

NO_x Solutions

SNCR | SCR | COA | O₃

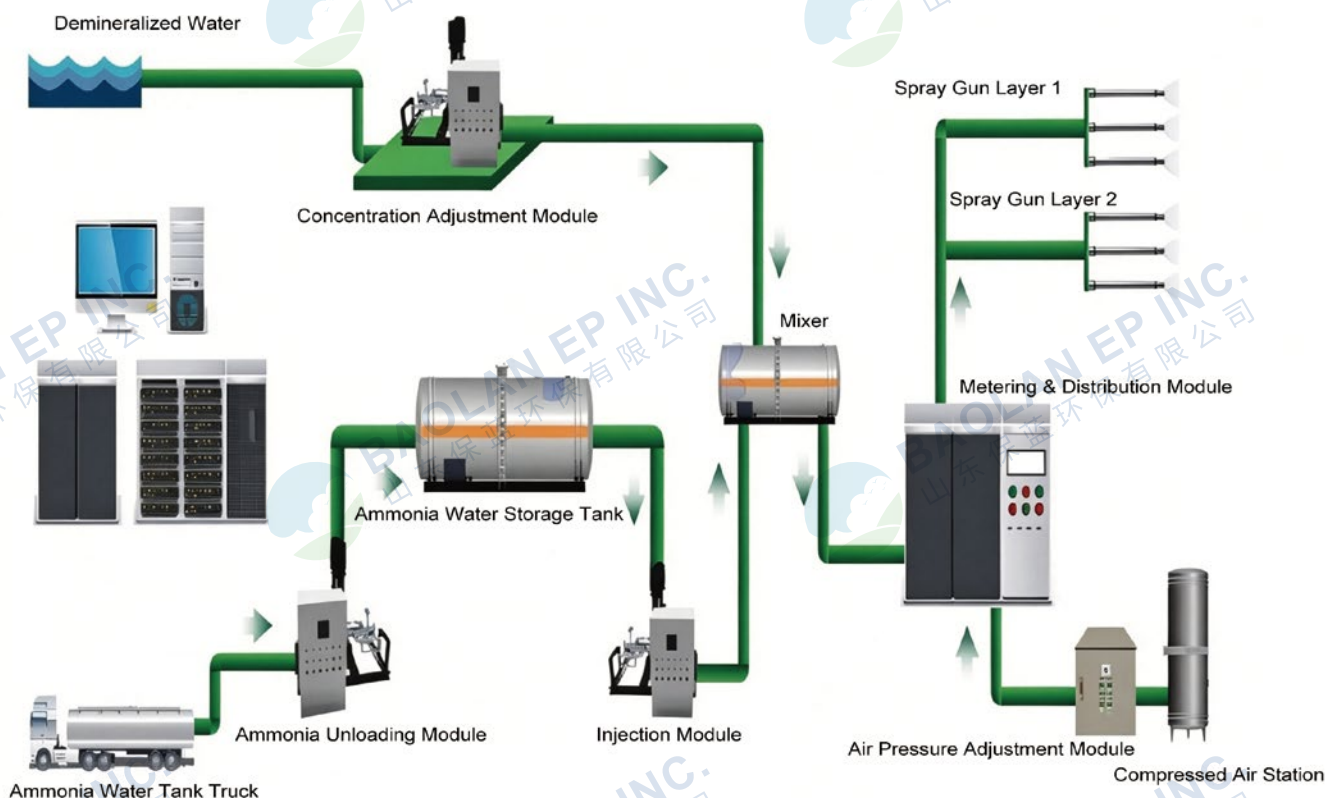


SNCR

NO_x

Overview

Selective Non-Catalytic Reduction (SNCR) is a common, cost-effective denitrification technology widely applied in industrial flue gas treatment. Unlike SCR, this process requires no catalyst and relies on a high-temperature reaction environment ranging from 850 to 1100 degrees Celsius. Reductants such as ammonia or urea solution are atomized and sprayed directly into the high-temperature flue gas zone inside the furnace or boiler. The reducing agent mixes fully with flue gas and selectively reacts with nitrogen oxides, converting harmful NO_x into harmless nitrogen and water vapor. Although its denitrification efficiency ranges from 50% to 70%, lower than the SCR system, it features simple structure, low investment and operation cost, and no catalyst replacement cost.



Working Principle

Selective Non-Catalytic Reduction (SNCR) is a mature commercial NO_x control technology.

In the absence of a catalyst, and within a temperature range of 850 °C to 1050 °C, it reduces nitrogen oxides in flue gas to harmless nitrogen and water using a reducing agent.

In this process, an amino-containing reducing agent is injected into the appropriate temperature zone in the furnace or outlet flue. At high temperatures, the reducing agent decomposes rapidly into ammonia, which then reacts with NO_x in the flue gas to form nitrogen and water.

Using the furnace and flue as the reactor, SNCR features relatively low investment and a short construction period.

However, its denitrification efficiency is lower than that of Selective Catalytic Reduction (SCR).

In laboratory tests, SNCR can achieve a NO_x removal rate of over 90%.

In large-scale boiler applications, it can reach 75% during short-term demonstration, while long-term field performance is typically 30%–60%.

Higher efficiency can be obtained by adding suitable additives to the reducing agent, which can improve the efficiency by 3–5%, as discussed in detail below.

Reduction reactions:

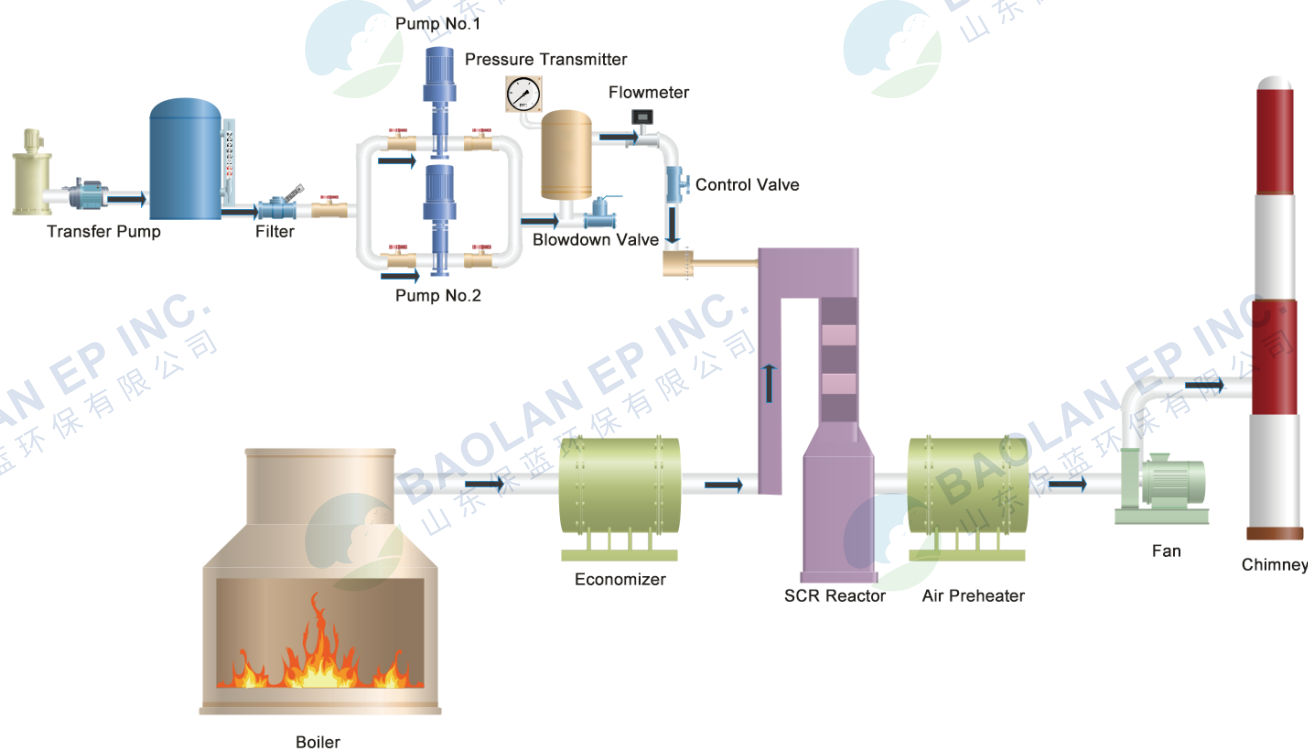


SCR

NO_x

Overview

Selective Catalytic Reduction (SCR) is the most widely used and efficient denitrification technology for industrial flue gas treatment, which is essential for enterprises to meet national ultra-low emission standards. It works stably in a temperature window of 300 to 400 degrees Celsius. In the working process, atomized ammonia is fully mixed with flue gas, and selectively reacts with nitrogen oxides (NO_x) on the surface of the catalyst. The reaction converts toxic NO_x into harmless nitrogen and water vapor, avoiding unnecessary reaction with oxygen in flue gas. With a denitrification efficiency of over 85%, it can effectively reduce NO_x emissions from industrial boilers, power plants and kilns.



Working Principle

SCR refers to a process in which, in the presence of O₂ and a catalyst, NO_x in flue gas is reduced to harmless N_x and H₂O using reducing agents (mainly NH₃, CO or hydrocarbons).

It is called "selective" because, under catalytic conditions, the reducing agent reacts preferentially with NO_x in the flue gas rather than being oxidized by O₂.

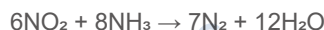
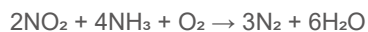
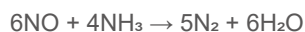
The presence of O₂ in flue gas promotes the denitrification reaction and is an indispensable part of it.

The main reducing agent for SCR denitrification is ammonia water.

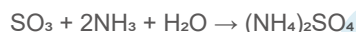
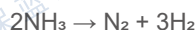
Urea is pyrolyzed to produce ammonia, which is atomized and injected into the system.

Under the action of the catalyst, ammonia reduces NO_x in the flue gas to N₂ and H₂O.

The main reaction equations are as follows:



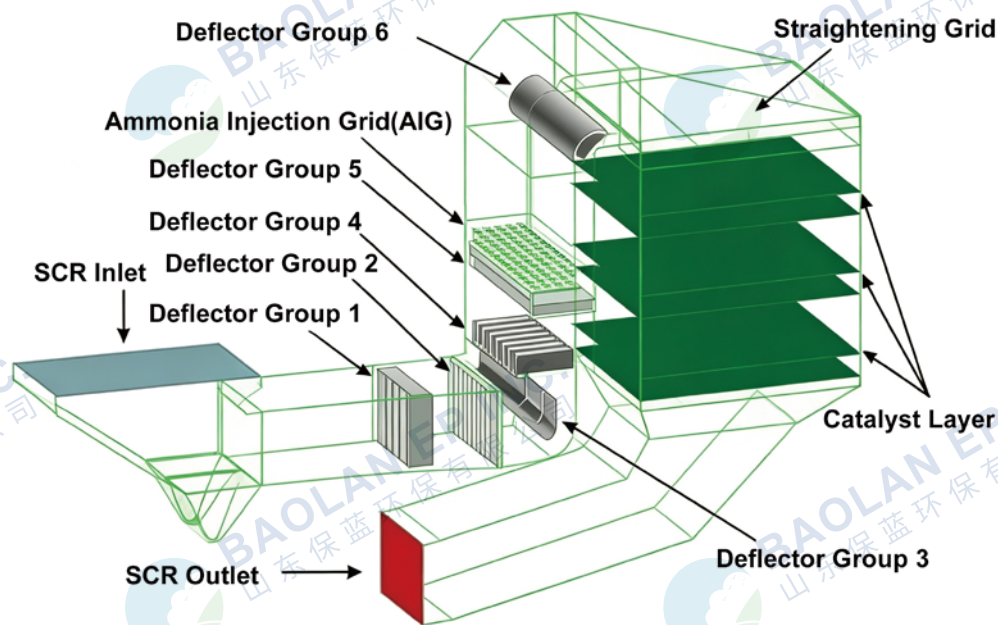
In addition to the above reactions, the following side reactions may occur under changed conditions:



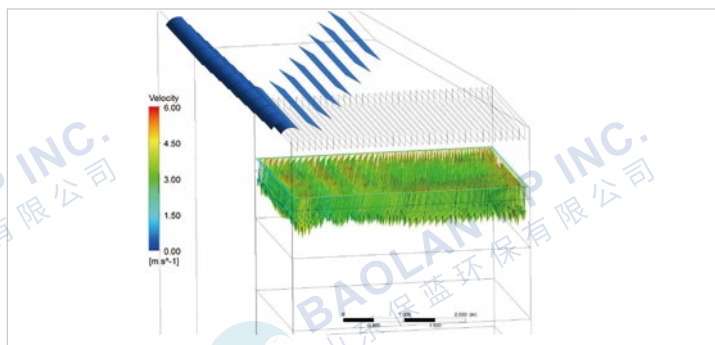
SCR NO_x

Internal Structure

The denitrification process system of this project mainly consists of the flow guide system, ammonia injection system, SCR reactor main body, SCR catalyst, soot blowing system, control system and other components.



Flow guide system:As the core of SCR flow field optimization, the flow guide system rectifies biased flow, eddy current and swirling flow in the flue duct. It ensures flue gas enters the catalyst bed uniformly and perpendicularly, avoiding catalyst abrasion from high local velocity and decreased denitrification efficiency due to low local velocity. Its core components include flue duct deflector group, reactor inlet flow guide structure and flow straightening grid.



Ammonia Injection Grid (AIG):Ammonia Injection Grid (abbreviated as AIG) is the core ammonia distribution equipment of the SCR denitrification system. It is installed in the flue duct upstream of the reactor and is responsible for uniformly injecting ammonia-air mixture into the full cross-section of flue gas, which directly determines the denitrification efficiency and ammonia slip control level.

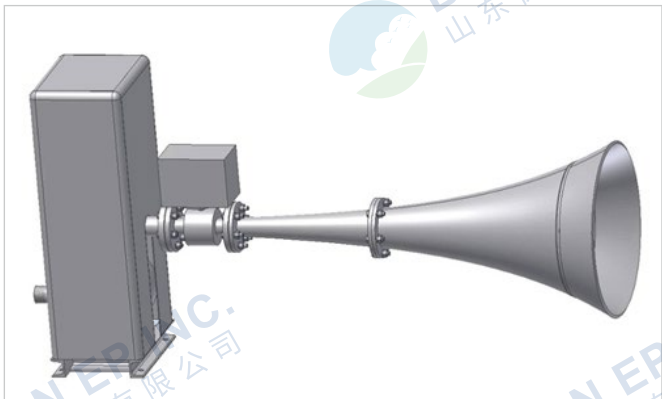
Internal Structure

SCR Reactor:The SCR reactor is the core equipment of the flue gas denitrification system. Its main function is to support the catalyst, provide space for denitrification reactions, ensure smooth flue gas flow and uniform gas distribution, and create favorable conditions for the denitrification reaction. Apart from the properties of the catalyst itself, the quality of reactor design is the decisive factor for the SCR system to achieve denitrification performance.

SCR Catalyst:At present, catalysts worldwide can be divided into three categories: honeycomb catalyst, plate catalyst and corrugated plate catalyst. There are three mainstream types of SCR catalysts available on the market, namely honeycomb, plate and corrugated plate. The comparison is as follows:

Item	Honeycomb Type	Plate Type	Corrugated Plate Type
Structural form			
Manufacturing process	Extrusion with uniform forming	Coating type (steel frame support)	Coating type (glass fiber frame support)
Specific surface area	Large	Small	Medium
Required volume under identical conditions	1	153% ~ 176%	1.3
Pressure drop	1.24	1	1.48
Poison resistance	Strong	Medium	Medium
Safety	Non-combustible	Combustible	Non-combustible
Global SCR reference share	>65%	<33%	Minor

Soot Blowing and Control System:The soot blowing system is used to periodically remove fly ash deposits on the catalyst surface, prevent catalyst channel blockage, activity reduction and increased pressure drop. It is an essential guarantee for maintaining the long-term stable operation of the system.



Acoustic Soot Blower



Steam Soot Blower

Internal Structure

Ammonia Water Storage System: The ammonia water tank serves as the core reducing agent storage unit of the aqueous ammonia-based SCR denitrification system. It stores industrial ammonia water with a mass concentration of 9%~10%, acting as the carrier of ammonia source for denitrification reactions. Compared with high-pressure liquid ammonia storage tanks, ammonia water tanks are mostly atmospheric or low-pressure equipment with lower safety risks and simpler operation & maintenance management. They represent the mainstream ammonia storage solution for denitrification projects in scenarios such as medium and small generating units, chemical parks, and iron and steel sintering.



Ammonia Water Delivery System: The ammonia water delivery module is the core power and metering unit of the aqueous ammonia-based SCR denitrification system. It connects the ammonia water storage tank upstream and links to the ammonia water evaporator or metering distribution unit downstream. It is responsible for delivering ammonia water from the storage tank to the subsequent reaction unit quantitatively, at stable pressure and continuously according to system load requirements. It also integrates functions of filtration, safety protection and condition monitoring. The mainstream engineering solution adopts skid-mounted integrated design. After prefabrication in the factory, the whole skid is hoisted and connected on site, bringing convenient installation and operation & maintenance.

Ammonia Water Injection System: The design of the aqueous ammonia injection system shall be capable of continuous and safe operation at any load between the boiler minimum stable combustion load condition and BMCR, and shall meet the requirements of unit load variation and unit start-stop cycles.

The spray gun is made of stainless steel and consists of four parts: gun body, nozzle seat, atomizing head and nozzle shroud. The reducing agent solution inlet and atomizing compressed air inlet on the gun body are threaded connections, and they are connected to the reducing agent solution pipeline and atomizing compressed air pipeline respectively via two metal hoses.



This spray gun shall have the following characteristics: compact structural design. The complete set of equipment requires no additional supports and is extremely convenient for on-site installation; it only needs to be bolted to the reserved flue duct interface.

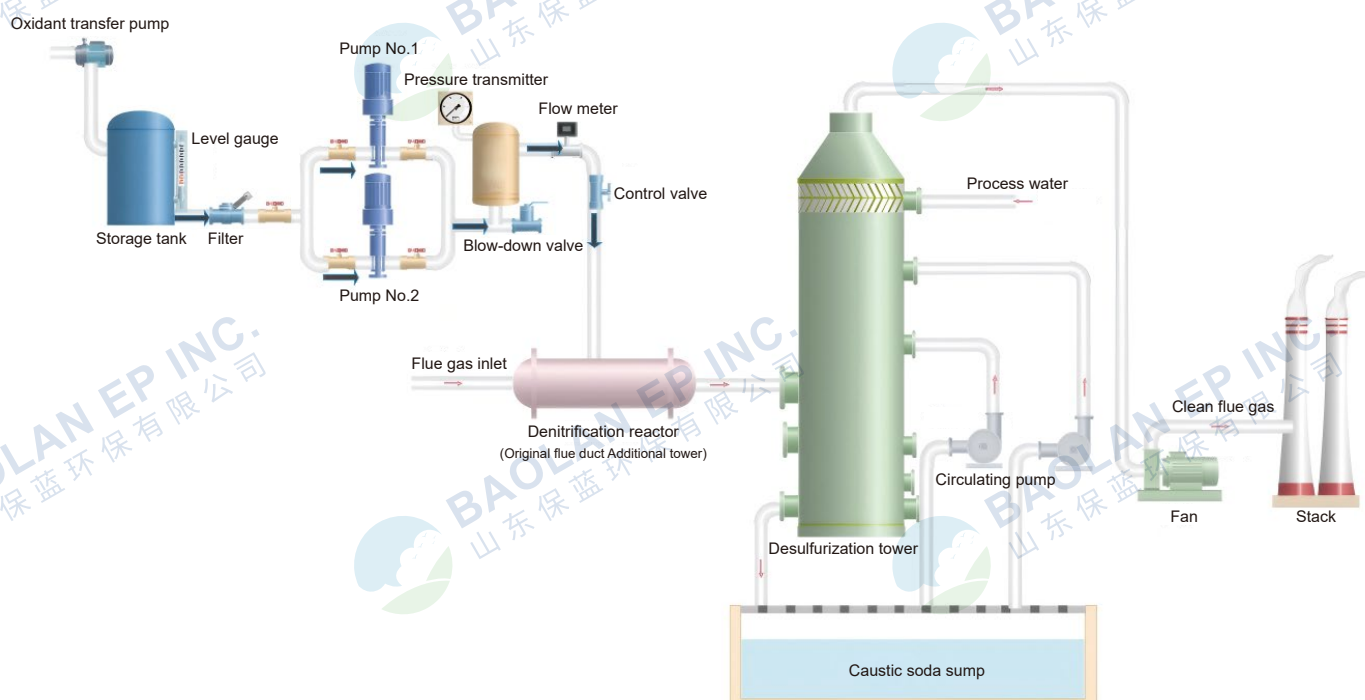
It features stable and reliable spraying performance. The spray gun can produce evenly atomized fine spray particles with small particle size. The spray has a turndown ratio of 10:1, and the injection flow rate can be precisely adjusted to the required value.

COA

NO_x

Overview

This technology adopts sodium chlorite solution as the oxidant, which is injected into the oxidation reactor to undergo redox reaction with NO_x (mainly NO) without using catalysts. The sodium chlorite solution injected into the system converts nitrogen oxides (NO_x) in flue gas into nitrate ions (NO₃⁻). Three-layer oxidant spray lances are installed inside the oxidation reactor. The oxidant enters the oxidation reactor through the spray lances for thorough mixing and scrubbing with flue gas, and the reacted flue gas flows into the absorption tower.



Working Principle

In the oxidative denitrification process, flue gas is delivered by the ID fan into the spray oxidation reactor. The oxidant solution is fed to spray lances via diaphragm metering pumps. High-efficiency spraying enables full contact between the oxidant solution and flue gas inside the reactor. Low-valent NO_x contained in the polluted gas is oxidized into High-valent NO_x, which is then absorbed by the alkaline absorbent in the absorption tower to finally form nitrates. The slurry is discharged once a certain concentration is reached.

The oxidation reactor is equipped with three-stage denitrification oxidation. Slurry spraying achieves sufficient contact between oxidant slurry and flue gas to oxidize NO in flue gas. The slurry ejected from nozzles flows by gravity to the bottom of the oxidation reactor. The required denitrification efficiency is adjusted by controlling parameters such as oxidant concentration of denitrification slurry and flow rate of the denitrification circulating pump.

Flue gas after oxidative denitrification passes through the flue duct to the absorption system and first enters the absorption tower. After being purified inside the absorption tower and removing water mist by the mist eliminator, the flue gas is discharged to atmosphere through a dedicated stack (or the existing flue-gas stack).

O₃-DeNO_x

NO_x

Overview

Ozone denitrification, full-name ozone-oxidation plus wet-absorption denitrification technology (O₃-DeNO_x), is an advanced oxidation denitrification process for low-temperature flue gas. It ranks among the mainstream technologies for industrial flue-gas NO_x control and is especially applicable to low-temperature flue-gas conditions where SCR / SNCR cannot work effectively.

Over 90% of NO_x in flue gas exists in the form of NO (nitric oxide). Since NO is barely soluble in water, it cannot be directly captured by conventional wet desulfurization towers. With strong oxidizing property, ozone oxidizes NO into high-valent soluble nitrogen oxides, which are then absorbed and removed by the alkaline washing tower to complete denitrification. Meanwhile, it can realize the simultaneous co-removal of SO₂, mercury, dioxins and partial VOCs.

Ozone has an extremely high redox potential and rapidly oxidizes NO inside the low-temperature flue duct. The core reactions are shown below:

$\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$ (Primary oxidation, O₃/NO molar ratio $\approx 0.9\text{-}1.0$, producing NO₂ with denitrification efficiency of 80%-85%)

$\text{NO}_2 + \text{O}_3 \rightarrow \text{NO}_3 + \text{O}_2$

$\text{NO}_3 + \text{NO}_2 \rightarrow \text{N}_2\text{O}_5$ (Deep oxidation with increased ozone dosage to form N₂O₅; denitrification efficiency can reach 90%-95%)

$2\text{NO} + 3\text{O}_3 = \text{N}_2\text{O}_5 + 3\text{O}_2$

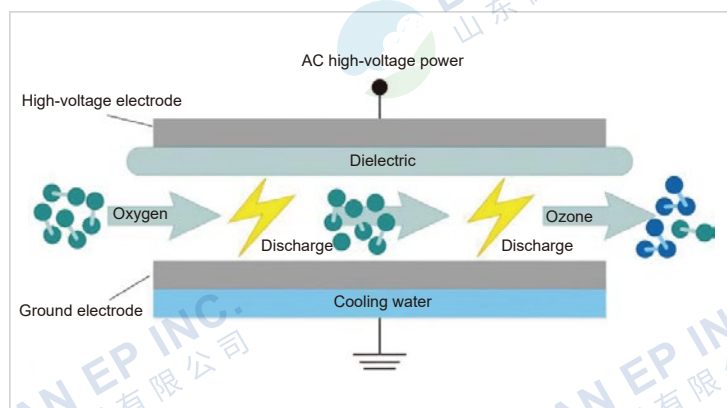
The oxidized products flow into the absorption tower and react with alkaline liquor (such as NaOH / Ca(OH)₂) to form nitrates and nitrites which remain in the liquid phase. The flue gas is discharged up to emission standards. Excess residual ozone is decomposed in the scrubbing tower to prevent ozone slip. The reaction product is oxygen. There is no solid catalyst dust and no risk of ammonia slip.

Working Principle

Principle of Ozone Generation: Most of the ozone in nature is formed in the stratosphere approximately 18-20 km above the earth's surface. Ozone (O₃) is generated when short-wave ultraviolet rays in sunlight act photochemically on the air in the stratosphere.

Natural phenomena such as lightning, high-speed impact and friction of waterfalls and ocean waves, as well as photosynthesis of green plants, also produce trace amounts of ozone (O₃) or large quantities of negative-charge ions. Accordingly, trace ozone (O₃) can be found in forests, seashores, waterfall areas and other locations.

Common industrial ozone-production methods include electrolysis, nuclear radiation, ultraviolet radiation, plasma and corona discharge. At present, the most mature and widely industrialized approach uses ozone generators to produce ozone by discharging against air or pure oxygen. High-energy alternating current ionizes oxygen molecules in air to form ozone.



The corona discharge method is generally adopted for industrial-scale production. Its principle is as follows: The core of the ozone generator adopts advanced dielectric-barrier double-gap discharge technology. The raw-material gas stream passes through narrow gaps, one between the dielectric medium and the high-voltage electrode and the other between the dielectric layer and the grounded tank electrode of the ozone generator. Double-sided discharge takes place in the high-voltage electric field across these two annular gaps, which converts the passing oxygen into ozone with high ozone-generation efficiency.

O₃-DeNO_x

Internal Structure

Glass Discharge Element:The ozone-generation mechanism is as follows: the raw-material gas stream flows through narrow gaps between the dielectric medium and the high-voltage electrode, as well as between the dielectric layer and the ground electrode of the ozone-generator tank. Double-sided discharge occurs in the high-voltage electric field within these two annular gaps, converting the passing oxygen into ozone and achieving higher ozone-generation efficiency.

The borosilicate special glass features unique physical and chemical properties, which is the primary reason why our company adopts this material for manufacturing discharge tubes of ozone generators.This special glass meets the highest precision standards in the industry. Glass tubes with diameters of 8-40 mm can be coated to avoid scratches and improve surface smoothness, which reduces adhesion of impurities. In addition, it features a higher breakdown-resistance voltage (37 kV/mm at 100 ℃). These advantages improve the stability and discharge efficiency of discharge tubes, extend the maintenance interval of glass tubes, and further make the operation of ozone generators more stable and efficient.

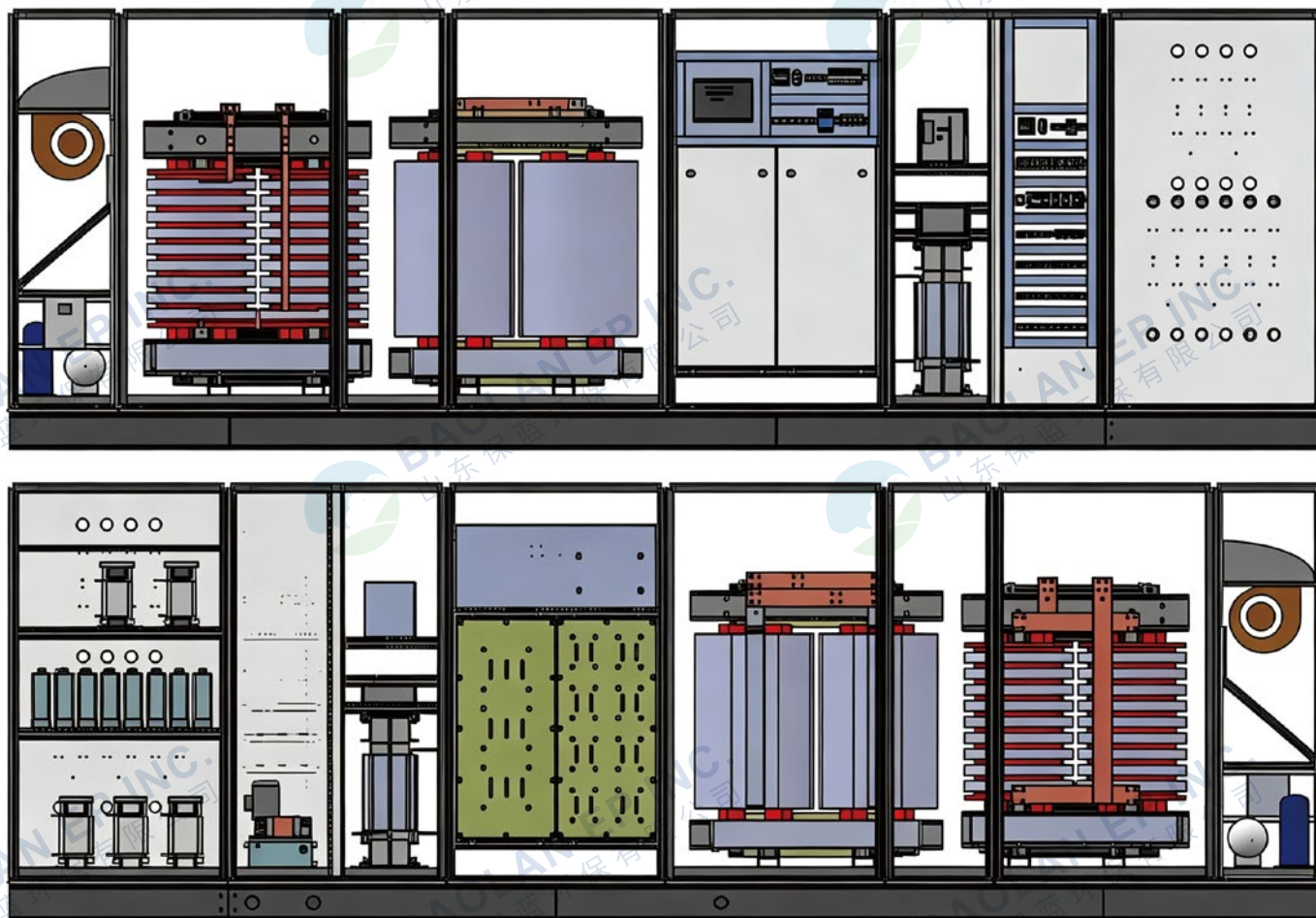
Advantages of Discharge Tubes	
Equipment Technology Type	High efficiency Glass Dielectric Technology
Structural Features	Dual air gap discharge; centering is achieved by spiral support and gas guiding device.
Dielectric Material Type	Borosilicate glass
Post treatment	Proprietary nano coating treatment for partial surface self cleaning
Mechanical Properties	Certain toughness, higher mechanical strength than ordinary glass tubes
Dielectric Layer Thickness	1.2-2.0mm
Assembly Features	Dielectric and electrodes assembled via spiral gas guiding device
Normal Maintenance Cycle	5-10 years
Structural Dimensions	The discharge tubes feature small diameters, delivering high space utilization efficiency of the generation chamber and compact structure for large size equipment.



O₃-DeNO_x

Internal Structure

Special-purpose Power Cabinet for Ozone Generator: Electric energy for ozone production of the ozone generator is supplied by the dedicated ozone power-supply system. The dedicated power-supply system converts utility-frequency power supply into medium-and-high-frequency high-voltage electricity matched with the capacitive load of the ozone generator via rectifier, inverter and boost units. The high-voltage power is connected to the high-voltage electrodes of the ozone generation chamber through special high-voltage cables and custom-made high-voltage connectors. By means of dielectric-barrier discharge, oxygen-containing air is converted into ozonized gas.



The incoming three-phase AC power of phases A, B and C (380 V, 50 Hz) passes through the disconnecter and AC contactor, and then is connected in series with a three-phase line reactor. After the reactor, power is fed into a three-phase fully-controlled bridge rectifier circuit. The three-phase power goes through fast fuses to the rectifier circuit. The rectifier bridge converts the input power into adjustable DC, which is then sent to the inverter unit of the inverter bridge.

The DC power is filtered by a large-value inductor. The filter inductor keeps the current continuous and stable, ensures continuous-current operation of the rectifier, and suppresses intermediate-frequency current from feeding back into the utility grid. In case of inverter failure, it limits surge current and provides protection.

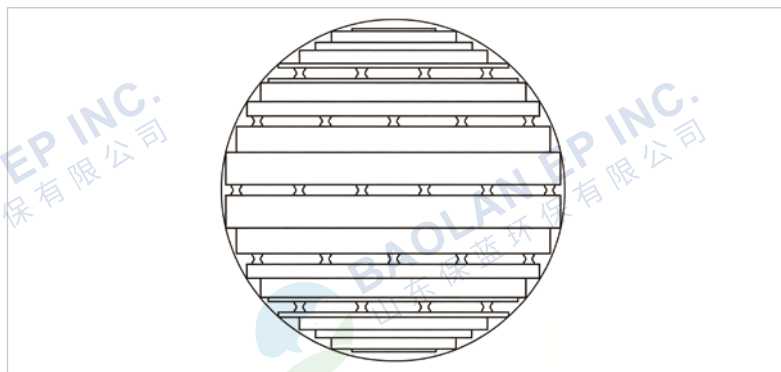
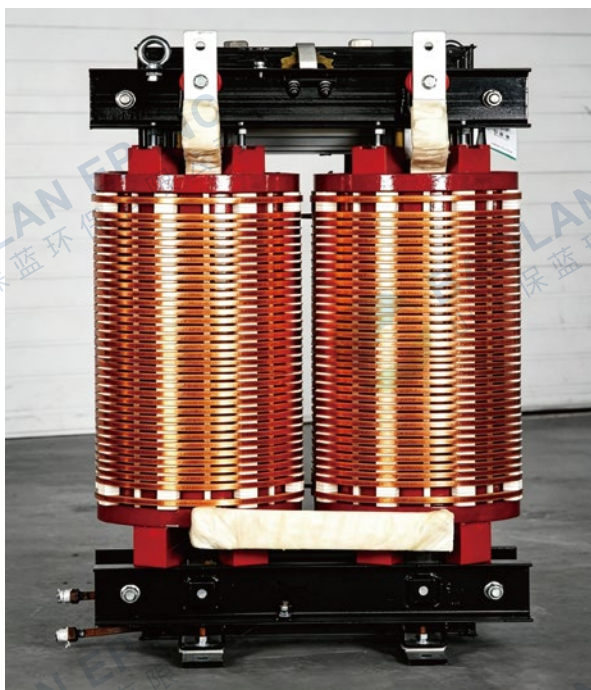
The output current of the inverter passes through a high-power high-voltage step-up transformer and is delivered to the discharge chamber of the ozone generator. The capacitive load formed by ozone-generating units inside the chamber and the transformer leakage inductance constitute a resonant circuit.

O₃-DeNO_x

Internal Structure

Dry-type High-voltage Transformer: The ozone-dedicated transformer transmits power and matches the output of the electronic power circuit with the generation chamber, whose parameter requirements differ from those of conventional transformers. During the whole operation of the generation chamber, the load varies substantially in magnitude, and its characteristics also change between striking and normal-operation states. With a unique design, this dry-type transformer for ozone capacitive loads possesses certain leakage inductance to balance the above-mentioned variations and protect electronic components. Meanwhile, the structure design adopting introduced German technology and special winding process greatly reduce the skin effect and power waste, and improve the power-utilization efficiency of the transformer.

In view of the particularity of transformer application, our company independently designs and manufactures dry-type transformers for ozone generators. Cold-rolled oriented silicon steel sheets are adopted as transformer cores to enhance magnetic effect and reduce core loss, so as to improve the operating efficiency of transformers.



In accordance with our company's process characteristics, an approximately-circular cross-section is adopted for the iron core to facilitate coil winding and reduce overall volume. To achieve this circular-like core cross-section, laminations of appropriate stages with different thicknesses are stacked and assembled, which reduces processing difficulty and improves production efficiency. Cooling passages are arranged between multi-stage laminations to effectively suppress eddy-currents and promote heat circulation inside the iron core.

Cooling Water System: The cooling system of an ozone generator is critical for ozone output and long-term stable operation. Nearly 90% of corona energy during ozone generation is dissipated in the form of heat. If this heat is not removed in a timely manner, the temperature of electrodes will keep rising to over 100 °C or even higher, which causes substantial thermal decomposition of ozone and consequently reduces ozone output.

For ozone generators, sufficient cooling water inside the ozone generation chamber achieves heat-exchange balance and carries away heat. The heat generated by the BaoLan ozone generator must be dissipated, which is accomplished by cooling water flowing over the outer wall of discharge tubes.

The internal-circuit cooling water flows along outer walls of discharge tubes and removes the generated heat, resulting in a temperature rise of the cooling water. The excess heat from the internal circulation is transferred to the external-circuit cooling water via a heat exchanger. The external circulation takes away heat from the internal circulation. Such cyclic process realizes temperature reduction for the ozone generator.



Environ. trouble? Baolan trustable!

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