

# Low Temperature Flue Gas Treatment Technology and Product Application Manual

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**2026**



# 01

## Corporate Introduction



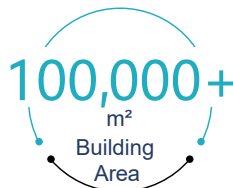
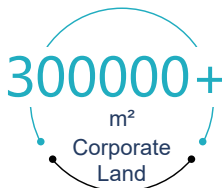
Tonexus listed on the Shenzhen Stock Exchange Main Board (003027), upholds the corporate philosophy of “Co-Creating a Net-Zero Industrial Future”. The company is committed to becoming a globally recognized strategic partner in pollution, carbon reduction and industrial net-zero, contributing Tonexus’s expertise to the world’s green transition.

### Core Business Areas

Flue Gas Treatment (EPC & Catalysts), CCUS,R&D and Production of New Energy Materials and Equipment, etc.

### Key Service Sectors

Steel, Power Generation, Coking, Construction Materials, Chemical Industry, Non-Ferrous Metals, Waste Incineration, Pulp & Paper, Renewable Energy, etc.



# 02 Challenges and Opportunities for Flue Gas Treatment

## 2.1 Increasingly Tightening Smoke and Gas Treatment Policies

Southeast Asia	Key Policy Indicators	Magnitude of Change	Execution Node	Potential Economic Impact
Indonesia	NOx limit ≤ 200mg/Nm <sup>3</sup> [New regulation]	Tightened by 40% from the old standard (350 → 200)	2023 Mandatory	Excess emissions penalty \$45/ton
Thailand	NOx limit ≤ 150mg/Nm <sup>3</sup> [New standard for power plants]	25% reduction from current level (200→150)	2025 Mandatory	Stopping work to rectify the situation + Annual fines exceeding \$1,000,000
Vietnam	SO <sub>2</sub> emission concentration ≤ 500mg/Nm <sup>3</sup>	Setting a hard cap for the first time	Pilot implementation in 2024	Emission rights freeze + Export quota reduction

Middle East	Key Policy Indicators	Magnitude of Change	Execution Node	Potential Economic Impact
Saudi Arabia	SO <sub>2</sub> ≤100 mg/Nm <sup>3</sup> [Calcined Coke Desulfurization Standard] Dust ≤10 mg/Nm <sup>3</sup>	Mandatory numerical limits for the first binding tender	Continues to this day	Suspension + Criminal penalties
Istanbul	Mandatory MRV for the CBAM industry	Domestic ETS hedges against EU carbon tariffs	Effective July 2025	Administrative fines + Criminal prosecution

European	Key Policy Indicators	Magnitude of Change	Execution Node	Potential Economic Impact
EU	SCR technology mandatory [Cement industry]	NOx≤200 mg/Nm <sup>3</sup> (Secondary fuel)	Retrofit completed by 2025	15% penalty on annual costs + Quota credit
EU	NOx ≤300 mg/Nm <sup>3</sup> SO <sub>2</sub> ≤500 mg/Nm <sup>3</sup> Medium-sized Combustion Facilities Directive	Filling the regulatory gap for medium-sized equipment	2025 (>5MW equipment)	Customized by Member States (Example: Germany 100,000 euros/year)

### The Nature of Trends:

- 3 Yearly cycle iteration: ASEAN countries' standards are tightened on average every 3 years, with a second wave of upgrades in 2025-2027 (e.g., Thailand's SO<sub>2</sub> is proposed to be reduced to 100mg/Nm<sup>3</sup> in 2027, with a further 50% reduction).
- Rigidization of penalties: moving from "warnings to rectify" to economic sanctions + production restrictions (forced shutdown of Morowali Industrial Park in Indonesia due to EIA violations).

## 2.2 Challenges to Flue Gas Treatment in Various Industries

### High-sulfur fuels run amok:

- A coal-fired power plant has a sulfur content of 8,000-12,000 ppm (72% of the total), and conventional catalysts fail with poisoning in 3-6 months.
- The flue gas from a palm oil mill contained potassium and sodium alkali metals, resulting in a catalyst pore plugging rate that exceeded the industry average by 300%.

### Extreme fluctuations in working conditions:

- A steel mill started and stopped 2.3 times per day due to power shortage, with 50% of the operating temperature <200°C, and the denitrification efficiency of the traditional catalyst plummeted to <40%.
- Load fluctuations in a coal-fired power plant resulted in flue gas temperature variations of ±80°C/day, increasing the risk of system instability by 45%.

\*The above data is calculated based on the cases served by Tonexus

## 2.3 Invisible Losses are Eating into Profits

Problems with Flue Gas Control	Data to Quantify Impact	Lost Profits
Sulfur poisoning losses	Annual catalyst replacement frequency increased twofold	Resulting in an increase in paper mill costs of approximately \$520,000/year.
Downtime losses	Temperature zone mismatch leads to 120-180 hours of annual downtime	Resulting in a loss of approximately \$2.8 million/year to the steel mill.
Energy wastage	Energy consumption for maintaining the heating system temperature is 35% of the total denitrification cost	Resulting in additional power consumption of the power plant of about \$380,000/year

\*The above data is calculated based on the cases served by Tonexus

## 2.4 Opportunities Presented by Tonexus Wide-temperature SCR Catalysts

**"Wide-temperature, sulfur-resistant SCR technology as the spear and full life-cycle engineering as the shield to help global industry leapfrog the dual challenges of environmental compliance and cost control"**

- **Technology tip of the spear:** 150-400°C full temperature domain denitrification + 100mg/Nm<sup>3</sup> sulfur resistance sulfur immunity → Cracking working condition fluctuation and high sulfur poisoning;
- **Engineering Shield Guard:** Industry Customized Design-Construction-Operation and Maintenance → Project delivery delays reduced to <5%;
- **Value Promise:** Through catalyst life extension + Energy consumption reduction → Customer total operating cost compression ≥35%.



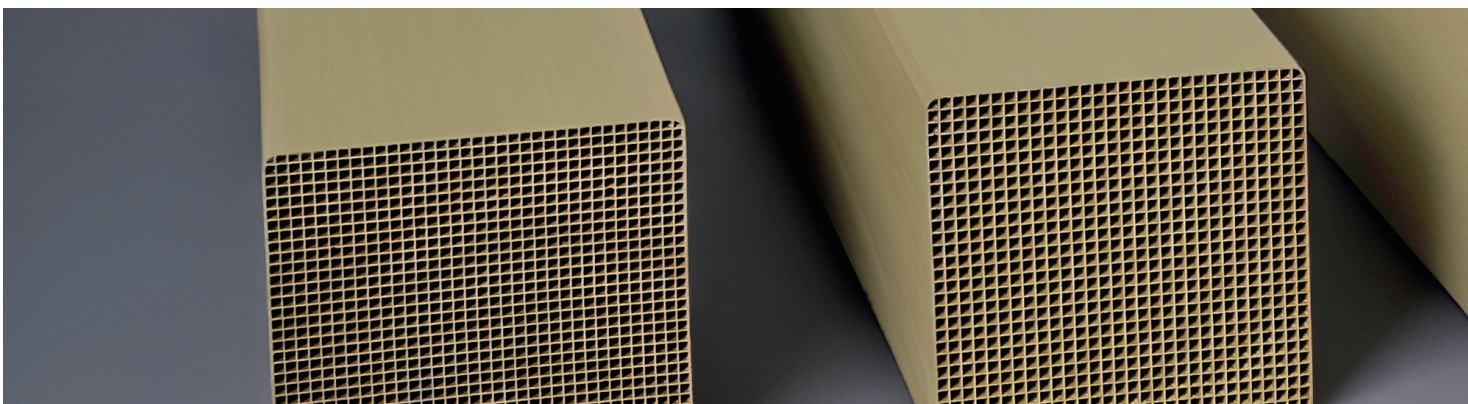
# 03 Disruptive Solutions for Wide-temperature SCR Catalysts

## 3.1 Three Technological Revolutions: Solving the Flue Gas Treatment Dilemma

Aiming at the three core challenges of high sulfur, fluctuating working conditions, and energy consumption and cost, Tonexus Technology has realized three subversive breakthroughs through material science and reaction engineering innovation:

<p style="text-align: center;">— Wide temperature revolution —</p> <p>Active component gradient doping and composite carrier design, breaking through the traditional catalyst 220-380 °C temperature zone limitations, to achieve 150-400 °C full temperature range of high-efficiency denitrification, a complete solution to the iron and steel, coking, garbage incineration, paper and other industries of low-temperature flue gas denitrification of energy-consuming governance problems.</p>	<p style="text-align: center;">— Anti-sulfur revolution —</p> <p>Honeycomb pore sulfur-phobic coating + Active site anti-poisoning modification, maintains denitrification rate &gt;90% in 100mg/Nm<sup>3</sup> sulfur-containing flue gas, and extends the catalyst life to more than 4 years, putting an end to the frequent replacement dilemma caused by sulfur poisoning.</p>	<p style="text-align: center;">— Energy-saving revolution —</p> <p>Microporous diffusion enhancement technology to reduce the reaction activation energy, the system energy consumption decreased by 30-60%, 200,000 Nm<sup>3</sup>/h flue gas volume of paper mills, for example, the annual savings of \$ 480,000 in electricity costs, ROI &lt; 2 years 36.</p>
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Breakthrough Dimension	Technological Realization	Customer Value
Highly efficient denitrification over a wide temperature range	Gradient active layer design: <ul style="list-style-type: none"> <li>• Ultra-low temperature layer (150-160°C)</li> <li>• Ultra-low temperature layer (150-160°C)</li> </ul>	Adaptation to start-stop working conditions: steel mills average 2.3 times a day without efficiency degradation. No heating system: eliminating gas preheating device (15% of investment).
High-sulfur immunization barriers	Dual protection mechanisms: <ul style="list-style-type: none"> <li>• Dual protection mechanisms</li> <li>• Antiviral vector</li> </ul>	High-sulfur fuel compatibility: 12,000ppm sulfur coal directly applicable. Lifespan doubled: replacement cycle from 8 months to 4 years.
Energy Saving Economic Engine	Microporous diffusion enhancement: <ul style="list-style-type: none"> <li>• Reduction of air resistance by directional penetration pores (20-50 nm pore size)</li> <li>• Microporous diffusion enhancement</li> </ul>	Sharp reduction in energy consumption: 40% reduction in wind turbine power. Carbon cost optimization: 1.2 tons of carbon allowance consumption per 10,000 tons of flue gas emission reduction



### 3.2 Hardcore Parameters and Scene Adaptation: Accurately Matching Industry Needs

Based on performance parameters exceeding international standards, Tonexus catalysts are customized to meet the pain points of the iron and steel, coking, paper, gas power generation, waste incineration and other industries:

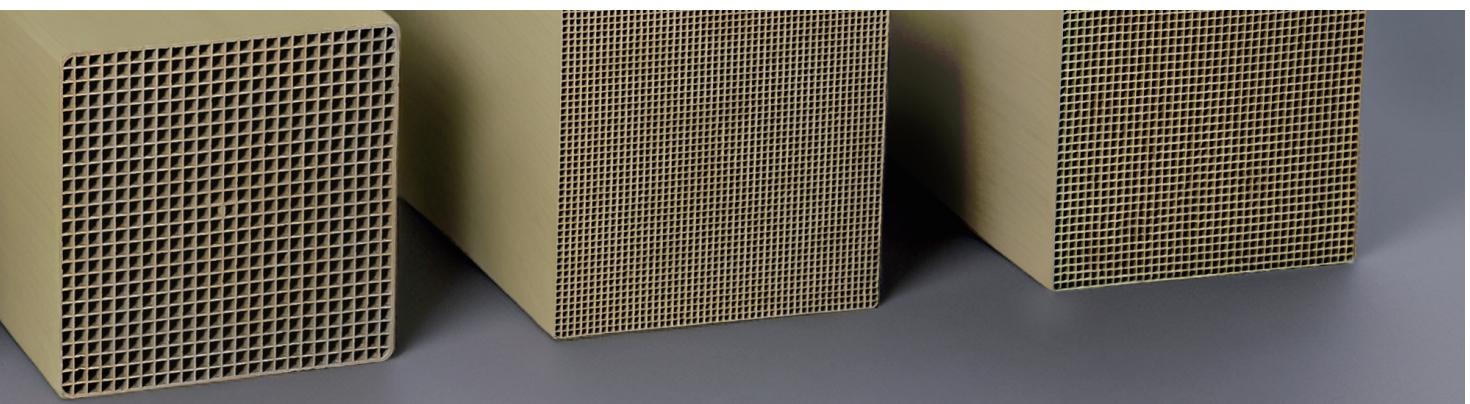
- **Parameters hardcore:** compressive strength  $\geq 2.5\text{MPa}$  (exceeding ISO standard by 39%),  $\text{SO}_2$  conversion rate  $< 0.5\%$  (industry average 1.2%), guaranteeing structural stability and by-product control under high dust impact;
- **Scenario deep plowing:** Customized ultra-low temperature module (150-160°C corrosion-resistant alloy support) for the steel industry.

Norm	Tonexus Parameters	International Standard	Competitor's Average	Transcendence
Activity Temperature Window	150-400°C can be customized	220-380 C	200-350 C	Low temperature extension 50°C
Compressive Strength	$\geq 2.5\text{MPa}$	1.8MPa	2.0MPa	+39%
$\text{SO}_2$ Conversion Rate	$< 0.5\%$	$\leq 1.5\%$	1.2%	Inhibition of sulfate generation
Pore Density	35 hole/cm <sup>2</sup>	25 hole/cm <sup>2</sup>	30 hole/cm <sup>2</sup>	Diffusion efficiency +40%

—Core performance against international standards

Sector	Focus on Pain Points	Tonexus Solutions	Quantitative Value
Steel	Flue gas with dust $> 50\text{g}/\text{Nm}^3$ , start/stop temperature drop	Ultra-low temperature module + Cyclone dust pre-filtration	Dust removal rate 99.2% + low-temperature denitrification rate of 91%
Coal-fired power station	High load fluctuation ( $\pm 80^\circ\text{C}/\text{day}$ ), high sulfur coal popularity	Wide temperature medium-high dust type + Intelligent ammonia spray dynamic control	Adaptable to load changes, sulfur tolerance of 12,000ppm
Pulp	Alkali metal (K/Na) enriched, high humidity ( $> 20\%$ )	Anti-toxic coating + Hydrophobic honeycomb	Indonesia project test: no failure at 25% humidity
Cement	High dust at kiln end ( $> 80\text{g}/\text{Nm}^3$ ), co-disposal of solid waste	High temperature and low dust solution + Self-cleaning orifice design	Eliminates clogging, catalyst life of 5 years +
Ship	Heavy oil with 3.5% sulfur, space constraints	Compact HP-SCR + Anti-sulfur catalysts	IMO Tier III compliance, installation cycle $< 72\text{h}$

—Industry pain points and customized solutions



### 3.3 Economic Value Under Real Cases

**Project:** Renovation of flue gas denitrification EMC for 360m<sup>2</sup> sinter at Jiangsu Shagang Iron & Steel Co.

SCR denitrification unit flue gas operating conditions

**Smoke volume:** 2×69wNm<sup>3</sup>/h

**Denitrification inlet:** NO<sub>x</sub>≤400 mg/Nm<sup>3</sup>

SO<sub>2</sub>≤35mg/Nm<sup>3</sup>

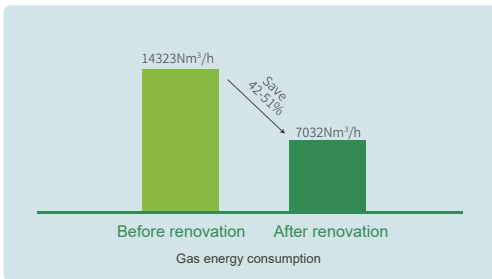
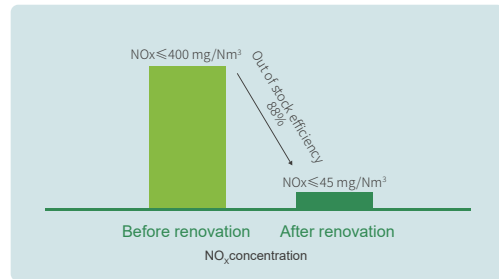
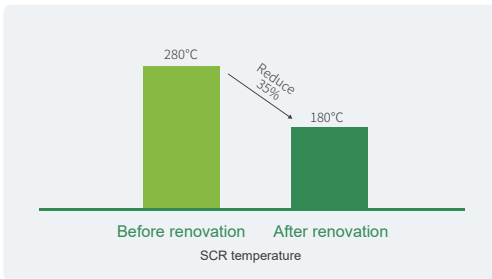
Dust≤10mg/Nm<sup>3</sup>

**Operating temperature:** 180-200°C

**Chimney outlet:** NO<sub>x</sub>≤45mg/Nm<sup>3</sup>

**Process route:** SDA semi-dry desulphurization + bag filter + GGH heat exchanger + hot blast furnace heating + SCR denitrification + booster fan + chimney

**Retrofitting time:** 2023.9



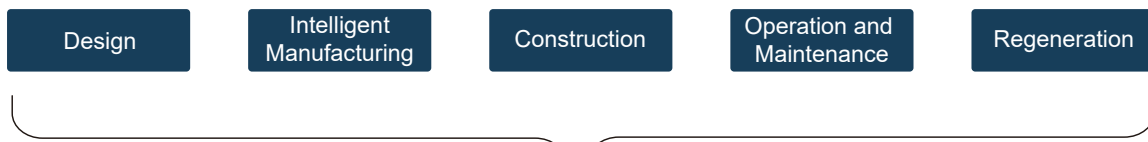
The SCR temperature is 280°C before renovation, 180°C after renovation. Stack NO<sub>x</sub>≤45mg/Nm<sup>3</sup>, gas from 14,323 to 7032Nm<sup>3</sup>/h, saving gas energy consumption about: 42-51%.



# 04 Whole Process Flue Gas Treatment Engineering Ecology

## 4.1 Engineering Services Value Chain: Full Life Cycle Services from Design to Commissioning to After-sales Services

"Tonexus is more than a catalyst supplier - we are a lifelong partner for your flue gas treatment system."



A fifth-order service system to ensure that technological advantages are translated into quantifiable emission reductions

Service Module	Core Competencies and Tools	Customer Value	Commitment to Timeliness
Design Consulting	Proprietary customized solutions: <ul style="list-style-type: none"> <li>• 3D modeling design solutions</li> <li>• Site survey customization</li> </ul>	Programmatic one-time pass rate >95%	≤ 15 days to program
Core Intelligence	Self-developed and self-produced high-precision equipment: <ul style="list-style-type: none"> <li>• Titanium ammonia-sprayed grating (error &lt;3%)</li> <li>• Sulfur-resistant GGH heat exchanger</li> </ul>	15-20% increase in catalyst efficiency	80% prefabrication rate
Engineering and Construction	Highly experienced construction team: <ul style="list-style-type: none"> <li>• 800+ projects experience</li> <li>• Covering 20+ industries</li> </ul>	100% adaptability to customer solutions Engineering Quality Assurance	Delay rate <5% Delivery pass rate 100%
Operations & Maintenance	Tonexus Cloud Monitoring Platform: <ul style="list-style-type: none"> <li>• AI Warning Catalyst Failure</li> <li>• Remote adjustment of ammonia injection</li> </ul>	60% reduction in failure rate (Annual O&M cost reduced by \$120,000+)	7×24h response
Recycling Industry	Ultrasonic activation + active component recoating	Extended life up to 6 years (Cost only 35% of new agent)	Regeneration cycle ≤ 20 days

## 4.2 Industry Customized Solutions: Pain Point Precision Blast Meter

Sector	Core Pain Points	Tonexus Customized Technical Solutions	Quantitative Benefits and Cases
Pulp	<ul style="list-style-type: none"> <li>Alkali metal (Na ion) poisoning</li> <li>Flue gas humidity &gt; 25%</li> <li>Low flue gas temperature, typically 160-230°C</li> <li>Dust is mainly sodium salt, water-absorbing and easy to slate, ultra-fine powder ash removal is difficult.</li> <li>Chemical recovery boilers, unlike conventional boilers, require periodic downtime for maintenance and flushing of the furnace tube chamber</li> </ul>	<p><b>Special catalyst for SCR of paper alkali furnace:</b> strong resistance to sodium ion poisoning, strong hydrophobicity, high low-temperature activity, strong sulfur resistance</p> <p><b>Denitrification reactor innovation:</b> R &amp; D use of catalyst protection devices, multi-bin design to achieve non-stop maintenance, compressed gas source heating pre-treatment, etc., electric dedusting directly grafted to the SCR, without the need for additional bags of dust;</p>	<ul style="list-style-type: none"> <li>Operating cost savings of 20%-40% compared to other denitrification processes</li> <li>Denitrification efficiency of up to 95% to meet more stringent emission targets</li> <li>Small footprint, about 20% less footprint than other conventional processes</li> <li>Moderate investment, saving 15%-30% compared to other conventional processes (chlorine dioxide)</li> </ul> <p><b>Case:</b> Singapore Golden Eagle Group Asia Symbol(Shandong) Pulp and Paper 1500TDS/D Alkali Recovery Boiler SCR denitrification, 3500TDS/D Alkali Recovery Boiler SCR denitrification, 7500TDS/D Alkali Recovery Boiler denitrification.</p>
Steel	<ul style="list-style-type: none"> <li>Sudden drop in flue gas temperature (from start/stop to 150 C )</li> <li>Dust&gt;50g/Nm<sup>3</sup></li> <li>High-sulfur corrosion (H<sub>2</sub>S &gt;200ppm)</li> <li>Coexistence of multiple pollutants with high alkali metal content</li> </ul>	<ul style="list-style-type: none"> <li>Special low-temperature catalyst for sintering flue gas, which can stably operate at 180~220 C ;</li> <li>The design of GGH circulating air and MGGH system reduces the risk of system corrosion;</li> <li>The material selection is more customized according to the characteristics of flue gas, providing better corrosion resistance;</li> </ul>	<ul style="list-style-type: none"> <li>Adopting the design concept of "medium-temperature design, low-temperature operation", which saves 30%~50% of gas;</li> <li>The denitrification efficiency is as high as 95%, which can meet more stringent emission standards and synergistically reduce the emission of dioxins.</li> </ul> <p><b>Case:</b> BOT project for flue gas desulfurization and denitrification of the 566m<sup>2</sup> sintering machine in the Ironmaking General Plant of Benxi Iron and Steel Plate Co., Ltd.</p>
Coal-fired Power Station	<ul style="list-style-type: none"> <li>Temperature variation of ±80 C per day caused by load fluctuation</li> <li>High-sulfur coal (~12,000ppm)</li> <li>Ammonia slip exceeding the standard</li> </ul>	<ul style="list-style-type: none"> <li><b>Wide temperature range catalyst:</b> adaptive at 150-400 C</li> <li><b>Dynamic ammonia injection control system:</b> real-time adjustment based on CEMS data</li> <li><b>Simulated ash cleaning technology:</b> solving the problem of catalyst blockage</li> </ul>	<p>The denitrification efficiency is as high as 95%, which can meet more stringent emission standards.</p>

# 05 Asia Symbol Benchmarking Project Decoding

## The world's first low-temperature SCR project for alkali recovery boiler Cracking the three world problems of high humidity, high alkali and low temperature

**Project background:** Asia Symbol (Shandong) Pulp and Paper Co., Ltd - China's largest producer of commercial wood pulp, with an annual production capacity of 2 million tons, the flue gas from its alkali recovery boiler exists in the form of low temperature, high humidity, high alkali metal content, and other persistent problems of governance.

### 5.1 Project Challenge: The "Impossible Triangle" of Paper Alkali Recovery Boiler Management

Challenge Dimension	Specific Pain Points	Limitations of Traditional Programs in the Industry
Flue Gas Characterization	<ul style="list-style-type: none"> <li>• Large temperature fluctuations (160-230°C)</li> <li>• Humidity &gt; 25%</li> <li>• Alkali metal (K/Na) concentration 5 times above normal</li> </ul>	Catalyst orifice clogging rate of 80% in 3 months
Environmental Compliance	<ul style="list-style-type: none"> <li>• Indonesian JV requires NOx ≤ 50mg/Nm<sup>3</sup> (stricter than national standard)</li> <li>• Frequent complaints about visual pollution from smoke plumes</li> </ul>	Ammonia escape > 8ppm (visual white smoke)
Running cost	<ul style="list-style-type: none"> <li>• Conventional catalysts are replaced twice a year at a cost of \$420,000 per replacement.</li> <li>• Annual energy consumption of steam heating system \$380,000</li> </ul>	Denitrification cost 12% of total production cost

**Technical dilemma:** No successful cases in the world in 2021 - European and American enterprises have failed many tests due to "low temperature inactivation + alkali metal poisoning".

### 5.2 Innovative Solutions

- Innovative application of special low-temperature denitrification catalyst for alkali recovery boiler for the characteristics of papermaking recovery boiler alkali flue gas, with high low-temperature activity, strong sulfur resistance, hydrophobicity, and most importantly, good resistance to alkali metal poisoning;
- Single-bin denitrification technology for no downtime for maintenance and catalyst replacement;
- On-line thermal resolution technology realizes catalyst activation and on-line thermal resolution to guarantee catalyst activity;
- Catalyst protection technology to further reduce the effect of sodium salt on the catalyst and extend catalyst life;
- Denitrification reactor improvement, key parts of the material upgrade, ammonia injection system and soot blowing system improvement

### 5.3 Project results: Environmental and Economic Breakthroughs

Norm	Measured Value of Tonexus Program	Design Goal	Traditional Programme Average
NOx emission concentration	38mg/Nm <sup>3</sup>	≤50mg/Nm <sup>3</sup>	120mg/Nm <sup>3</sup>
Ammonia Escape	1.8ppm	≤2.5ppm	8.5ppm
Catalyst life	4 years + (26 months of operation)	3 years	8 months
System energy consumption	0.9kWh/Nm <sup>3</sup>	≤1.2kWh/Nm <sup>3</sup>	2.1kWh/Nm <sup>3</sup>
Plume Removal Rate	100% (visual transparency)	50% reduction	No improvement

#### Total Economic Gain

##### Direct cost savings:

- Catalyst replacement cost ↓\$1.26M/4 years (3 fewer replacements).
- Energy costs ↓\$1.52M/4 years (Steam heating savings + Electricity savings).

##### Implicit Risk Avoidance:

- Waiver of \$5.8 million/year order default penalty for Indonesian JV (NOx compliance guarantees export qualification)
- Chimney Visual Pollution Complaints Reduced to 0 (Community Relationship Repair).

### 5.4 Customer Testimonials: From Advanced Technology to Global Expansion

Asia symbol Voice of the Customer



Tonexus low-temperature SCR program makes us realize environmental protection is not a cost, but competitiveness. After the project is put into operation, NOx emission 50mg/Nm<sup>3</sup>, below; comprehensive operating costs than the original sulfur dioxide reduced by 50%, realizing the low-cost environmental protection operation, reduce the enterprise environmental protection operation costs, improve the economic efficiency of enterprises; Our 1500TDS/D alkali recovery boiler SCR denitrification, 3500TDS/D alkali recovery boiler SCR denitrification, and 7500TDS/D alkali recovery boiler SCR denitrification projects have been successfully put into operation one after another, and the operation has been stable and exceeded expectations.



China Environmental Protection Industry Association appraisal conclusion

To solve the alkali recovery boiler low-temperature, high humidity, high alkali metal pain points, the results of the appraisal concluded that: "the technology reaches the international leading level, to fill the gaps in the country."

SGS Emission Reduction Verification Report



Annual carbon reduction of 6,200 tons (Energy saving + Fewer catalyst changes), equivalent to planting 340,000 trees.



# 06 A Four-dimensional Collaborative System of Flexible Cooperation

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## 6.1 Long-term Strategic Supply of Catalysts

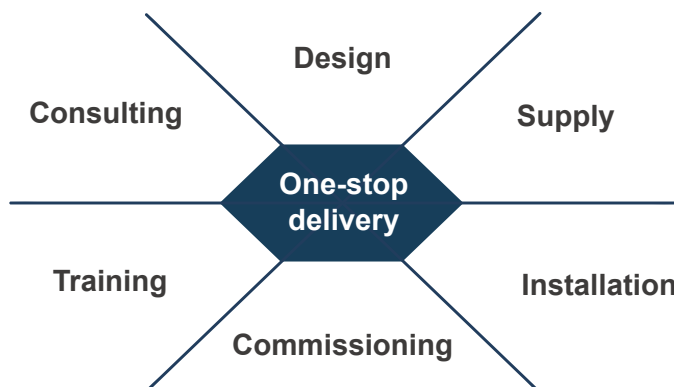


## 6.2 Regional Agency Cooperation Program



## 6.3 EPC Turnkey Projects

Turnkey project, from consulting, design, supply, installation, commissioning, training package solutions



## 6.4 Direct supply of Modular Equipment

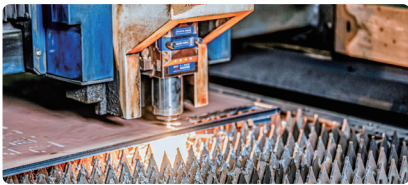
Plug and play flue gas treatment equipment

# 07 Global leading production system

## 7.1 Tonexus Equipment Manufacturing Production Bases

**35000m<sup>2</sup> +**

Digital, Intelligent and Fully automated production base



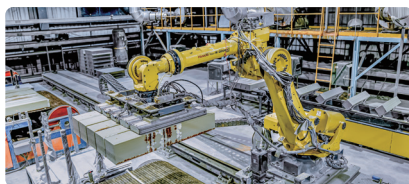
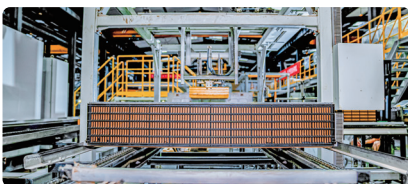
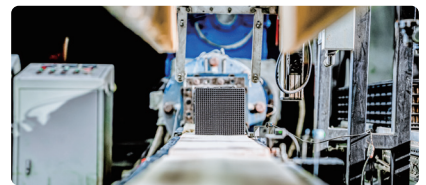
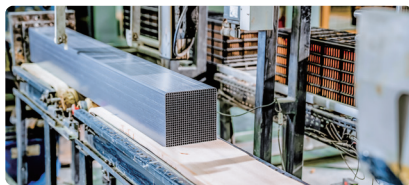
**20000t +**

Annual production capacity of environmental protection equipment

## 7.2 Tonexus Materials Production Bases

**18000m<sup>3</sup> +**

Annual production capacity of honeycomb low-temperature SCR catalysts



**4000m<sup>3</sup> +**

Annual production capacity of coated catalysts

# Selected Project Portfolio

Over 400 Coking Industry Projects							
No.	Company	Project Name	Furnace Type	Process	Flue Gas Volume (Nm <sup>3</sup> /h)	Denitrification Temperature (°C)	Commissioning Date
1	Baosteel Zhanjiang Steel Co.	Coke Oven Flue Gas Purification Facility EP Project Phase I of the Integrated Dust Removal and Denitrification Unit	2'65-hole 7m top-charged coke oven	Integrated SDA Desulfurization + Dust Removal and Low-Temperature SCR Denitrification	600000	180-200	2015.11
2	Baosteel Zhanjiang Steel Co.	Phase II of the Integrated Dust Removal and Denitrification Unit for Coke Oven Flue Gas Purification Facility EP Project	2'65-hole 7m top-charged coke oven	Integrated SDA Desulfurization + Dust Removal and Low-Temperature SCR Denitrification	600000	180-200	2016.07
3	Hebei Feng Coal Coking Co., Ltd.	Phase I and II Coke Oven Flue Gas Desulfurization, Denitrification, and Dust Removal	4'42-hole 7m top-charged coke oven	Integrated SDA Desulfurization + Dust Removal and Low-Temperature SCR Denitrification	440000	200-260	2017.01
4	Shanxi Coking Co., Ltd.	#6 Coke Oven Flue Gas Desulfurization, Denitrification, and Waste Heat Recovery Project	2'65-hole 6m top-charged coke oven	Integrated SDA Desulfurization + Dust Removal and Low-Temperature SCR Denitrification	120000	210-270	2017.09
5	Handan Steel Group Co., Ltd.	Low-Temperature Desulfurization and Denitrification Project for Coke Oven Flue Gas from Coke Ovens No. 5 and No. 6	2'45-hole 6m top-charged coke oven	Integrated SDA Desulfurization + Dust Removal and Low-Temperature SCR Denitrification	450000	180-210	2017.09
6	Shanxi Meijin Huasheng Chemical New Materials Co., Ltd.	EPC Turnkey Contracting for Flue Gas Desulfurization, Dust Removal, and Denitrification Projects of Coke Ovens No. 1, No. 2, No. 3, and No. 4	4'70-hole 7.65m top-charged coke oven	SDS Desulfurization + Baghouse Dust Removal + Low-Temperature SCR Denitrification	580000	180-200	2021.06
7	Liuzhou Steel Co., Ltd.	Coke Oven Flue Gas Desulfurization and Denitrification Project (No. 2 Coke Oven) Project (EPC) Turnkey Contracting	2'60-hole 6m top-charged coke oven	SDS Desulfurization + Baghouse Dust Removal + Low-Temperature SCR Denitrification	380000	180-240	2021.09
8	Chongqing Steel Co., Ltd.	Design, Procurement, and Construction General Contracting for the New Coke Oven Flue Gas Desulfurization and Denitrification System (Lot 1)	2'60-hole 6m top-charged coke oven	Waste Heat Recovery + SDA (Calcium-Based) Semi-Dry Desulfurization + GGH Heat Exchange + SCR Denitrification	480000	180-230	2022.01
9	Bengang Steel Plate Co., Ltd.	5-Blast-Furnace Group Coke Oven Flue Gas Desulfurization and Denitrification Project	1'90-hole 6.0m top-charged coke oven	Dual-System Desulfurization (Calcium-Based & Sodium-Based Dry Process)+Baghouse Dust Removal+Low-Temperature SCR Denitrification	200000	170-220	2023.10
10	ACRE Coking & Refractory Engineering Consulting Corporation. MCC. (Dalian)	Turnkey Project for Large-Scale Retrofit of Coke Ovens in North Plant Zones 2 and 3	2'55-hole 7m top-charged coke oven	Calcium-Based Desulfurization + Integrated Dust Removal and Denitrification	458000	≤180-220	2023.11

Over 100 Steel Industry Collaboration Projects							
No.	Company	Project Name	Furnace Type	Process	Flue Gas Volume (Nm <sup>3</sup> /h)	Denitrification Temperature (°C)	Commissioning Date
1	Tangshan Reafon Iron & Steel (Group) Co., Ltd.	Northern Ironmaking Plant Sintering Denitrification Projects for Units 1, 2, and 3	3×200 m <sup>2</sup> sintering machine	CFB desulfurization + low-temperature SCR denitrification	960000	180-200	2019.04
2	Tangshan Reafon Iron & Steel (Group) Co., Ltd.	New Northern District 384 m <sup>2</sup> Sintering Denitrification Project	384m <sup>2</sup> sintering machine	SDA desulfurization + low-temperature SCR denitrification	1940000	180-220	2021.07
3	Tangshan Reafon Iron & Steel (Group) Co., Ltd.	320 m <sup>2</sup> Sintering Denitrification Project	320m <sup>2</sup> sintering machine	CFB desulfurization + low-temperature SCR denitrification	1590000	180	2023.05
4	Tangshan Reafon Iron & Steel (Group) Co., Ltd.	Sintering Machine Energy-Saving & Environmental Upgrade (Phase II) Denitrification Project	252m <sup>2</sup> sintering machine	Low-Temperature SCR DeNOx	785000-800000	180	Under Construction
5	Rizhao Steel Co., Ltd.	Sintering Machine #12 & #13 (2×360 m <sup>2</sup> ) Gas Outlet Denitrification and Flue Gas Whitening Project	2'360m <sup>2</sup> sintering machine	Wet FGD + Low-temperature SCR denitrification	2'1480000	220	2019.12
6	Rizhao Steel Holding Group Co., Ltd.	Sintering #8 & #9 (2×210 m <sup>2</sup> )	2'210m <sup>2</sup> sintering machine	Wet FGD + Low-temperature SCR denitrification	1425000	220	2020.04
7	Rizhao Steel Holding Group Co., Ltd.	Sintering #15, 600 m <sup>2</sup> – DeNOx Project	600m <sup>2</sup> sintering machine	Electrostatic precipitator at machine hood + activated coke adsorption + hot-air furnace + low-temperature SCR denitrification	1144000	220	2019.12
8	Rizhao Steel Holding Group Co., Ltd.	Sintering #10/11, 2×180 m <sup>2</sup> – DeNOx Project	2'180m <sup>2</sup> sintering machine	Ammonia-based desulfurization + GGH + hot-air furnace + low-temperature SCR denitrification	1480000	220	2020.03
9	Rizhao Steel Holding Group Co., Ltd.	Sintering Machine #16/17, 2×180 m <sup>2</sup> – DeNOx Project	2'180m <sup>2</sup> sintering machine	Limestone-gypsum desulfurization + GGH + hot-air furnace + low-temperature SCR denitrification	1480000	220	2020.01
10	Shanxi Taigang Stainless Steel Co., Ltd.	Sintering Machine, 660 m <sup>2</sup> – DeNOx Project	660m <sup>2</sup> sintering machine	Electrostatic precipitator at sinter machine hood + activated carbon desulfurization and denitrification + hot-air furnace + low-temperature SCR denitrification	2'1056000	220	2021.01
11	Shandong Tanshan Steel Group Co., Ltd.	Sintering Machine, 180 m <sup>2</sup> – DeNOx Project	180m <sup>2</sup> sintering machine	SDA semi-dry desulfurization + baghouse dust removal + GGH + hot-air furnace + low-temperature SCR denitrification	682707	200-220	2022.06
12	Bengang Steel Group North Plant Ironmaking Division	Sintering Machine, 400 m <sup>2</sup> – DeNOx Project	400m <sup>2</sup> sintering machine	Main induced draft fan + MGGH + wet desulfurization + wet electrostatic precipitator + CCS + demister + MGGH + GGH + built-in hot-air furnace + SCR	1370000	220	2023.03
13	Benxi Iron and Steel (Group) Co., Ltd.	Bengang Sheet Ironmaking Plant – 566 m <sup>2</sup> Sintering Machine Flue Gas DeSO <sub>x</sub> & DeNO <sub>x</sub> Ultra-Low Emission Retrofit (BOT) Project	566m <sup>2</sup> sintering machine	Efficiency upgrade of wet limestone-gypsum desulfurization + new wet electrostatic precipitator + SCR denitrification	2500000	180-220	2023.10
14	Jiangsu Shagang Steel Co., Ltd.	Supply of high-temperature-to-low-temperature catalyst + Retrofit + Energy-saving Assessment	360m <sup>2</sup> sintering machine	Electrostatic precipitator at sintering machine hood + SDA + baghouse + GGH heat exchange + hot air furnace heating + low-temperature SCR denitrification + induced draft fan + stack	2'690968	≥180	2023.10

# Flue Gas Treatment Technology and Product Application Manual

## er 10 Cooperative Projects in The Non-Ferrous Smelting Industry

No.	Company	Project Name	Furnace Type	Process	Flue Gas Volume (Nm <sup>3</sup> /h)	Denitrification Temperature (°C)	Commissioning Date
1	Almatis (Qingdao) Co., Ltd.	Alumina Sintering Furnace Denitrification Project	Alumina Sintering Kiln	Low- and mid-temperature SCR denitrification	25000	230-270	2019.02
2	Hubei Zhenhua Chemical Co., Ltd.	#1 & #2 Chromate Rotary Kiln Flue Gas Denitrification (EPC)	Chromate Rotary Kiln	Low-temperature SCR denitrification	200000	≥180	2019.03
3	CITIC Jinzhou Metal Co., Ltd.	#12 Kiln Flue Gas Treatment Project	Chromate Rotary Kiln	Baghouse dust removal + Low-temperature SCR denitrification	100000	180-200	2021.01
4	Chinalco Shanxi New Material Co., Ltd.	First Alumina Plant – Clinker Kiln Flue Gas Denitrification Environmental Project	Clinker Rotary Kiln	Dust collector reuse + new SCR denitrification + hot air furnace + induced draft fan + chimney emission	360000	170	2022.12
5	Hebei Jicheng New Materials Co., Ltd.	10,000-ton Lithium Battery Flue Gas Denitrification Project	10,000-ton Lithium Battery	CFB semi-dry desulfurization + baghouse dust removal + GGH + low-temperature SCR denitrification	77680	200	2021.10

## Over 10 Collaborative Projects in The Paper Industry

No.	Company	Project Name	Furnace Type	Process	Flue Gas Volume (Nm <sup>3</sup> /h)	Denitrification Temperature (°C)	Commissioning Date
1	Asia Symbol (Shandong) Pulp & Paper Co., Ltd.	RBI SCR Denitrification	1,500 TDS/d Alkali Recovery Furnace	Electrostatic Precipitator (ESP) + Low-Temperature SCR Denitrification	300000	170-180	2021.06
2	Asia Symbol (Shandong) Pulp & Paper Co., Ltd.	RB1R Alkali Recovery Furnace Low-Temperature SCR Denitrification	3,500 TDS/d Alkali Recovery Furnace	ESP + SCR Denitrification + Flue Gas Whitening	660000	224	2023.06
3	Jiangsu Oji Paper Co., Ltd.	3,400 T Paper Alkali Recovery Furnace	3,400 TDS/d Alkali Recovery Furnace	Low-Temperature SCR Denitrification	838000	170-190	2024
4	Jiangsu Bohui Paper Co., Ltd.	800 T Paper Alkali Recovery Furnace	800 TDS/d Alkali Recovery Furnace	ESP + Low-Temperature SCR Denitrification	2*109950	180-240	2024
5	Nanning Sun Paper Co., Ltd.	450 t/d Lime Kiln SCR Denitrification Project	450 t/d Lime Kiln	Low-Temperature SCR Denitrification	75000	200-350	2023.08
6	Taisheng (Guizhou) Bamboo Resources Development Co., Ltd.	2,400 T Alkali Furnace Flue Gas SCR Denitrification Project	2,400 TDS/d Alkali Recovery Furnace	ESP + Low-Temperature SCR Denitrification	600000	≥ 180	2025
7	Guangxi Sun Paper Co., Ltd.	Lime Kiln Flue Gas Denitrification for Alkali Recovery Project	950 t/d Lime Kiln	Kiln Tail Gas + ESP + Induced Draft Fan + New SCR Denitrification + Gas Cooler + Stack	120000	200-300	2024
8	Sichuan Yongfeng Paper Industrial Co., Ltd.	800 tds/d Alkali Recovery Boiler Flue Gas Denitrification Project	800 TDS/d Alkali Recovery Furnace	Sodium-Based Dry Desulfurization + ESP + Low-Temperature SCR Denitrification + GGH Heat Exchange	220000	180-200	Under Construction
9	Asia Symbol (Shandong) Pulp & Paper Co., Ltd.	7,500 TDS/d RB2 Alkali Furnace Denitrification Retrofit Project	7,500 TDS/d Alkali Recovery Furnace	ESP + Low-Temperature SCR Denitrification	1404000	170-190	Under Construction
10	ChongQing Lee & Man Paper Mfg.Ltd.	#2 Alkali Furnace Ultra-Low Emission Retrofit Project	1,080 TDS/d Alkali Recovery Furnace	ESP + Dry Desulfurization + Low-Temperature SCR Denitrification	250000	170° C	Under Construction

## Over 40 Sets of Waste Incineration Industry Cooperative Projects

No.	Company	Project Name	Furnace Type	Process	Flue Gas Volume (Nm <sup>3</sup> /h)	Denitrification Temperature (°C)	Commissioning Date
1	Ningguo Chuangeng Biomass Energy Technology Co., Ltd.	Biomass boiler flue gas denitrification project	15 biomass boilers	Boiler flue gas + low-temperature SCR denitrification	75000	180-200	2021.12
2	Ningbo Mingzhou Environmental Energy Co., Ltd.	750t/d(3#) waste incineration project	750t/d(3#)	SNCR + lime slurry semi-dry + activated carbon + baghouse dust removal + SGH + low-temperature SCR denitrification + wet acid removal (NaOH + GGH (first domestic catalyst application in this industry))	179181	175-180	2017.09
3	Ningbo Mingzhou Environmental Energy Co., Ltd.	750t/d(1#) waste incineration project	750t/d(1#)	SNCR + lime slurry semi-dry + activated carbon + baghouse dust removal + SGH + low-temperature SCR denitrification + wet acid removal (NaOH + GGH (first domestic catalyst application in this industry))	179181	175-180	2018.11
4	Qingdao West Coast Kangheng Environmental Energy Co., Ltd.	750t/d waste incineration project	750t/d	SNCR + lime slurry semi-dry + dry acid removal + activated carbon + baghouse + flue gas recirculation + SGH + SCR + wet process	188250	175-180	2019.08
5	Chiping County Guohuan Renewable Energy Co., Ltd.	2*600t/d waste incineration project	2*600t/d	SNCR + waste gas absorption tower acid removal + activated carbon + baghouse + preheater + low-temperature SCR denitrification	2*136350	180	2020.01
6	Jiaxing Lvsenengyuan Co., Ltd.	3*650t/d waste incineration project	3*650t/d	SNCR + lime slurry semi-dry + dry process + activated carbon + baghouse + SGH + low-temperature SCR denitrification	3*158502	170	2020.12
7	Fuzhou Minhou Kangheng Energy Co., Ltd.	600t/d waste incineration project	600t/d	SNCR + lime slurry semi-dry + activated carbon + baghouse + wet acid removal + H <sub>2</sub> GCH + 2#GCH + SGH + low-temperature SCR denitrification	163716	175-180	2020.12
8	Taizhou Huangyan Kangheng Renewable Energy Co., Ltd.	2*750t/d waste incineration project	2*750t/d	SNCR + rotary spray semi-dry + dry powder injection + activated carbon + baghouse + GGH + wet process + GGH + SGH + low-temperature SCR denitrification	2*163000	175-180	2021.01
9	Xianghe Kangheng Renewable Energy Co., Ltd.	750t/d waste incineration project	750t/d	SNCR + rotary spray semi-dry + dry process (sodium bicarbonate) + activated carbon + baghouse + SGH + SCR	155295	175-180	2022.03
10	Shunping Kangheng Renewable Energy Co., Ltd.	2*500t/d waste incineration project	2*500t/d	SNCR + Rotary Atomizing Semi-dry Process + Dry Method + Activated Carbon + Bag Filter + GGH + SGH + Low-temperature SCR DeNO <sub>x</sub> + Wet Method	2*101683	180	2022.04
11	Liuzhou Kangheng New Energy Co., Ltd.	3*750t/d waste incineration project	3*750t/d	SNCR + rotary spray semi-dry + dry process + activated carbon + baghouse + GGH + SGH + low-temperature SCR denitrification	3*173778	230	Under Construction
12	Taizhou Municipal Solid Waste Incineration Power Plant (Phase II)	850t/d waste incineration project	850t/d	SNCR + PNCR + rotary spray semi-dry acid removal + dry acid removal + activated carbon injection + baghouse + SGH + SCR + baghouse dust removal + low-temperature SCR denitrification	211619	180	2023.03

**Over 90 Collaborative Projects in the Industrial Silicon Sector**

No.	Company	Project Name	Furnace Type	Process	Flue Gas Volume (Nm <sup>3</sup> /h)	Denitrification Temperature (°C)	Commissioning Date
1	Ningxia Jingtai New Energy Materials Co., Ltd.	10×33,000 kVA industrial silicon electric furnace Desulfurization and denitrification project	10*33,000 kVA Industrial Silicon Electric Furnace	Waste Heat Boiler + Dry Desulfurization + Baghouse + Fan + SCR Denitrification	10*230000	160-200	2023.07
2	Changji Jisheng New Building Materials Co., Ltd.	6×33,000 kVA industrial silicon electric furnace Desulfurization and denitrification project	6*33,000 kVA Industrial Silicon Electric Furnace	Moving Bed Dry Desulfurization + Low-Temperature SCR Denitrification	6*220000	150-180	2021.12
3	Inner Mongolia Xinyuan Silicon Materials Co., Ltd.	12×33,000 kVA industrial silicon electric furnace Desulfurization and denitrification project	12*33,000 kVA Industrial Silicon Electric Furnace	SDS Dry Desulfurization + Baghouse + Low-Temperature SCR Denitrification	12*265000	160-200	2022.11
4	Changji Jisheng New Building Materials Co., Ltd.	2×33,000 kVA industrial silicon electric furnace Desulfurization and denitrification project	2*33,000 kVA Industrial Silicon Electric Furnace	SDS Dry Desulfurization + Baghouse + Low-Temperature SCR Denitrification	2*220000	160-200	2023.10
5	Xinjiang CCL Silicon Technology Co., Ltd.	16×33,000 kVA industrial silicon electric furnace Desulfurization and denitrification project	16*33,000 kVA Industrial Silicon Electric Furnace	SDS Dry Desulfurization + Baghouse + Low-Temperature SCR Denitrification	16*265000	160-200	2023.08
6	Lanzhou Dongjin Silicon Industry Co., Ltd.	28×33,000 kVA industrial silicon electric furnace Desulfurization and denitrification project	28*33,000 kVA Industrial Silicon Electric Furnace	SDS Dry Desulfurization + Baghouse + Low-Temperature SCR Denitrification	28*230000	150-180	2023-2024





## 8.2 Technical Research and Development

Tonexus has three major R & D centers, more than 130 R & D team, equipped with more than 100 sets of high-end R & D test equipment, long-term investment in flue gas treatment, catalytic chemistry and other project research, has a wealth of R&D and innovation capabilities, has accumulated more than 80 authorized patents technology.

### A Invention Patent



### B Utility patent



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