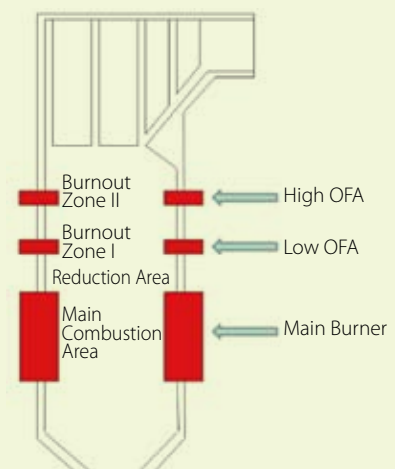
Composite Air Staged Low NOx Combustion System mainly uses the following technical measures

1. Compact OFA
2. Separated horizontal swing OFA
3. Preset horizontal angle auxiliary air nozzle
4. Wide turn down ratio strengthen fire pulverized coal nozzle



Advanced Composite Air Staged Low NOx Combustion System features:

1. Compared to a composite Air Staged Low NOx combustion system, this system is added with one section of separation overfire air, which means disposing two sections separated overfire air above the main combustion zone.
2. Combined with the one-dimensional test furnace, and combustion furnace.



Ancillary SCR Retrofit of Air Preheater

Purpose of Retrofit

After furnace SCR denitration, in middle temperature zone of the APH, unreacted ammonia and SO_3 in the flue gas react and form ammonium bisulfate, ammonium bisulfate transition state from gaseous to liquid, which easily lead APH ash block and corrosion, it is consequently necessary to retrofit APH accordingly.

APH denitrification retrofit is an ancillary retrofit of SCR denitration outside of furnace, but it also can be used on original equipment to solve practical problems of aging and high rate air leakage. After retrofit, APH air leakage rate can be reduced to 5.5% or below.

The New Arrangement of APH Heat Transfer Element

The new arrangement is usually elevating APH element at cold end above ammonium bisulfate fouling band, generally make cold section heat transfer element elevated to 900mm high or more (according to the specific flue gas temperature distribution in the case).

The advantages of this arrangement:

1. The corrosive sulfuric acid area and ammonium bisulfate deposition zone are simultaneously tolerated by cold section layer. It can reduce the workload while changing the heat transfer element and cleaning element.
2. Since the media could not be blew in the void space between the two elements, soot-blowing and cleaning media has good effect on single heat transfer element without dissipating energy.
3. By combining intermediate layer and the cold layer, it reduces the component package frame materials, while reducing the weight of the rotor and improving the rotor internal space utilization.

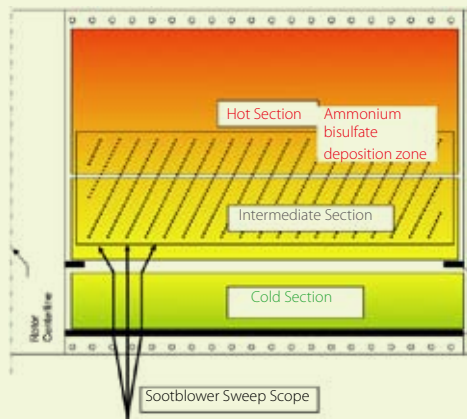
Retrofit Technology

1. Combine temperature transfer element of APH original cold and mid-temperature end, and adopt enamel components.
2. Calculate whether to replace the hot end components basis of heat transfer area.
3. Dual media (steam + pressure water) soot blowers retrofit.

APH Retrofit

APH Roter Structure Before Retrofit

Structure Disadvantages



Height of heat transfer element layer in cold section is 305mm. Ammonium hydrogen sulfate is deposited over the intermediate temperature section layer even hot section layer, by penetrating cooling section layer.

This causes preheater block, and sharply raise operation resistance.

Conventional steam soot blowers sweep capacity is between 1.0 ~ 1.5MPa, which can not effectively penetrate ammonium bisulfate permeable layer, especially after acrossing cold section layers, soot-blowing medium pressure will drastically reduce.

It then requires the use of plenty of water and shut-down operation.

APH Roter Structure After Retrofit

Improvement Reached

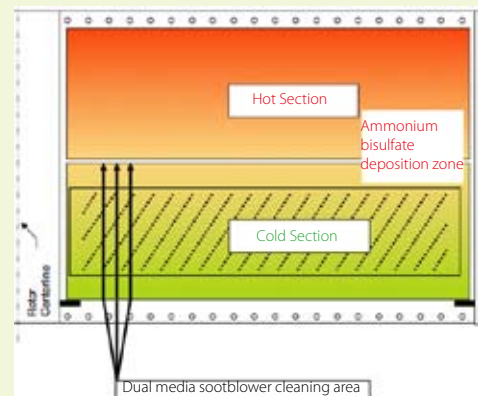
Heighten cold section element to restrict all of the ammonium hydrogen sulfate deposition in cooling zone layer.

Enameled corrosion resistant element is adopted to ammonium bisulfate deposition zone.

Sealed flue duct plate-type element is adopted to ammonium hydrogen sulfate deposition zone, for easy washing and soot-blowing.

By increasing water flushing pressure, multi-media soot blowing will minimize the impact on resistance influenced by ammonium bisulfate deposits.

High-pressure water flushing reduces water consumption, and does not have to operate during shut down



High Efficiency ESP Technology

Full Production Range

Electrostatic precipitator (comprises low-low Temperature ESP and mobile electrode), pulse jet bag filter, Electrostatic Fabric Filter and Wet ESP.

Flexible Technique Scope

Combine European forefront Balcke-Durr technology with China domestic mainstream technology. Flexible designing and complete measures.

Advanced Patented Technology

Bi-Corona® --PM2.5 Killer

Delta Wing® -- Flexible & low resistance flow optimization device.

TVS -- Strong airflow and efficient cleaning

Note: the usage of above patents depends on specific practical project situation.

High Efficiency Dust Removal Rate

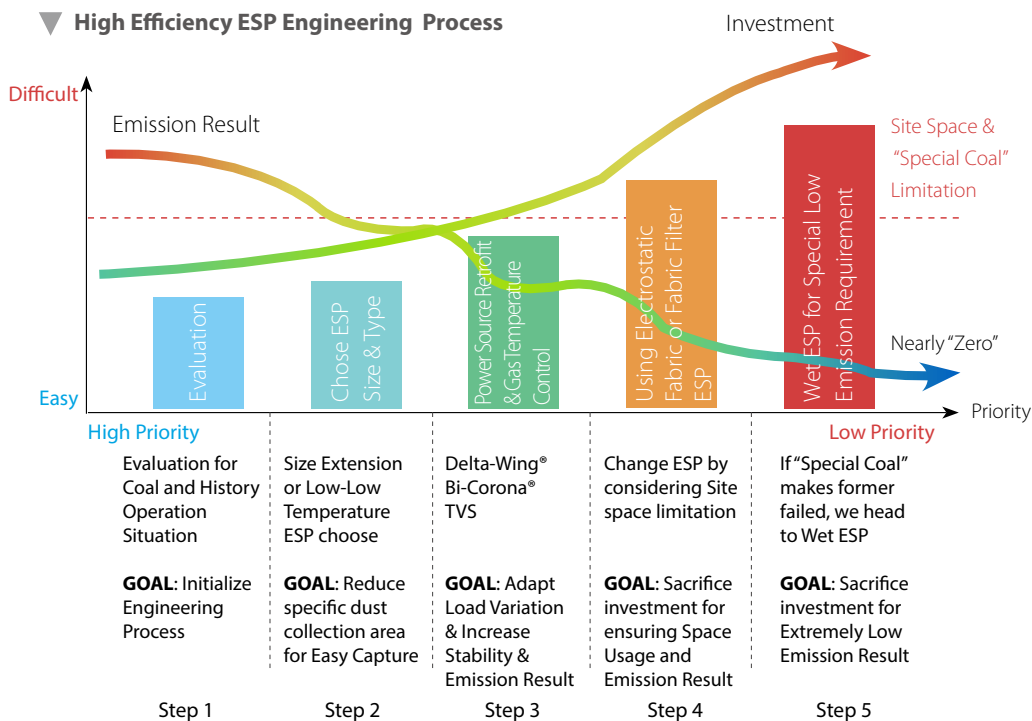
Reference Best record of ESP has reached to 6mg/Nm³.
Reference Best record of Fabric filter ESP has reached 5mg/Nm³.

Strong Adaptability

It can be applied to wide range of boiler fuel

Diversification Retrofit mode

With Delta Wing®, Bi-Corona®, efficient power, movable electrode, low low temperature ESP, expansion, electrostatic reform to fabric filter and other retrofit techniques

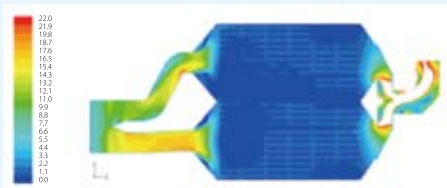


Patented Technology - Delta-Wing®

Delta wing technology is patented technology for optimized airflow, with characteristics as follows:

1. Installed at the entrance of the flue - efficient, low resistance
2. Reduce ESP operation cost and Site space requirement. More Environmental friendly.
3. Delta-Wing helps to better distribution of fly ash / temperature, thereby improving the efficiency of the precipitator.
4. Applied to complex flue duct
5. High-mix, low mixing length and the minimum flow separation

Even Flue Separation

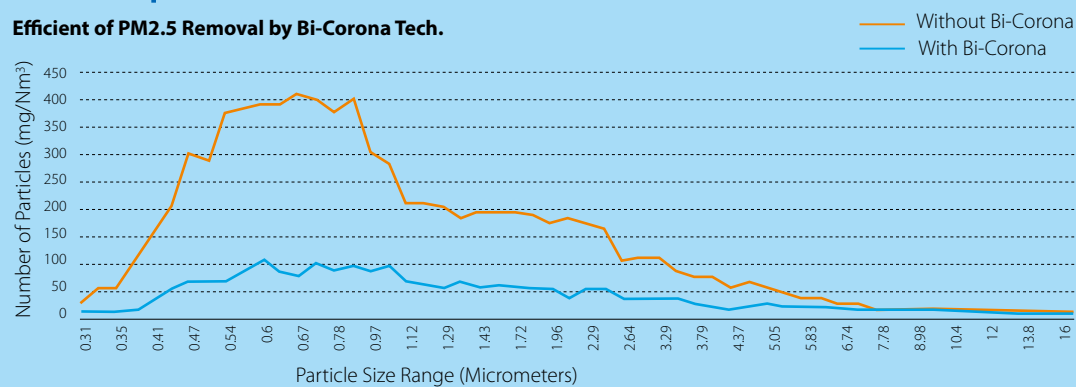


Turbulence Airflow to Prevent inside Dust Accumulation



Real Operation Record of Bi-Corona®

Efficient of PM2.5 Removal by Bi-Corona Tech.



Patented Technology -- Bi-Corona®

The patented technology Bi-Corona in the electrostatic precipitator is a very successful way developed on the basis of electrode arrangement experience, with the following features:

1. Electric field is divided into charging zones and collecting zones, resolve conflicts of charging and collecting function (Bi-corona principle)
2. Designed for different pole pitch of discharge electrodes and collecting electrode
3. Bi-corona electric field can be used in tandem
4. significant effect for PM2.5 removal
5. Simple structure

Low-Low Temperature ESP Technology

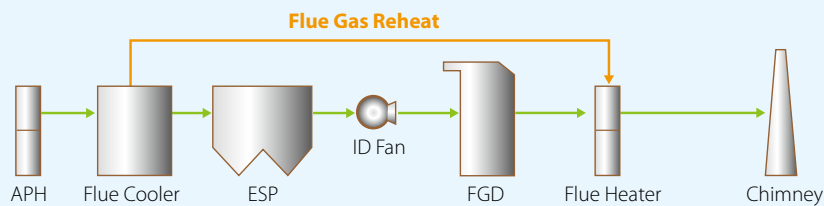
Low-Low Temperature ESP Technology

Flue gas cooler is disposed in the upstream electric precipitator. ESP operating temperature is reduced from 120 ~ 150°C to 80 ~ 100°C, then the flue gas volume flow and the resistance ratio of the flue gas is reduced, thus the collection efficiency is effectively improved.

After Flue Gas is cooled in the cooler, the gaseous SO₃ condenses into liquid sulfuric acid. Liquid sulfuric acid is coated with dust in the flue gas, and the liquid sulfuric acid and alkaline substances was in which neutralized, thereby reducing the corrosion of flue gas equipment.

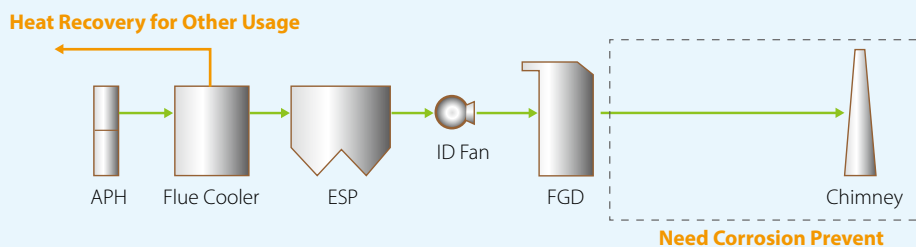
▼ Best Result Process

Using recovered heat to reduce initial investment on corrosion preventing, and guarantee emission result.



▼ Energy Saving Process

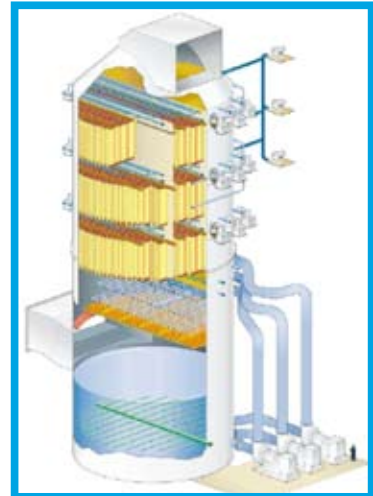
Increasing initial investment on corrosion preventing devices, while recovered heat for other use.



Wet ESP Technology

Principle of Wet ESP

1. Particles and water droplets in flue gas takes anion electronic in the wet electrostatic precipitator;
2. They are attracted to the positive electrode collection plate and format water film;
3. Then they flow into the bottom of the pool



Advantages of Wet ESP

Significant removal effect for fine particulate matter, such as (PM_{2.5} and SO₃ aerosols and heavy metals (mercury Hg, arsenic As, selenium Se, Pb Pb, Cr Cr). Efficiency could be up to 99% for sub-micron aerosol particles removal, and dust emissions can reach as low as 5mg / Nm³ or less.

Since adhesion charge of water droplets and particles reduces dust surface specific resistance, the dust with large or high viscous specific resistance than can be effectively collected, and therefore suitable for large flue gas treatment with high temperature, moisture content.

The collecting plate washed by the water film, which can avoid secondary flying dust, therefore dust removal efficiency and reliability of equipment operation could be improved.

Saturated flue gas after desulfurization carries water droplets. If Wet ESP is arranged in the back of the FGD tower, charged water droplets in the electric field are quantitatively trapped, which can effectively reduce the probability of the formation of gypsum rain.

Main Stream Technology of Flue Gas Desulfurization

Main Technology of SO_x Emission Control

Desulfurization Technology

Based on long-term professional background of power plant equipment manufacturing, Shanghai Electric is able to well combine all systems before and after FGD, and base on fuel type, a more simple structure and more reliable quality FGD system is designed. Flue gas volume and design conditions is fully considered, thus flue gas treatment system is optimized to achieve the lowest operating and construction costs.

Currently main usage of desulfurization technology includes: limestone - gypsum, magnesium, ammonia, sodium method and seawater methods. Projects have been undertaken ranges from 50MW to 1000MW.



➤ Magnesium Process Overview and Features

In the absorber, flue gas is simultaneously desulphurized and dust-removed by magnesium hydroxide slurry. In the bottom of the absorber, after desulfurization, slurry reacts with bubbling oxygen, then is discharged through the filter to separate the solid suspended matter and waste discharges.

Simple desulfurization process, and low equipment investment.

➤ Ammonia Process Overview and Features

In the absorber, flue gas is simultaneously desulphurized and dust-removed by ammonia slurry.

In the bottom of the absorber, after desulfurization, slurry reacts with bubbling oxygen, then discharged through the filter, to separating suspended solids,

it was sequentially imported to crystallizer and crystallized by drying, then ammonium sulfate grains precipitated, which could be recycled as fertilizer.

Byproduct - ammonium sulphate could be recycled as a fertilizer

➔ **Limestone - gypsum Process Overview and Features**

Limestone - gypsum process, is currently the world's most widely desulfurization process, gypsum slurry in absorber can perform dust removal and desulfurization simultaneously. In the bottom of the absorption column, desulfurized gypsum slurry and bubbling oxygen take oxidation reaction. Gypsum slurry discharged by the absorber, via dewatering machine, and reduced moisture below 10%, then the plaster is isolated, while part of the filtrate was recycled.

Absorbers are inexpensive, byproduct gypsum is recyclable

➔ **Sodium Process Overview and Features**

In the absorber, flue gas is simultaneously desulphurized and dust-removed by Sodium slurry. In the bottom of the absorber, after desulfurization, slurry reacts with bubbling oxygen, then discharged through the filter to separate the solid suspended matter and waste discharges.

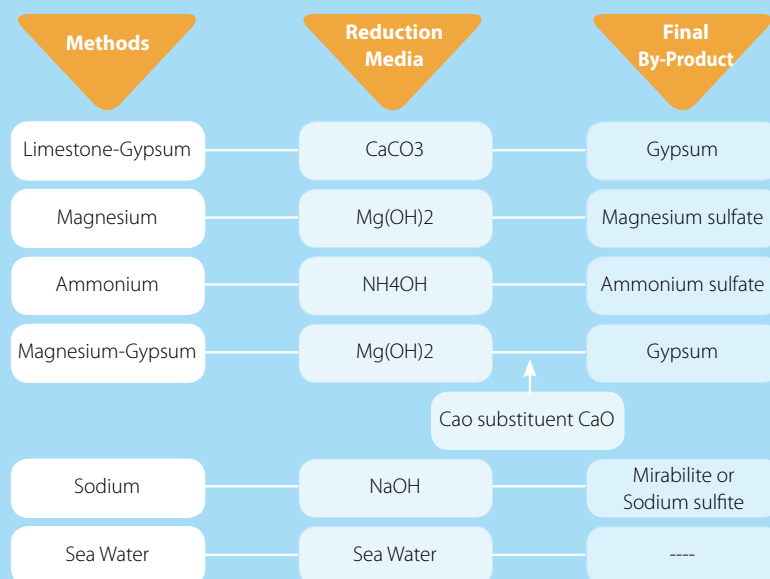
High desulfurization efficiency, simple process system

➔ **Seawater Process Overview and Features**

In absorber, flue gas dust removal by the sea water, simultaneously flue gas is desulfurized by HCO₃⁻ and other alkaline substances in seawater. After desulfurization, through aeration tank, water is oxidized and neutralized, PH value and the DO is restored, then discharge to the sea.

Simple Technology system, low operating cost

Indication Process of Different Desulfurization Methods.



Main Stream Technology of FGD

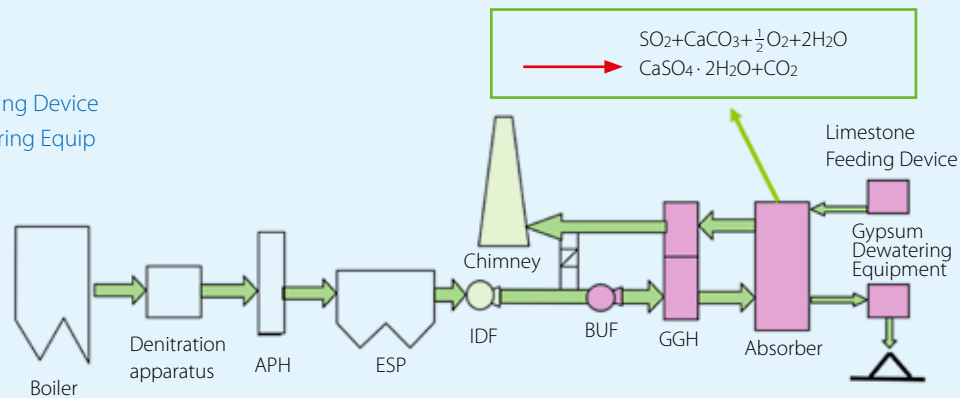
Lime / limestone - gypsum flue gas desulfurization technology, is used to remove flue gas SO₂. In reaction column, it washes gas by detergent slurry like limestone (CaCO₃) and lime (CaO) etc.

This process has over 50 year history, through our continuous improvement and perfection, this technology

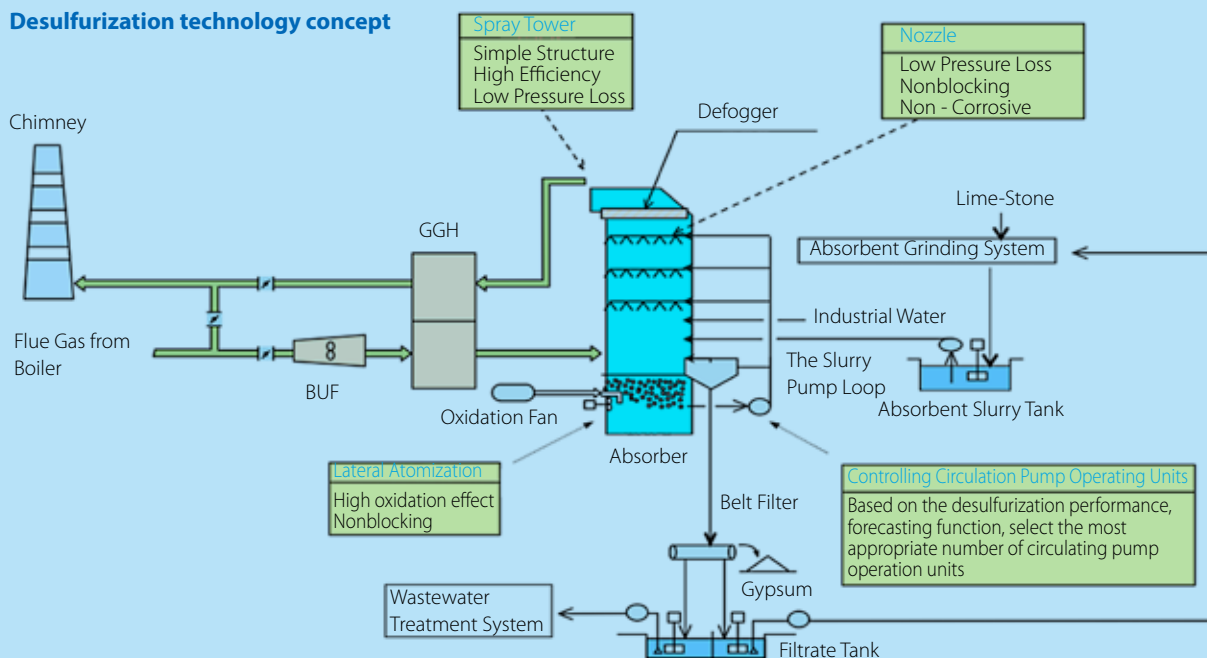
is presently mature. It has advantages of a high desulfurization efficiency, large unit capacity, strong coal adaptability, low operating costs and easy to recycle by-products etc. In China, more than 90% of the thermal power plants use lime / limestone - gypsum flue gas desulfurization process.

Main system of Limestone - gypsum desulfurization equipment

- Absorber
- GGH
- BUF
- Lime Stone Feeding Device
- Gypsum Dewatering Equip



Desulfurization technology concept



Improving Efficiency of Existing Desulfurization Technology

Absorber efficiency is improved by using new patent flow field optimization nozzle and PH control technology. When FGD inlet SO₂ concentration is about 3000mg / Nm₃, the desulfurization efficiency can reach 99%.

CFD flow field simulation: Optimize absorber flue gas inlet flow field, increase equalizing ring, and make the flow field in tower distributed more evenly, thus efficiency is increased.

Absorber: simple structure, small pressure loss, easy maintenance;

Hierarchical control PH of absorption zone : Depended on the different spray region, subregionally adjust the PH value of slurry in spray zones , PH values can be controlled at between 4.8 to 6, so that the desulfurization efficiency increases by 1% to reach 98 to 99% on original basis.

Desulfurization performance prediction: Desulfurization performance prediction model in DCS can correctly predict the desulfurization performance. Under the premise to guarantee the desulfurization performance, it reasonably controls of the circulation pump operating units and energy consumption.

New patented nozzle: Small pressure loss, no clogging and corrosion, slurry particle size reduction and even flue gas distribution, thereby transfer efficiency is improved.

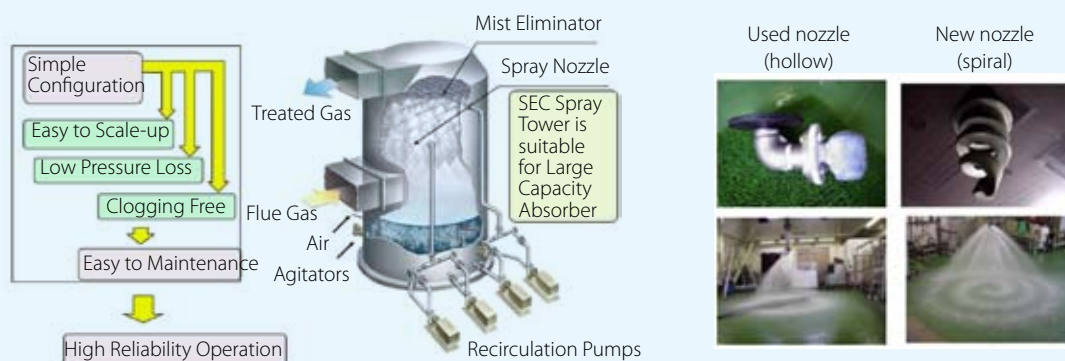
Two Desulfurization Tower Synergy

An additional absorber arranged for running with original one in series. No downtime is required.

Optimizing the spray layer arrangement (space): Rationalizing the pressure distribution, increasing gas-liquid contact time and improve desulfurization efficiency.

Lateral atomization: small retention capacity, high oxidation resistance, non-blocking and conducive to the generation of gypsum.

Single-loop spray scrubber technology: reduce absorber resistance, decrease slurry circulating pump pressure from 1/5 to 1/4, save power consumption.



SECPG Service Company Culture

A Message from The Chairman – Mr. Huang Dinan

Investors create our company, customers facilitate creation of our products, employees contribute to the corporate development, and society is the market we serve. Let all the stakeholders work together for a brighter future with Shanghai Electric's market environment and World class equipment.

SECPG Service Company Culture:

Provide what customers lack
Care what customers consider
Do what customers need
Solve what customers worry
Meet what customers expect



Economic

High economical operation :

Low-power emission control equipment is enabling to reduce the cost of electricity generation, compared to other plants, the low-cost operation indirectly enhance online profits.

1. Completely customized according to the customer the entire unit. To ensuring maximum power output, we provide the most economical solution
2. Ensure the maximum utilization of electricity and heat plant

Environment Friendly

Stringent environmental emission :

Our solution is far lower than the existing environmental emissions required by law, our customers can use the same investment to avoid future legal updated cost

1. Pollution Control
2. Space Optimizing
3. Water and electricity saving
4. Heat recovery

Reliability

Improve the reliability and adaptability :

We re-design and renovate of old units in order to improve the overall adaptability of the unit thus reduce loss caused by unscheduled shutdown.

1. Offer overhauling and life extension to existing environmental emissions control equipment
2. Design new high reliability and adaptability equipment
3. Whole Island Optimization

Contact Us:

400-880-6016

Business Contacts:

Peng Ling: (0086)13795222896, 0086(21)-67686999-8083

Pengling@shanghai-electric.com

Ding Jingyu: (0086)13918698833, 0086(21)-67686999-8270

Dingjy@shanghai-electric.com

Chen Liao: (0086)13816362986, 0086(21)-67686999-8113

Chenliao@shanghai-electric.com

Zhou Shuyu: (0086)13611988785 0086(21)-67686999-8135

Zhoushy3@shanghai-electric.com

