Ammonia combustion for industrial fabrication of ceramic tiles in China

WEBINAR

Prof. Yi-Bing Cheng
Strategic Scientist
Foshan Xianhu Laboratory

Ms. Chuyun Zhang
Assistant to the President
Monalisa Group

AMMONIA ENERGY ASSOCIATION

Tuesday, April 22
4PM China Standard Time (3AM Eastern Daylight Time)

House rules

- Please post your questions for the speakers in the Q&A section. Your questions will be answered by text by the speakers or will be discussed live.
- The recording of this webinar will be shared with all registrants after the webinar, and will be available at www.ammoniaenergy.org
- An article summarizing this webinar will be posted on www.ammoniaenergy.org in the coming days.

Ammonia for heat

Options for ammonia to heat:

- **Ammonia burners in refineries**: Hydrotreating results in ammonia production, which is already used around the heat (Duiker Clean Technologies). Typically, the heat generated is used for boilers.
- **Glass manufacturing**: First demonstrated in Japan in 2023, a 200 kW demonstration in a 2 MW furnace (AGC)
- **Ceramics manufacturing**: First commercially applied by Monalisa Tiles in China, started in September 2024 and still commercially used
- **Copper refining**: Ammonia for heat and as a hydrogen source in the process. Demonstrations with 20% ammonia co-firing demonstrated by Aurubis in Germany, in 2022-2023.
- **Cement production**: Demonstrations for cement clinker production by Mitsubishi UBE in Japan, first steps already in 2018.

Ammonia can complement electrification:
- When insufficient zero-carbon electricity supply is available
- When zero-carbon electricity is relatively expensive (e.g., Japan)
- For start-up heating in (partially) electrified heating systems

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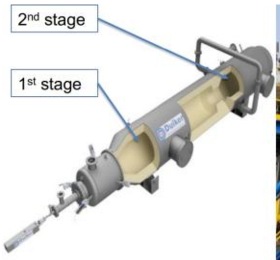
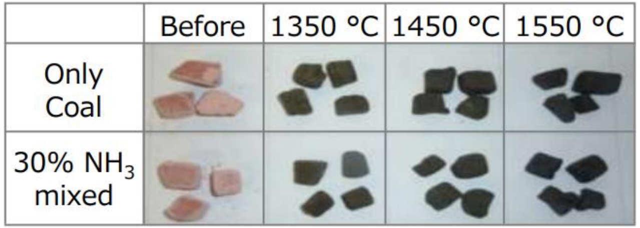


Natural gas 100% Ammonia 100%



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Ceramic tiles: Ammonia for heat

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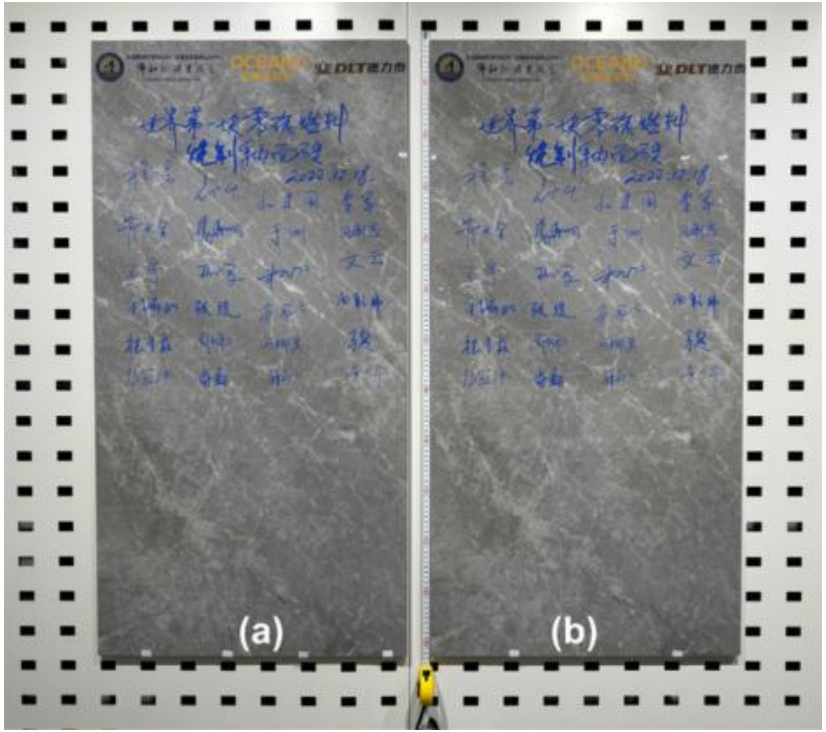
- In late 2023, Monalisa Group and Foshan Xianhu Laboratory announced an ammonia for heat project for ceramic tiles manufacturing in Nanhai District in Foshan City, China.
- Ammonia-hydrogen blends were first introduced in the firing process during ceramic tiles manufacturing in September 2024.
- Using ammonia as fuel rather than methane (natural gas) did not compromise the color and quality of the produced ceramic tiles.
- The two-stage burners using ammonia as fuel resulted in nitrogen oxides emissions of 79 ppmv, which were further mitigated to single-digit nitrogen oxides emissions using DeNOx emissions.



https://ammoniaenergy.org/articles/showcasing-ammonia-energy-developments-in-china/
https://pubs.acs.org/doi/10.1021/acs.energyfuels.4c03745

Ammonia combustion for industrial fabrication of ceramic tiles in China

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佛山仙湖實驗室
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FOSHAN XIANHU LABORATORY

22nd April 2025

Ammonia Combustion for Industrial Fabrication of Ceramic Tiles in China

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Foshan Xianhu Laboratory, Foshan, China

Guangdong Foshan Xianhu Laboratory

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- Xianhu Laboratory, jointly established by Foshan Municipal Government and Wuhan University of Technology, is a R&D institute focused on **hydrogen energy**; currently **170 researchers.**
- Establishing the **National Energy Key Laboratory for New Hydrogen-Ammonia Energy Technologies**
- 2020-2023 funding: **RMB ¥1.5 billion yuan** (US$210 million)
- 2024-2026 funding: **RMB ¥2 billion yuan** (US$280 million)

Foshan Xianhu Laboratory
佛山仙湖实验室

Pilot-scale Platform for Industrial Kilns at Xianhu Laboratory

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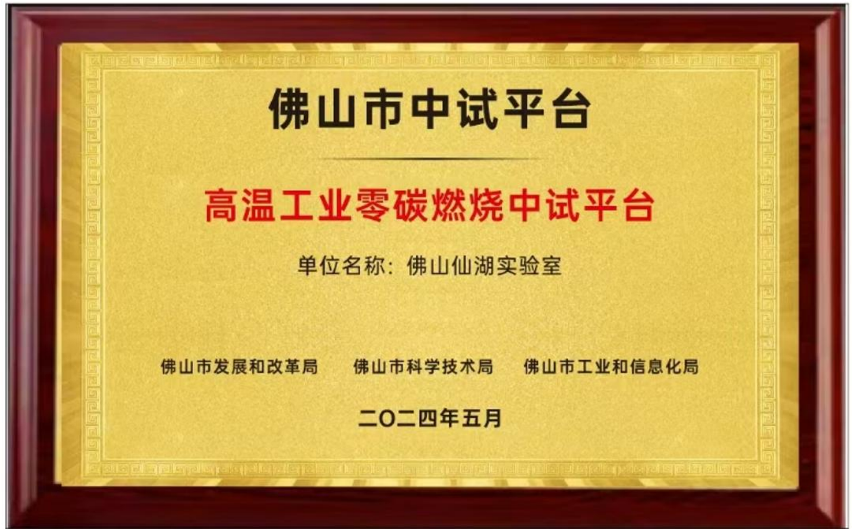
Lab size: 1700m², equipped with hydrogen, ammonia, natural gas, coal powder fuels and combustion facilities



Focused on low/zero carbon combustion technologies for building materials、 metal processing and thermal power generation

Zero-carbon combustion pilot platform at FXL

Ammonia vaporizing station

The lab is equipped with hydrogen, ammonia, natural gas and coal powder fuels.


MW burner test furnace


Ceramic shuttle kiln


Aluminum Melting furnace


kW burner test furnace


MW coal combustion boiler


Aluminum multi-bar Heating furnace


Aluminum single-bar Heating furnace

High temperature industries：major sources of carbon emission

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Electricity power 1400℃

Aluminium smelting 950℃

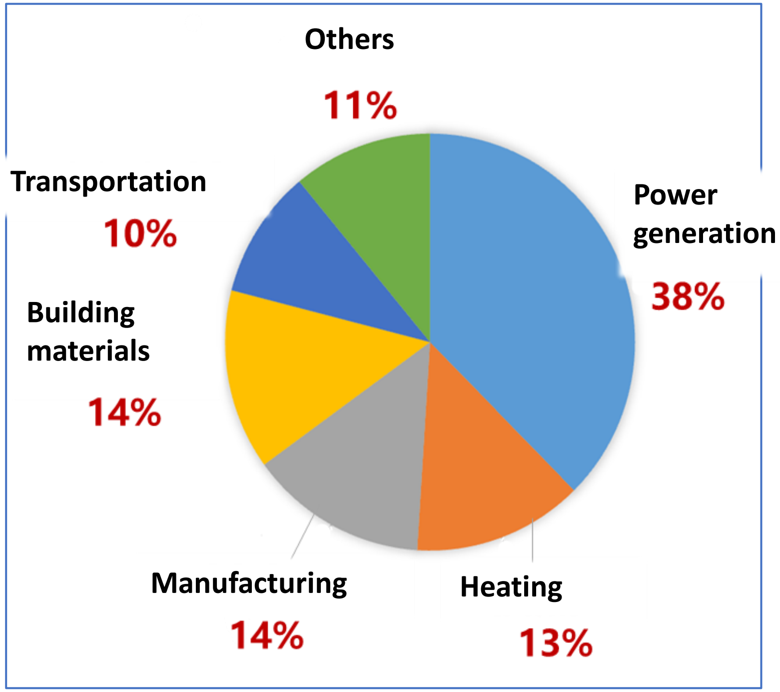
Steel making 1500℃

Ceramics 1200℃

Cements 1450℃

Glass 1600℃

China‘s "dual carbon" goals depend on green manufacturing



Major sources of carbon emission in China

- China aims to achieve carbon dioxide emissions peaking by 2030 and achieve carbon neutrality before 2060.
- China is the world's largest manufacturing country and it needs low-carbon and zero-carbon combustion technologies to achieve the dual carbon goals.

Two scalable renewable carbon-free fuels

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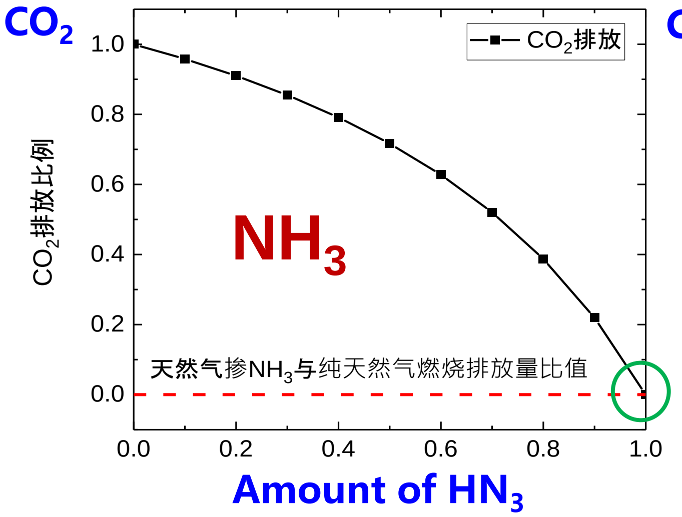
There are only two industrially scalable carbon-free fuels

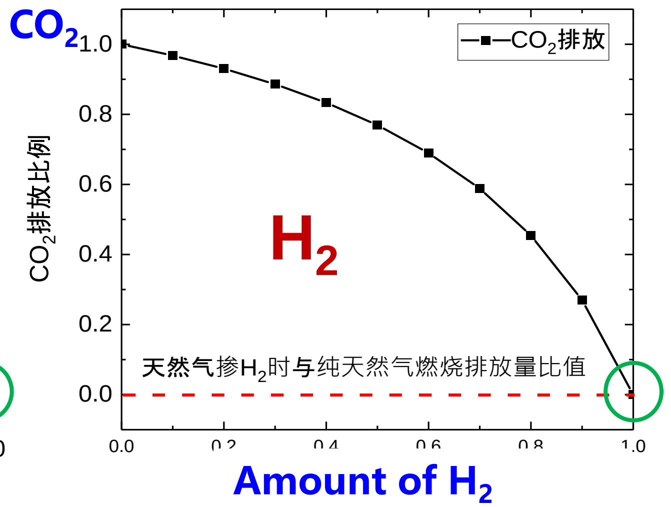
Solar，wind → Water electrolysis → Ammonia synthesis

$$2H_2\,(g) + O_2\,(g) \longrightarrow 2H_2O\,(g)$$

$$NH_3\,(g) + 3/4\,O_2\,(g) \longrightarrow 1/2N_2 + 3/2H_2O\,(g)$$

Burning of hydrogen and ammonia produces no carbon emission





H_2 and NH_3 combusion offers potential for carbon free manufacturing

Hydrogen difficult in transportation and storage

- Hydrogen has extremely **low liquefaction temperature** (-253℃) and is flammable and explosive.
- High cost of storage and transportation of gaseous hydrogen
- The freight of transporting **1 kg** of hydrogen for **100 km** is about **RMB 10 yuan** (~ £1.2).

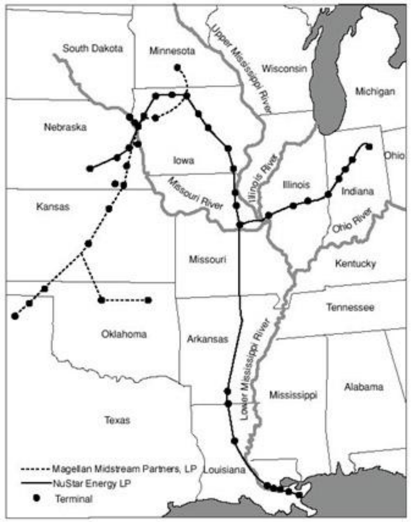
Industrial combustion consumes **huge amounts of hydrogen**, transportation being a major issue.

- 1 production line for ceramic tiles needs **8 tons hydrogen/day, 32 trucks/day!**
- There are 160 ceramic production lines in Foshan， requesting **1,280 tons hydrogen/day, 5,120 trucks/day!**

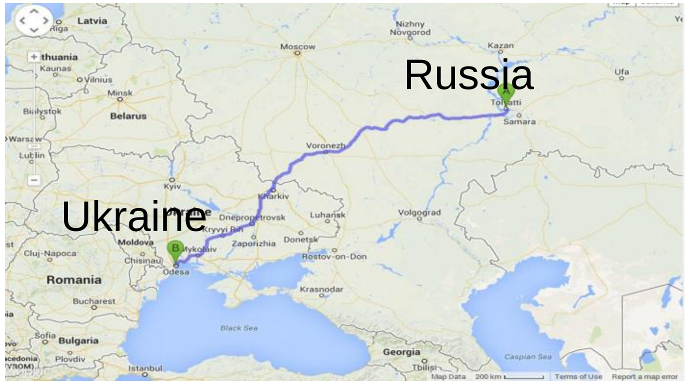
High pressure hydrogen tube bundle truck (40 tons load)

Ammonia convenient for transportation and storage

- Ammonia liquefies easily (-33℃, or 1 MPa. at room temperature).
- Matured technologies and infrastructure for anhydrous ammonia storage and transportation.



US anhydrous ammonia pipeline of 3200km, built in 1971
1.3MT/year



Russia-Ukraine anhydrous ammonia pipeline (2400km), built in 1981
2.3MT/year (anhydro NH_3)

Canned liquid ammonia truck in China (40 tons load)
RMB 0.08 /100km.kg (liquid NH_3)

Liquid ammonia vessel in US
RMB 0.006/100km.kg (liquid NH_3)

40,000T tanks for anhydrous ammonia, Netherland

Ceramic industry produces the largest carbon emission in Foshan

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- ❑ Ceramic industry in Foshan accounts for about 10% of China’s total ceramic production
- ❑ In 2023, the gross output value of Foshan ceramics was ￥102 billion Yuan (~A$21billion)
- ❑ Its carbon emission accounts for **~30%** of the total carbon emission of Foshan.

Carbon emission in ceramic manufacturing：

- ❑ 70% from combustion
- ❑ 30% electricity and raw materials

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因为专注 所以更逼真

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Joint R&D Centre for Advanced Zero-carbon Combustion Technology

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DLT德力泰

A Joint Centre of
Foshan Xianhu Laboratory
Foshan Oceano Ceramics Co., Ltd.
Foshan DLT Technology Co., Ltd.
Established on December 27, 2021

To convert the Oceano's pilot ceramic fabrication line from natural gas to ammonia fuel

(Feb. 2022 – Dec. 2022)

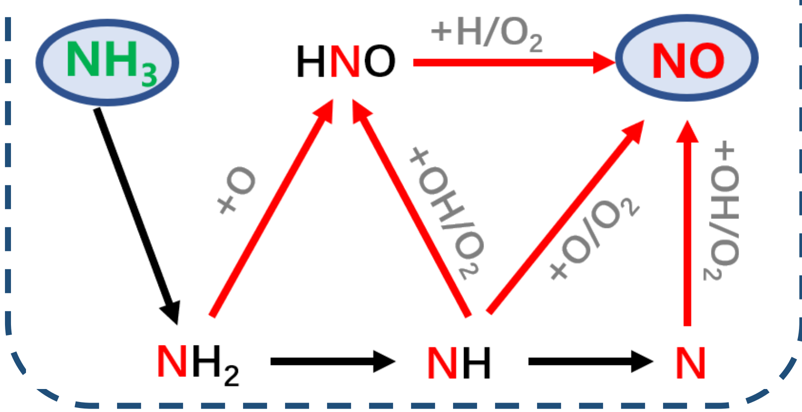
Challenges in ammonia combustion

□ Thermal properties and fundamental combustion characteristics

Fuel	Adiabatic flame temperature (℃)	Lower heating value (MJ/Kg)	Maximum laminar burning velocity (m/s)	Flammability limit (Equivalence ratio)	Minimum ignition energy (mJ)
H_2	2110	120	2.91	0.18-8.84	0.011
CH_4	1950	50	0.37	0.48-1.7	0.280
NH_3	1800	18.6	0.07	0.64-1.46	8.000

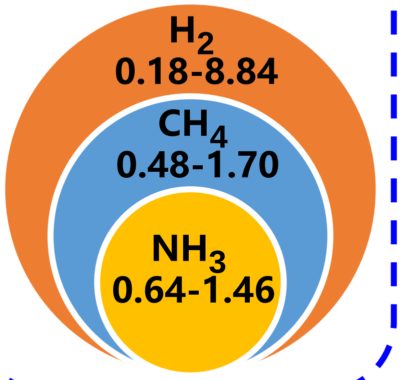
◆ Feature of NH_3 combustion (compared with CH_4/H_2)

Emission of fuel-NOx



Low flame speed

Narrow flammability Limit



Higher ignition energy

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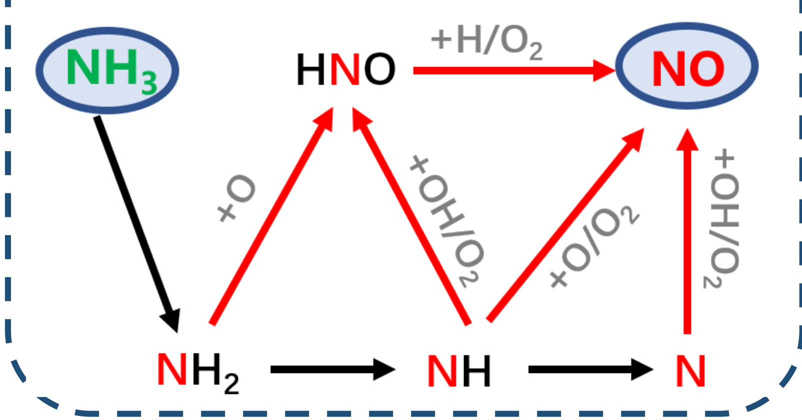
Challenges in ammonia combustion

Three major technical challenges in ammonia combustion applications：

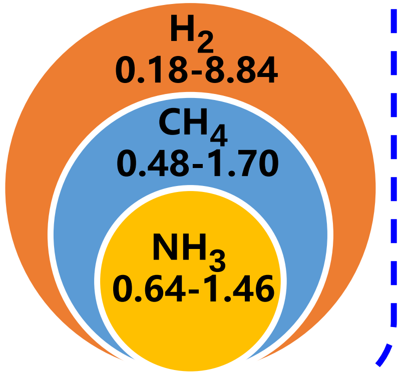
1) Controllable ignition of ammonia fuel
2) Controllable and stable high temperature combustion flame
3) Control of NOx emission and residual ammonia

Emission of fuel-NOx

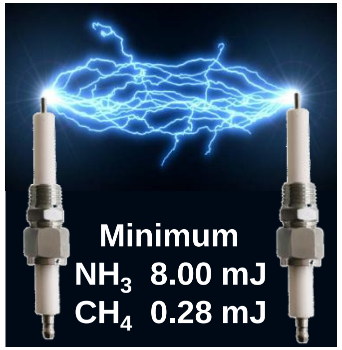


Low flame speed

Narrow flammability Limit

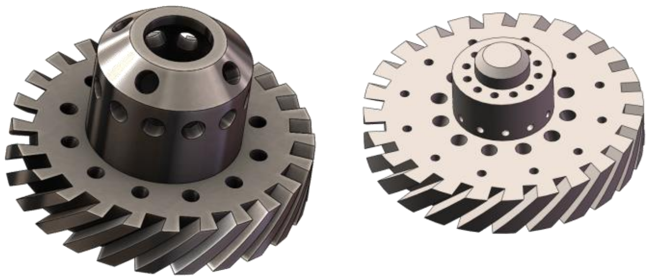


Higher ignition energy

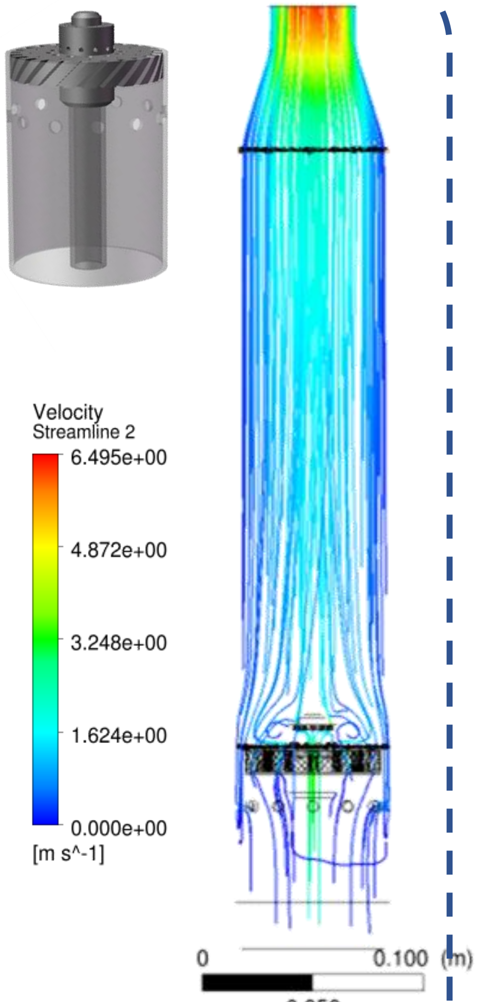


Ammonia swirl burners for stable ignition and combustion

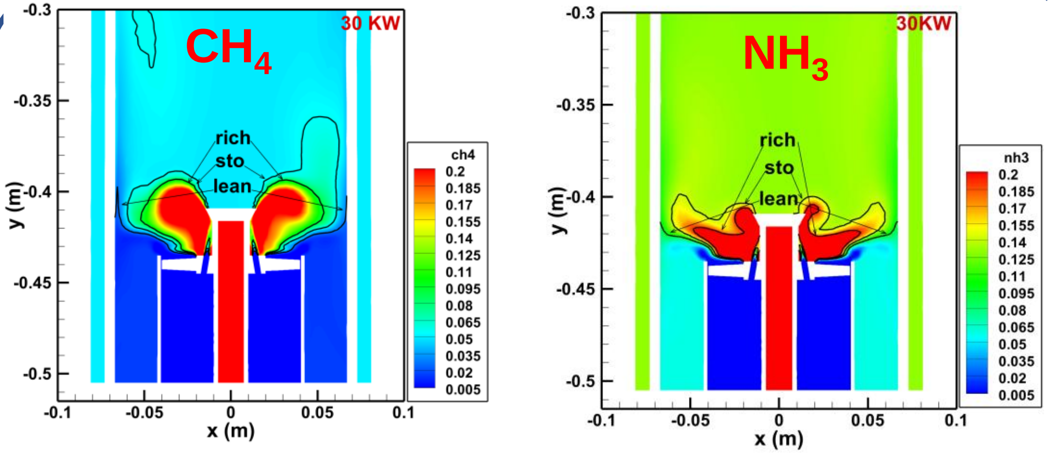
Laboratory NH_3 swirl burner



Industrial burner design

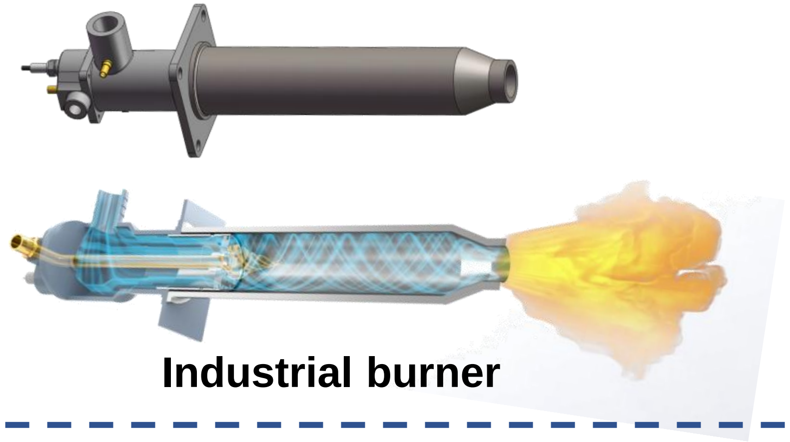


Simulation for flow field



Simulation for NH_3 and CH_4 ignition

15 burners were designed and optimized



Industrial burner

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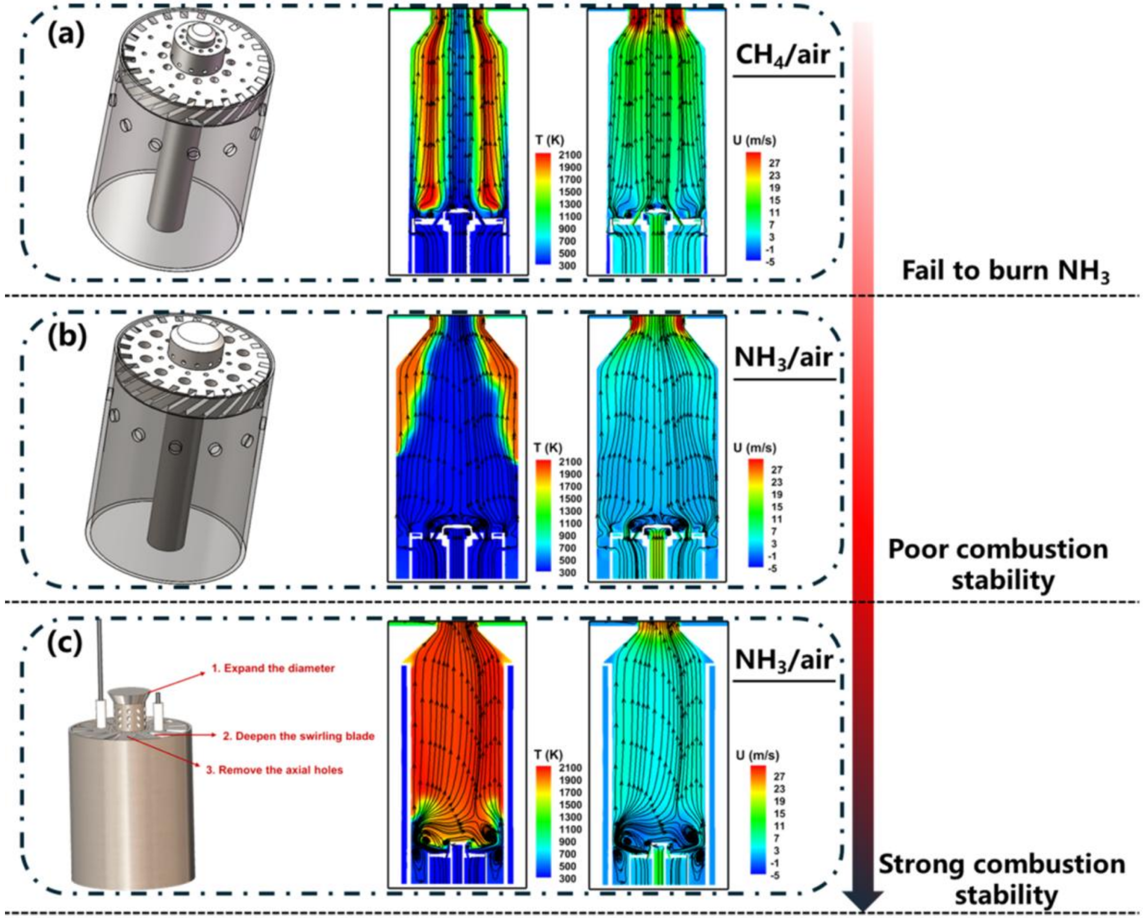
Ammonia swirl burners for stable ignition and combustion

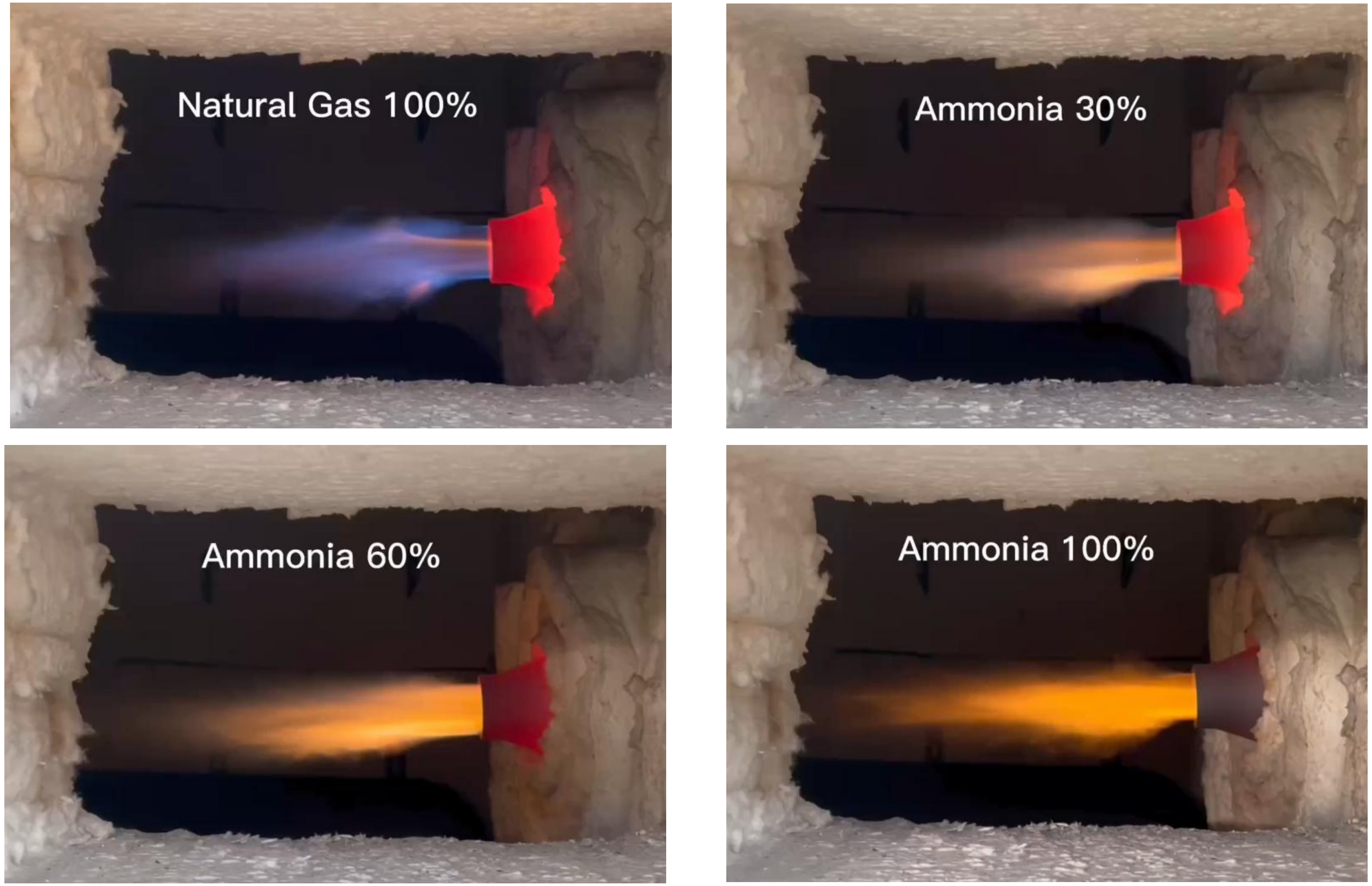


First generation ammonia burner, producing sparks, but no stable ignition of ammonia gas

Newly developed ignitor and burner (20kW) achieved stable ignition for pure ammonia gas

Ammonia swirl burners for stable ignition and combustion

Industrial ammonia burners



Combustion of ammonia-natural gases in industrial burners

Retrofitting of a pilot ceramic roller kiln from natural gas fuel to ammonia fuel

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佛山仙湖实验室
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Pilot ceramic roller kiln of 30m long, at the Oceano Ceramics Co., Ltd, ceramic tile production capacity of 100,000 m^2/year

Successful production of ceramic tiles with pure ammonia fuel

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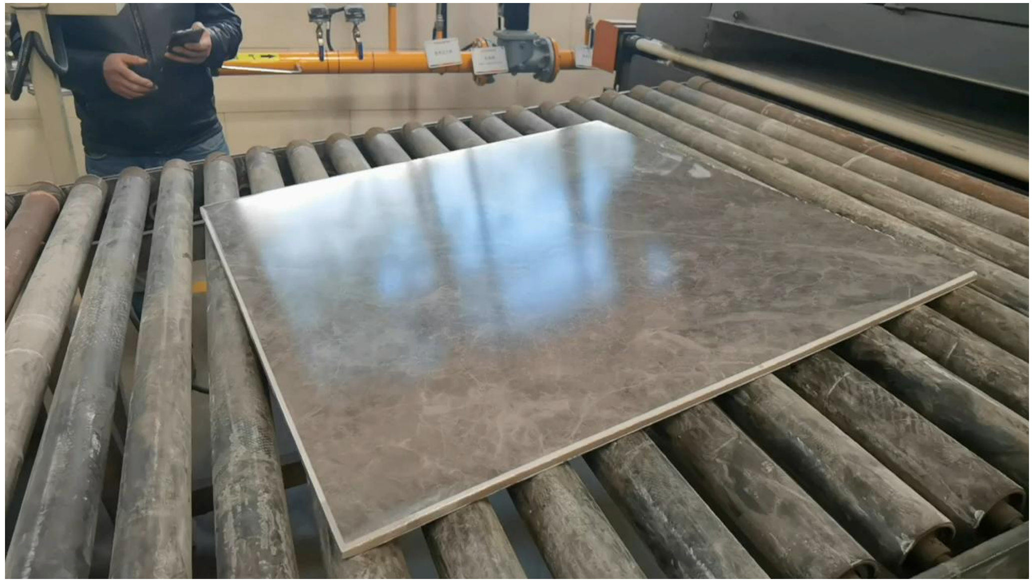
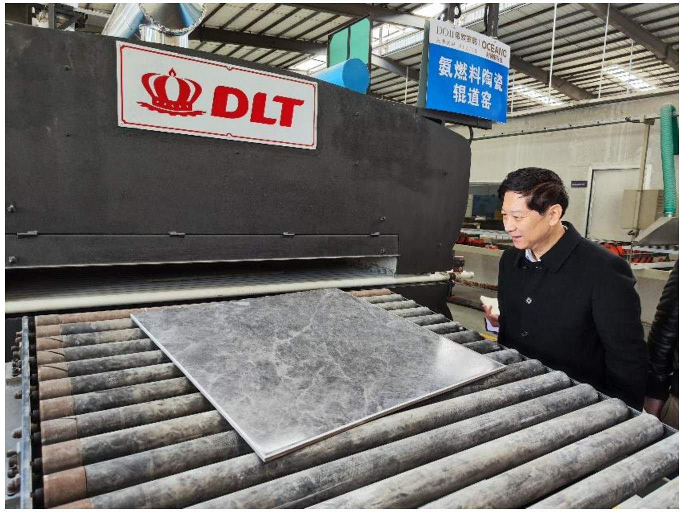
18 Dec. 2022



The world first carbon-free fuel fabricated ceramic tiles (750×750mm)



Third party certification report of emission

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Emission analysis report

报告编号：WT-2304056-002

CMA
202219002802

广东量源检测技术有限公司

检 测 报 告

委托单位名称：佛山欧神诺陶瓷有限公司

被测单位名称：佛山欧神诺陶瓷有限公司

检测项目类别：废气

报告编制日期：2023年04月25日

广东量源检测技术有限公司

第1页 共4页

报告编号：WT-2304056-002

五、检测方法、使用仪器、检出限

表2 检测方法、使用仪器、检出限一览表

检测项目		检测方法	使用仪器	检出限
废气	颗粒物	固定污染源废气 低浓度颗粒物的测定 重量法 HJ 836-2017	BTPM-AMS1 滤膜自动恒重系统	1.0mg/m³
	氮氧化物	固定污染源废气 氮氧化物的测定 定电位电解法 HJ 693-2014	ZE-8600 大流量低浓度烟尘自动测试仪	3mg/m³
	二氧化硫	固定污染源废气 二氧化硫的测定 定电位电解法 HJ 57-2017		3mg/m³

六、检测结果

1、废气检测结果

表3 废气检测结果

采样位置	窑炉废气处理后监测口 N:23°18′34.6″ E:112°59′25.0″			采样方式	连续采样		
炉型	窑炉			燃料	氨		
排放口高度	10米			治理方式	三元催化器		
检测项目	检测结果			参考标准浓度限值（mg/m³）	评价	含氧量（%）	标干流量（m³/h）
	实测浓度（mg/m³）	折算浓度（mg/m³）	排放速率（kg/h）				
氮氧化物	48	17	0.142	100	达标	12.6	2955
二氧化硫	3L	3L	8.86×10^{-3}L	30	达标		
颗粒物	7.1	2.5	2.10×10^{-2}	20	达标		

备注：1、项目参考广东省地方标准《陶瓷工业大气污染物排放标准》（DB 44/2160-2019）表1标准；
2、当三次检测中的浓度有低于检出限时以检出限参与计算，实测浓度以三次检测均值后加“L”表示，折算浓度以实测浓度折算结果后加“L”表示，排放速率以实测浓度计算结果后加“L”表示。

编 制：　审 核：　签 发：

签发日期：2023年04月27日

报告结束

第4页 共4页

Results of emission

Particles：2.5mg/m³ < STD 20mg/m³

SO_2：Below detection limit

NOx：17mg/m³ < STD 100mg/m³

Properties of ceramic tiles：

- Water absorption: 0.01%
- Bending strength: 41.6MPa

All above the national standard.

energy&fuels

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Article

Pure Ammonia-Fueled Roller Kiln for the Production of Ceramic Tiles: A First Demonstration

Jiwei Zhou, Zhou Yu,* Liuhao Ma, Xuren Zhu, Shiping Jin, Jianguo Du,* Xiru Cheng, Shanjun Ke, Guoqing Xie, Yi-Bing Cheng, and Yu Wang

Cite This: https://doi.org/10.1021/acs.energyfuels.4c03745

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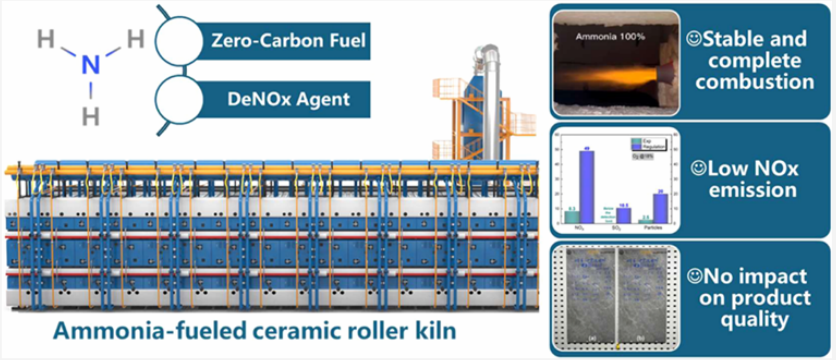
ABSTRACT: The implementation of zero-carbon fuels, such as hydrogen and ammonia derived from renewable sources, is a promising strategy for achieving the goals of carbon peaking and carbon neutrality in industrial sectors, where traditional hydrocarbon fuels still dominate. This paper discusses the recent successful application of 100% ammonia as both a fuel and a DeNOx (denitrification) agent in a ceramic roller kiln. First, the design of the ammonia burner is discussed. Stable, efficient, and low-NOx combustion of ammonia is achieved through the implementation of swirling combustion and air-stage combustion technologies. The combustion efficiency of ammonia can reach as high as 99.99%. It has been observed that the NOx emissions from the ammonia burner decrease from 400 ppm during single-staged combustion to 79 ppm during two-staged combustion at 18% O_2. Furthermore, diagnostic methods, fuel supply systems, and emission control strategies are demonstrated. A three-level NOx suppression strategy is proposed, which includes air-staged combustion, selective noncatalytic reduction (SNCR), and selective catalytic reduction (SCR). Ultralow NOx emissions (single-digit



Joint R&D Centre expanded to five organisations for applying the technology to mass production

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蒙娜丽莎瓷砖
MONALISA TILES

OCEANO
欧神诺瓷砖

DLT德力泰

安清科技

Monalisa mass production line: 150 meters in length, 300 burners, 1.50 million m² ceramic tiles p.a.

Monalisa mass production project launched on 28 Dec. 2023

Retrofitting of the Monalisa mass production roller kiln

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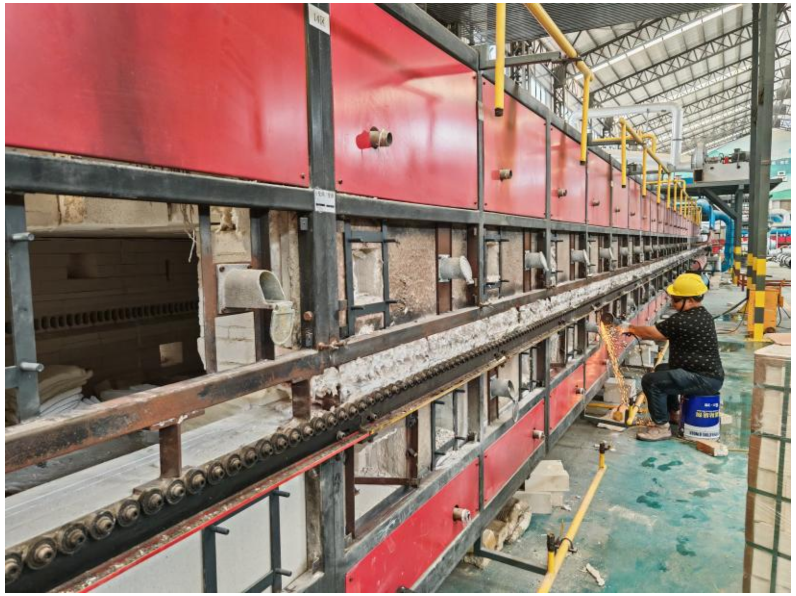
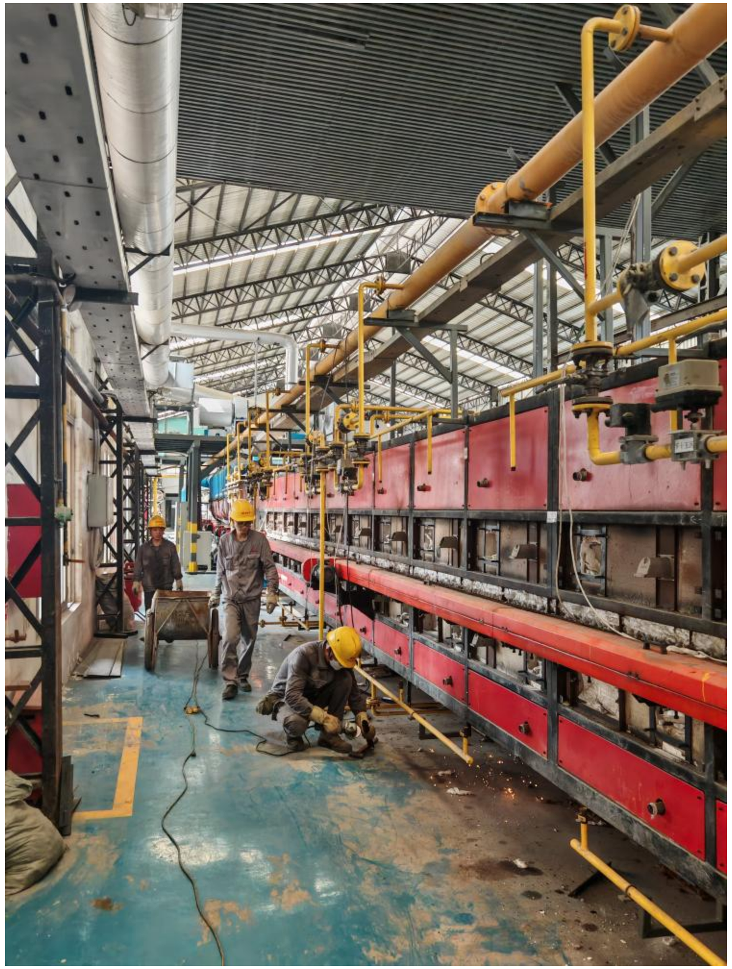
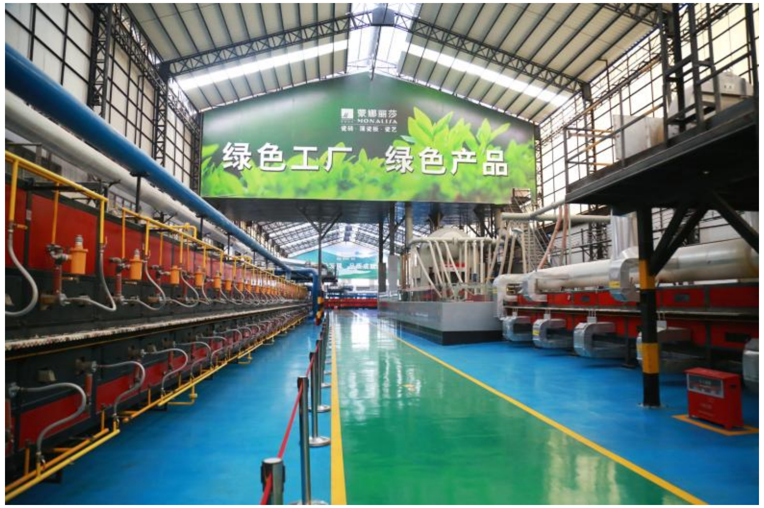




Completion between April and September 2024

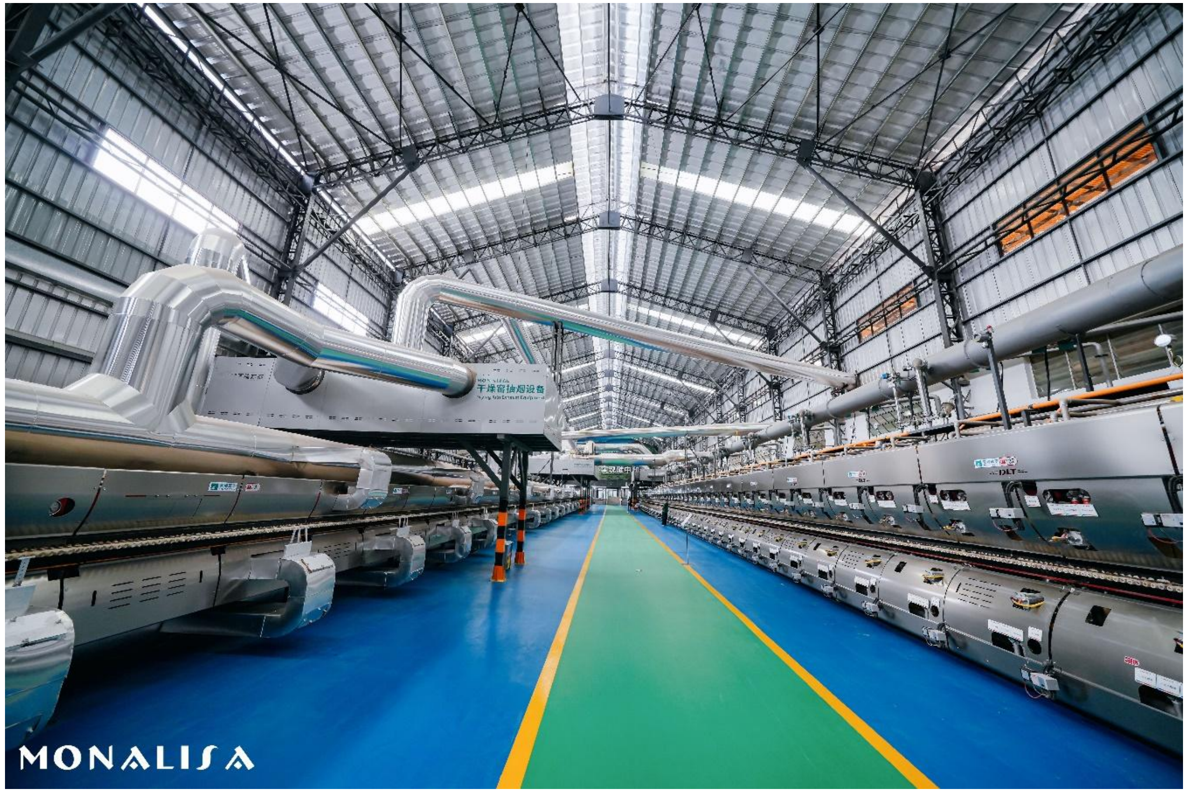
Construction of the anhydrous ammonia fuel station

Monalisa ammonia fired mass production roller kiln



Before retrofit

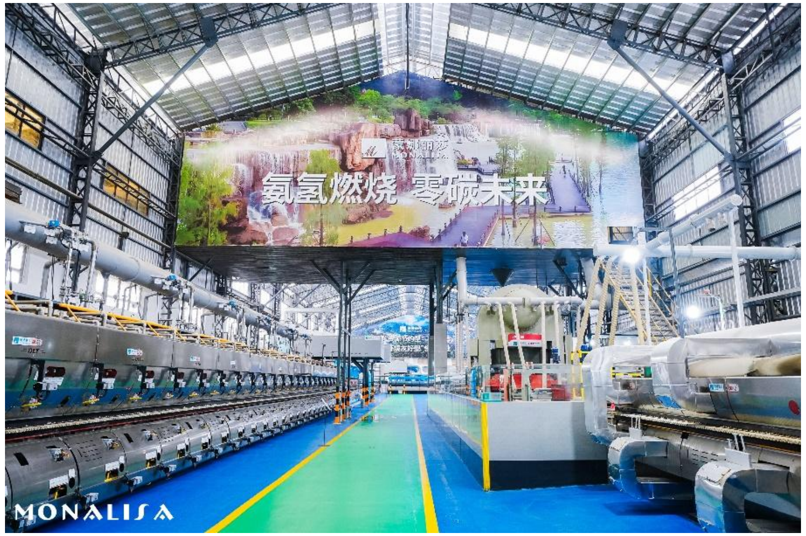
During retrofit



Retrofit completion

Retrofit between April and September 2024

Completion of retrofitting for Monalisa ammonia fired mass production roller kiln

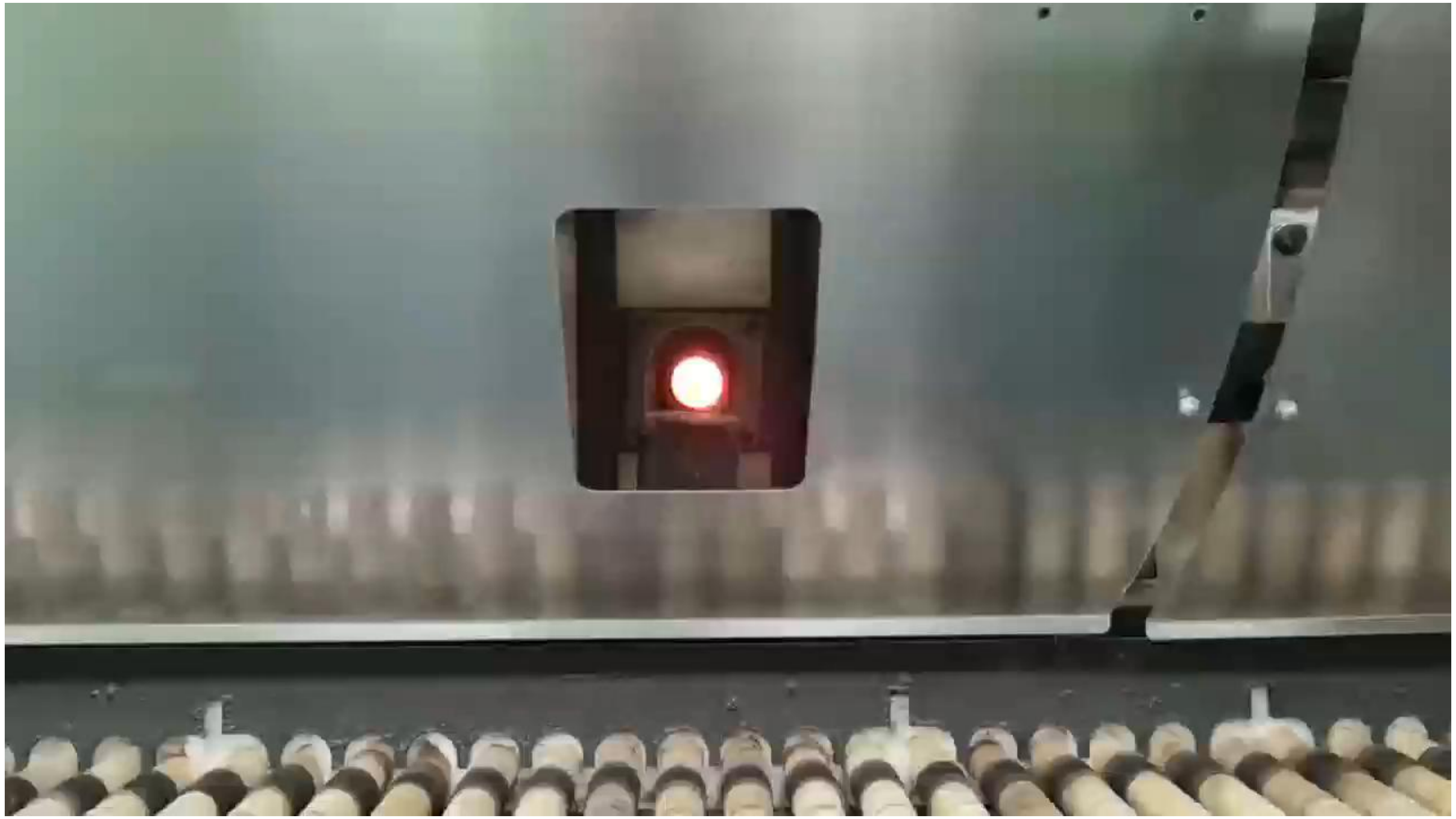


10 Sept 2024, the roller kiln ignition ceremony

Sept. 2024

Full operation of the ammonia fired mass production roller kiln

The world first zero-carbon combustion mass production ceramic kiln!



Full operation on 26 Sept. 2024

Full operation of the ammonia fired mass production roller kiln

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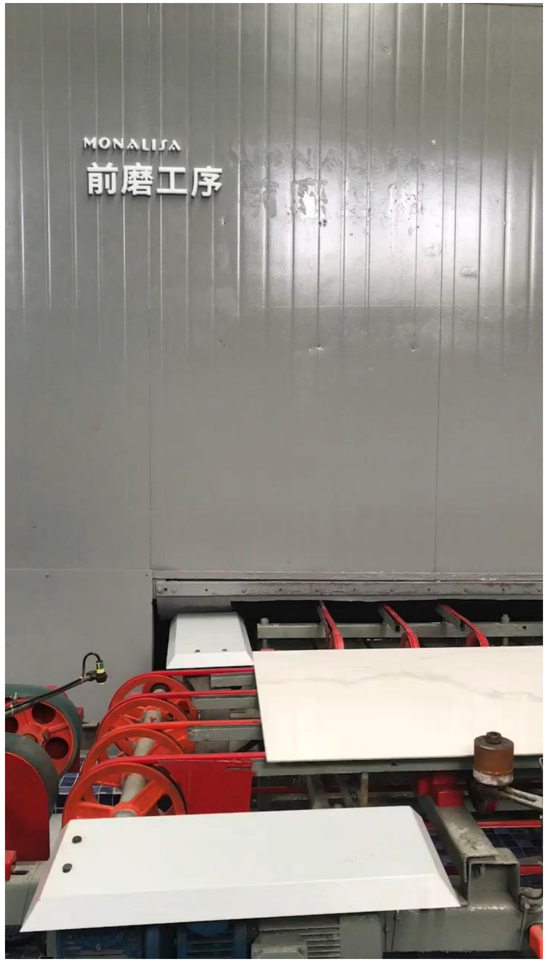
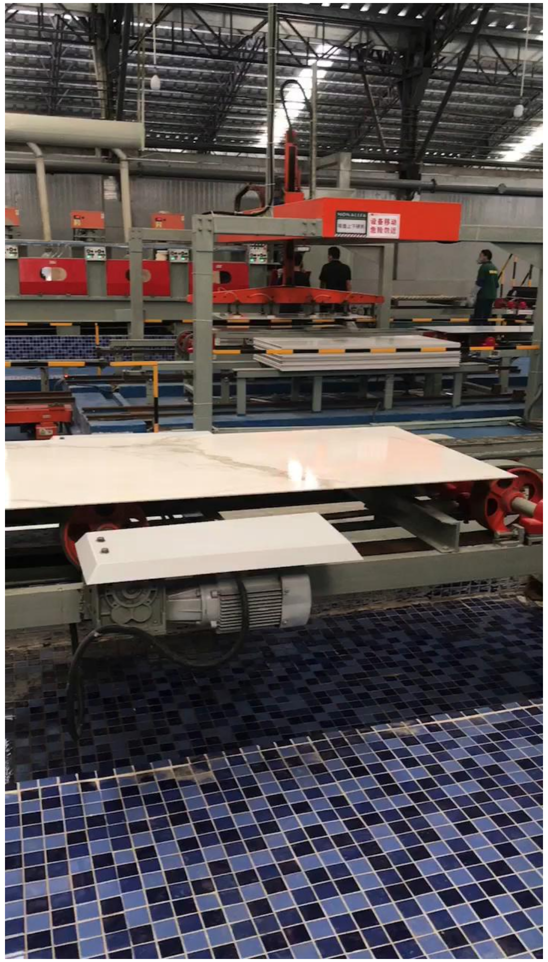
佛山仙湖實驗室
FOSHAN XIANHU LABORATORY



After cooling



Before polishing

After polishing

Packing

Ceramic tiles 0.9m (W) X 1.8m (L) X 5.5mm (T)

Some key questions related to ammonia combustion

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佛山仙湖實驗室
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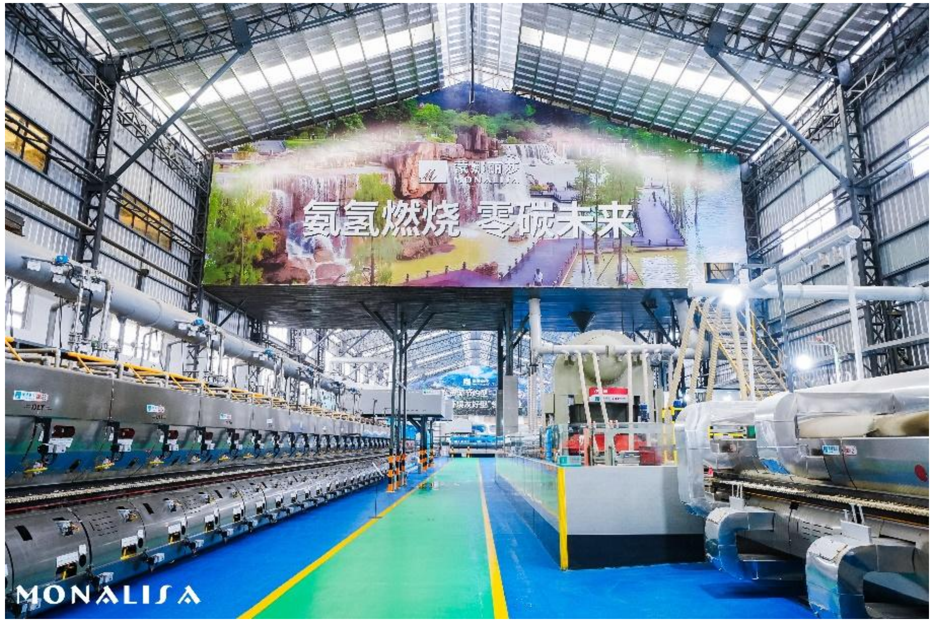
- Can NOx be controlled?
- Is ammonia safe for combustion?
- What are the economics of burning ammonia as a fuel?



NOx from ammonia combustion — a major challenge

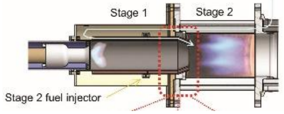
Emissions: CO_2 and thermal-NO_x (NO/NO_2)

CO_2

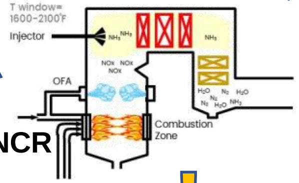
Captured and Stored underground

Emissions: fuel-NOx (NO/NO_2)

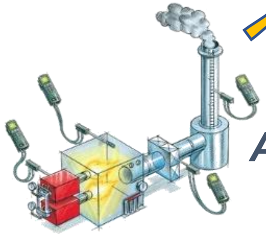
NO/NO_2



Staged-burner

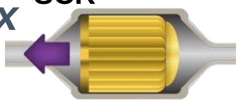


SNCR

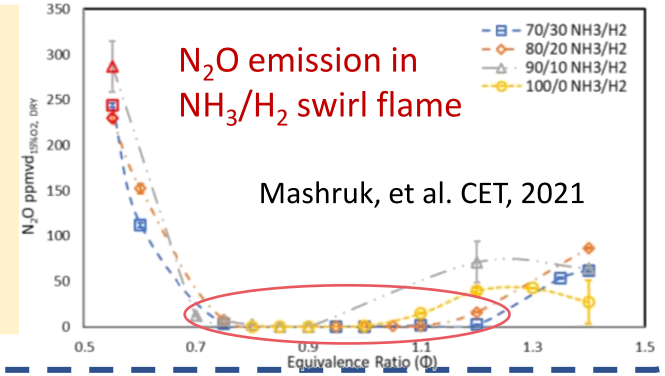


A variety of De-NOx technologies

SCR



N_2O emission becomes an issue typically at very lean conditions where flame temperature is low, whilst in **industrial burners** with moderately lean to-stoichiometric fuel / air mixtures has **almost zero N_2O.**



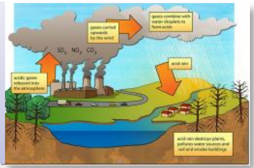
Environmental impacts of NOx

NO

NO_2

Ground level Ozone
(SMOG) damage to vegetation, lungs &crops

Acid rain
Damages forests, buildings & water sources

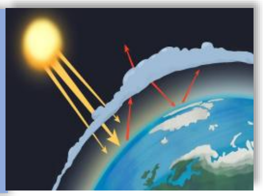


Visibility
Nitrates & NO2 block light, reduces visibility

Particles
Reacts to formic acid vapor particles, respiratory disease

N_2O

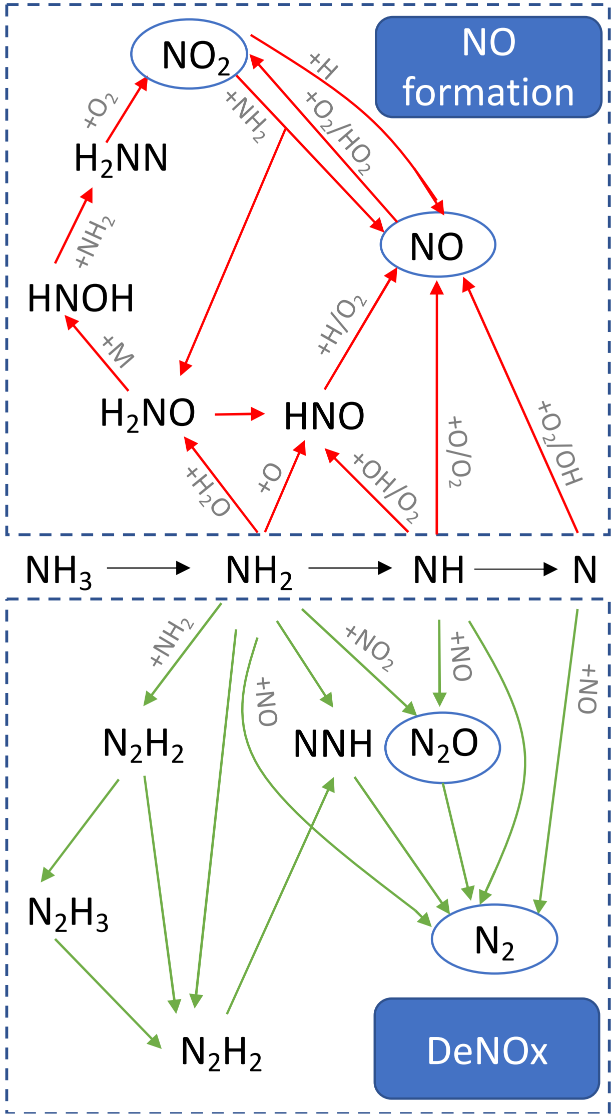
Global warming
N_2O is much more damaging greenhouse gas than CO_2, keeping the earth warm.



Can NOx be controlled?

Major differences between CO_2 and NOx:

- **CO_2 is a very stable compound. Splitting CO_2 into C and O_2 requires a significant amount of energy, which may produce more CO_2.**
- **NOx can react with ammonia (NH_i), to yield nitrogen gas (N_2) and water (H_2O):**
  - **$4NO+4NH_3+O_2 \rightarrow 4N_2+6H_2O$**
  - **$NO+NH_2 \rightarrow N_2+H_2O$**
- **Design of multi-level de-NOx techniques to control NOx emission**



Multi-level approaches for De-NOx in ceramic kiln

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佛山仙湖實驗室
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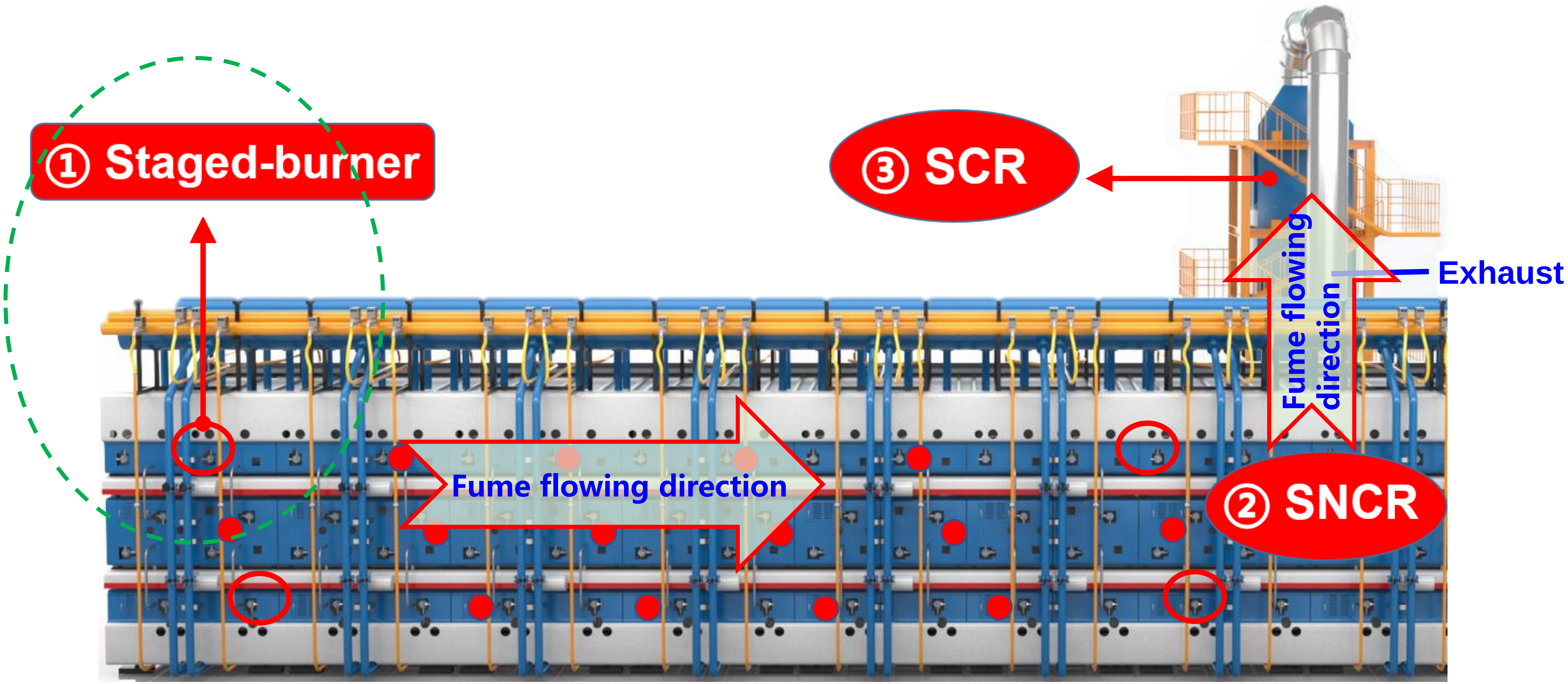
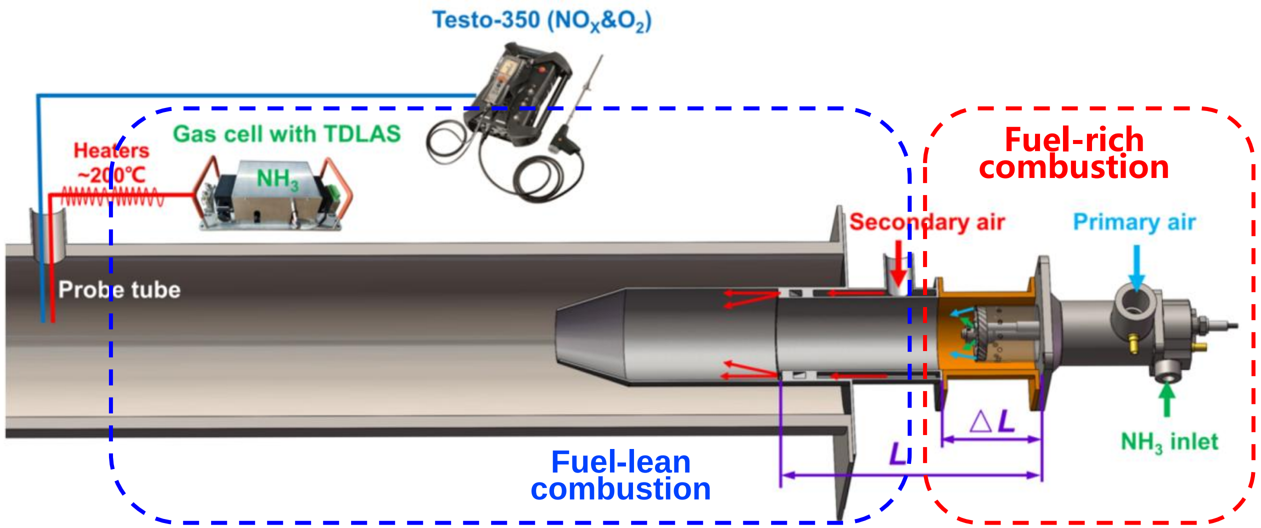


Designed multi-level De-NOx approaches

(1) Staged-combustion burner for NOx reduction



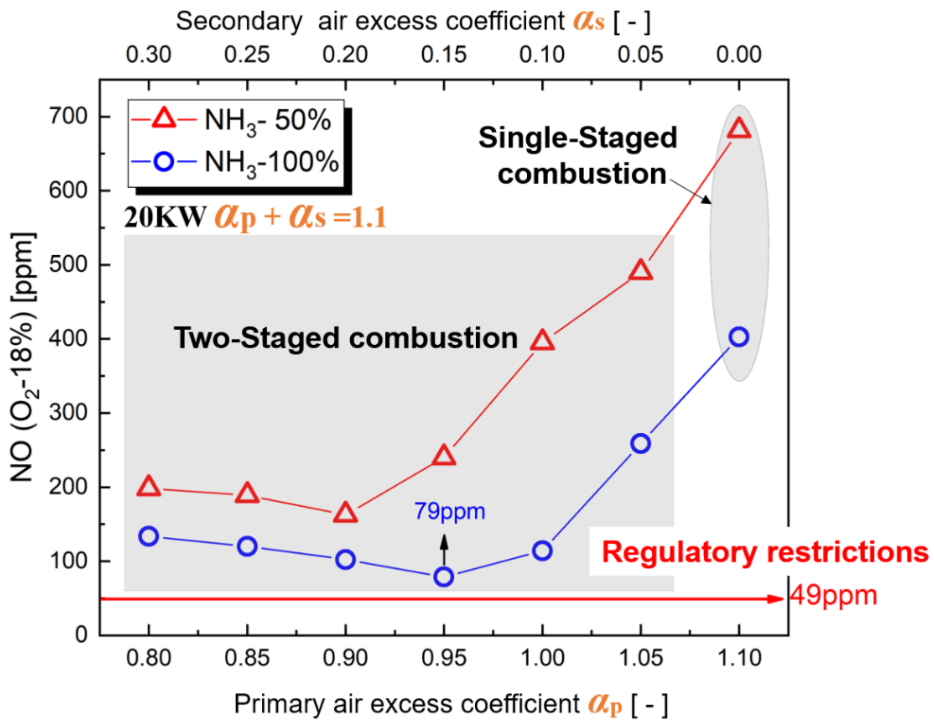
NO was reduced by NH_i (i = 2, 1, 0) species formed from excess NH_3 in the primary reaction zone.

$$NH_2 + NO \Leftrightarrow N_2H + OH$$

$$N_2H + O \Leftrightarrow NH + NO$$

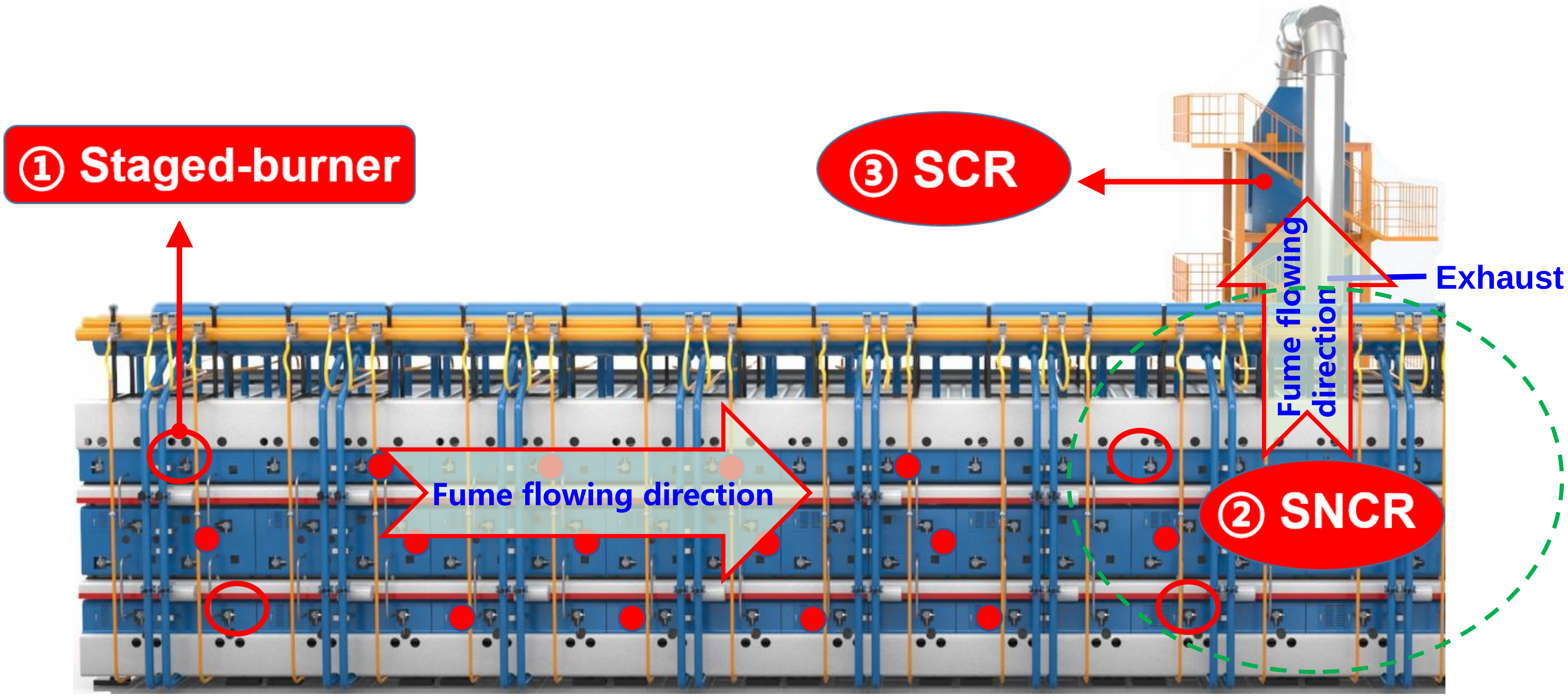
$$NH + NO \Leftrightarrow N_2O + H$$

$$N + NO \Leftrightarrow N_2 + O$$



NOx emissions of air-staged ammonia combustion with different primary/secondary air ratios and relative positions of the secondary air

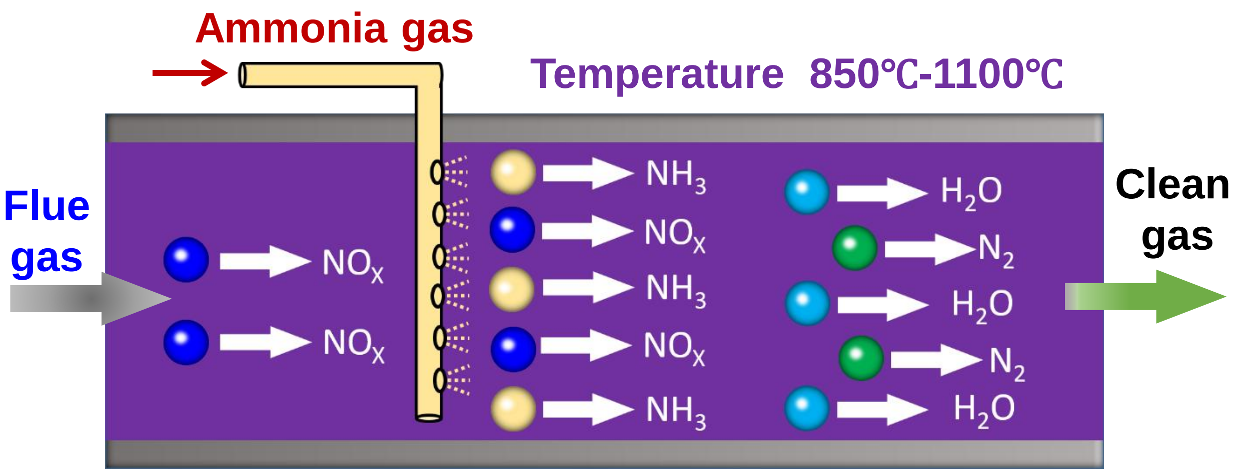
Multi-level approaches for De-NOx in ceramic kiln



Designed multi-level De-NOx approaches

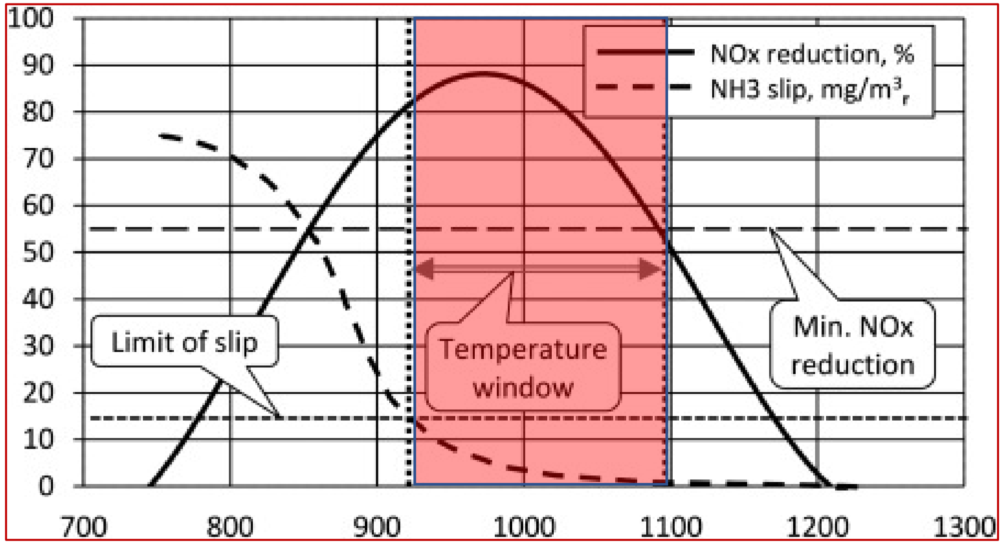
(2) SNCR for NOx reduction

Selective non-catalytic reduction (SNCR)



- SNCR is a method for NO$_X$ reduction at a high temperature range (850℃-1100℃) without the aid of a catalyst, **a unique advantage for ammonia combustion.**

$$NO_X + NH_3 + O_2 \longrightarrow N_2 + H_2O$$



Efficiency of SNCR at different temperature ranges

Advantages of SNCR with anhydrous ammonia

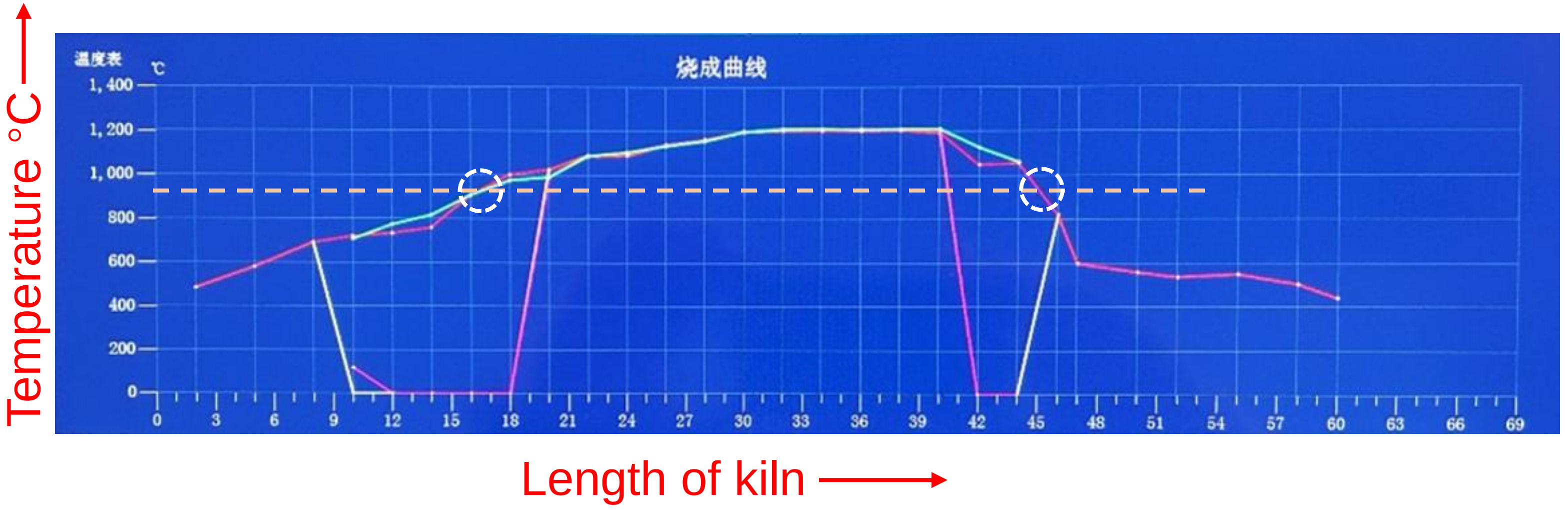
☑ Simple to apply and maintain

☑ High efficiency

☑ Ammonia as both fuel and reducing agent

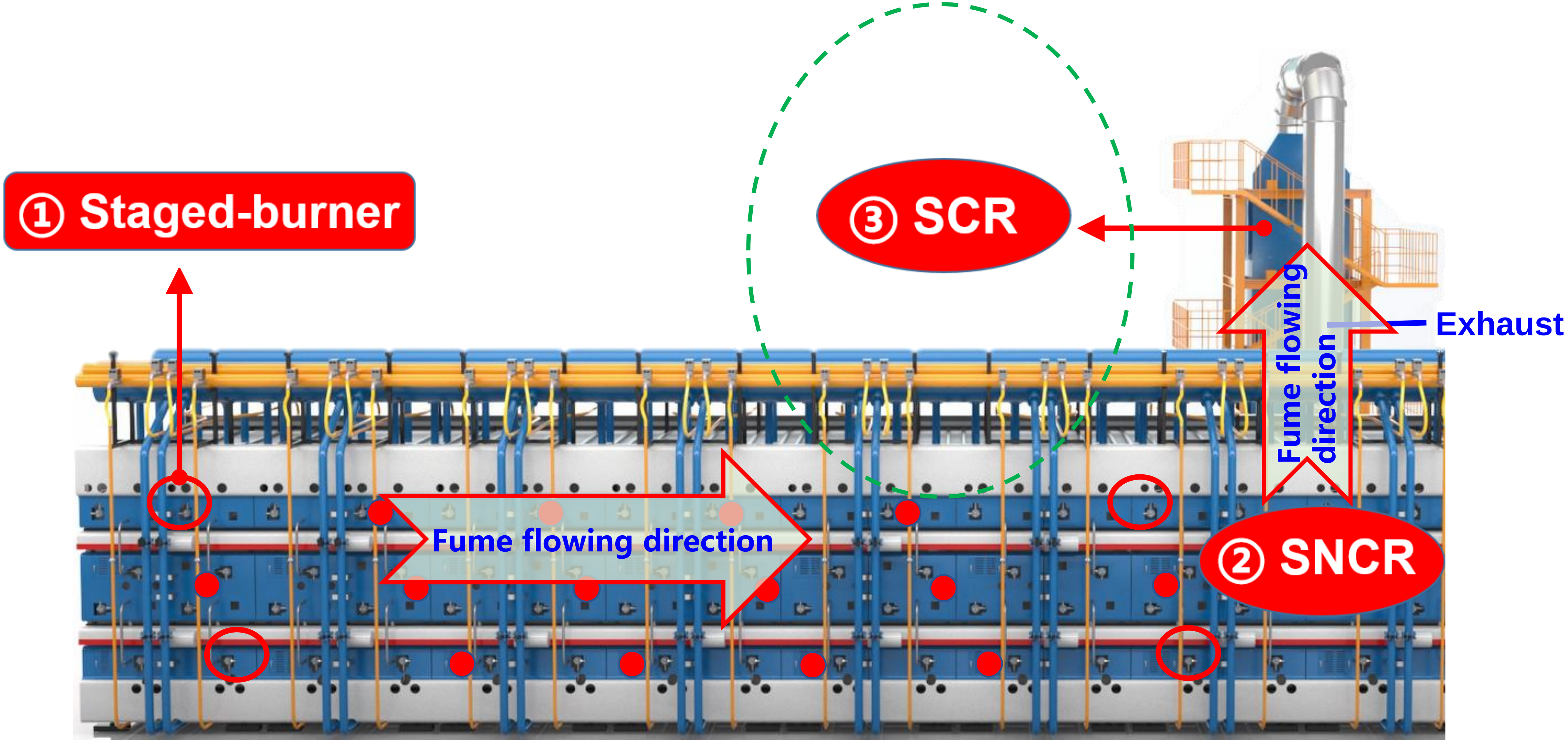
☑ Easy to retrofit, incurring little downtime

（2）SNCR for NOx reduction



- ☐ SNCR needs no catalyst and is a **lower-cost** technique compared to SCR
- ☐ Ceramic roller kiln has a **long firing profile.** It's easy to identify temperature zones suitable for SNCR reduction

Multi-level approaches for De-NOx in ceramic kiln

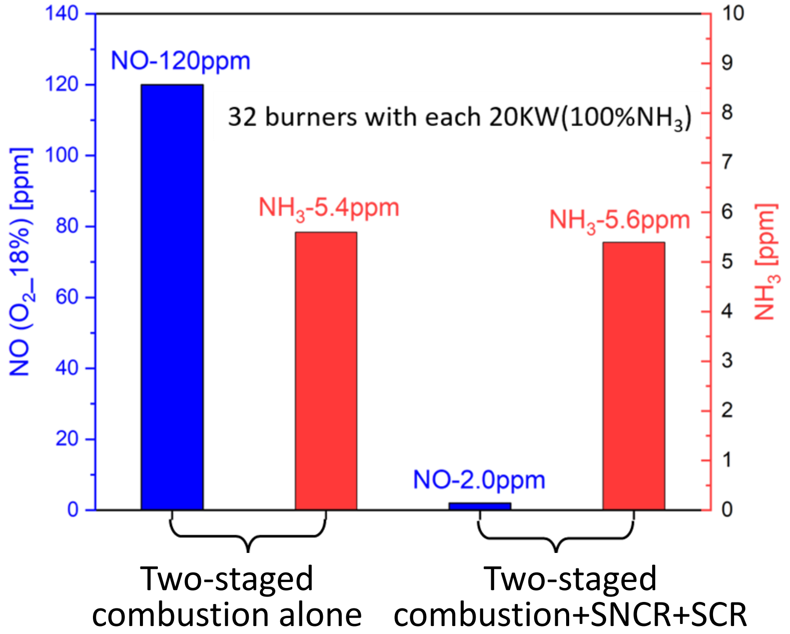


Designed multi-level De-NOx approaches

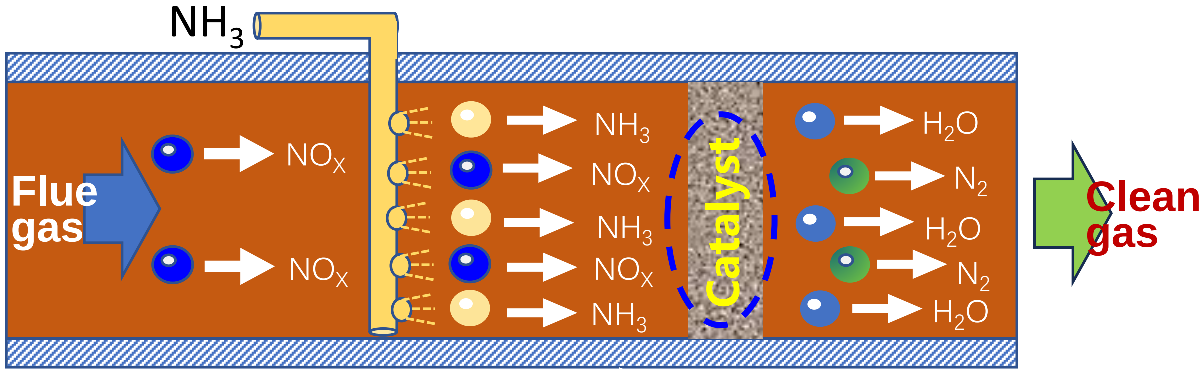
(3) SCR for NOx reduction

Selective catalytic reduction (SCR)

SCR with anhydrous ammonia



NO_X/NH_3 emissions with or without SNCR and SCR



$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O$$

$$4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$$

$$8NH_3 + 6NO_2 \rightarrow 7N_2 + 12H_2O$$

$$4NH_3 + 2NO_2 \rightarrow 3N_2 + 6H_2O$$

Advantages of SCR with anhydrous ammonia

- Higher efficiency and lower operational cost
- Avoid catalyst blockage due to urea crystallization
- Safety issues already considered as ammonia is also used as the fuel

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佛山仙湖实验室
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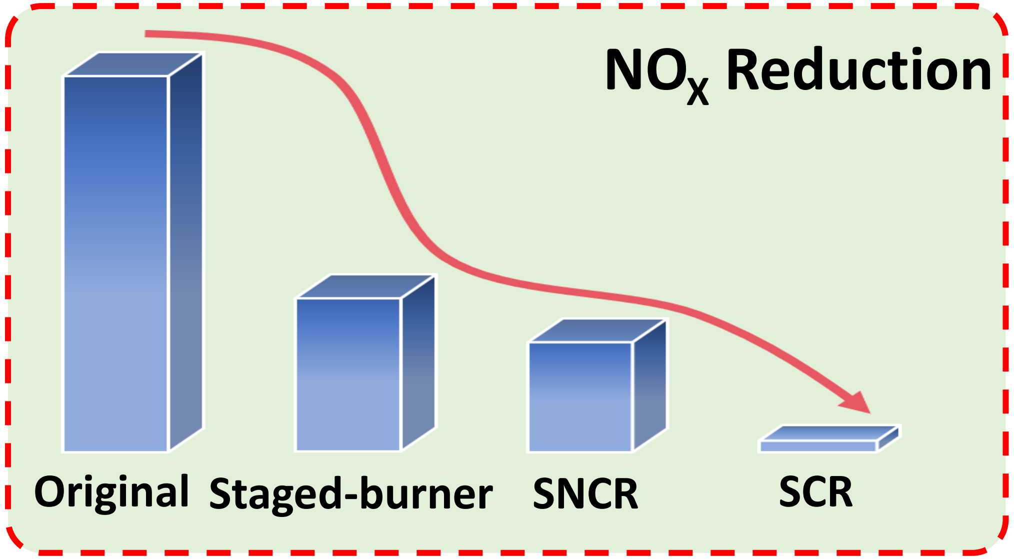
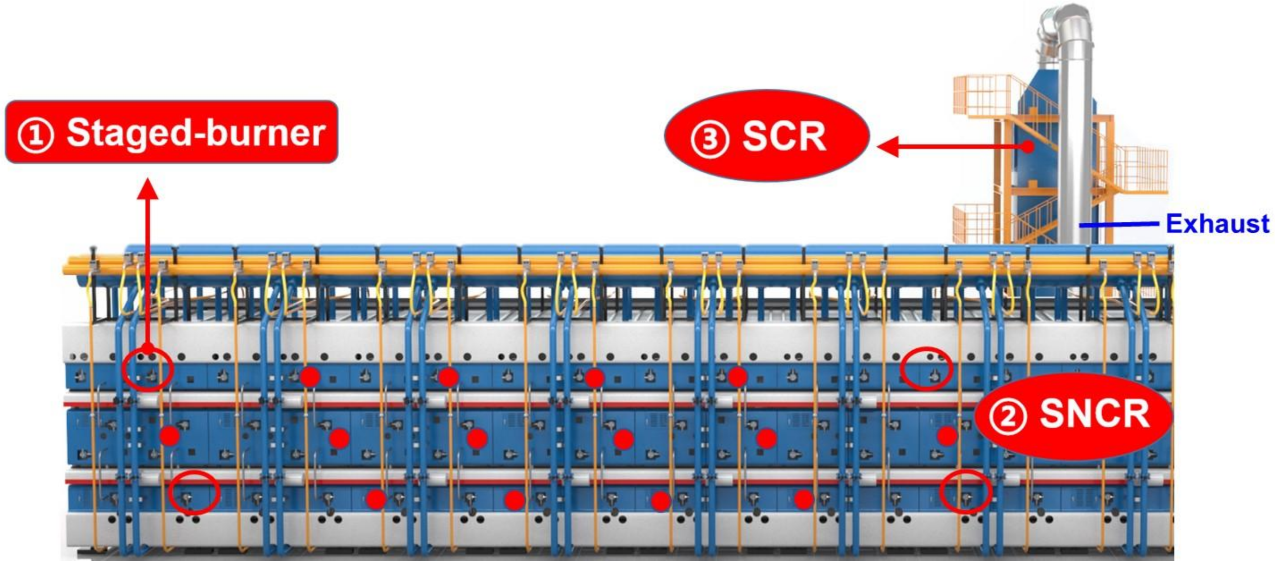
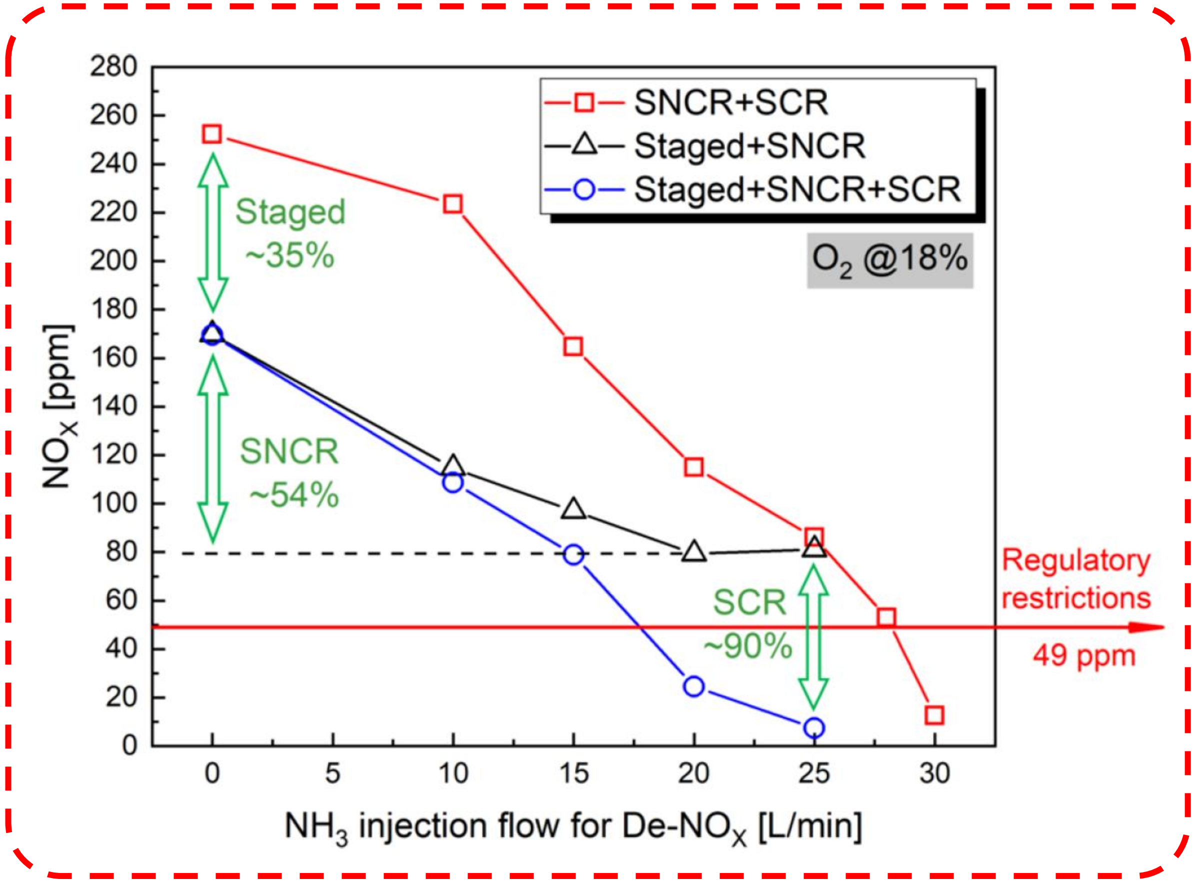
Multi-level De-NOx techniques proven very effective







Designed multi-level De-NOx approaches

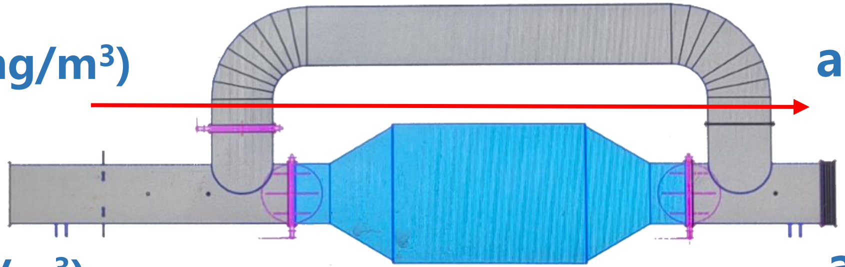
Multi-level De-NOx techniques proven very effective

(Results from the mass production line)

Provincial standard: ≤49ppm or 100 mg/m³ (converted to 18% O_2)

Staged comb+SCR prior: ~277ppm (565 mg/m³) → after: 29 ppm (60 mg/m³)

Fume in →



→ Fume out

Staged comb+SNCR+SCR prior: ~97ppm (198 mg/m³) → after: 10 ppm (21 mg/m³)

CMA certified measurement for **Staged combustion+SCR**

采样日期	检测点位	频次及均值	检测项目及结果					
			二氧化硫			氮氧化物		
			实测浓度（mg/m³）	折算浓度（mg/m³）	排放速率（kg/h）	实测浓度（mg/m³）	折算浓度（mg/m³）	排放速率（kg/h）
2024.10.25	118A 喷淋塔后	第一次	ND	ND	2.70×10⁻²	54	60	0.970
		第二次	ND	ND	2.70×10⁻²	55	64	0.992
		第三次	ND	ND	2.74×10⁻²	49	57	0.894
		均值	ND	ND	2.71×10⁻²	53	60	0.946

备注：1、检测值“ND”表示检测结果小于方法检出限，当检测结果为 ND 时，以该方法检出限的 1/2 参与排放速率计算；
2、、排放速率（kg/h）由实测浓度（mg/m³）×标干流量(m³/h)×10⁻⁶ 所得；
3、检测结果仅对此次采样样品负责。

CMA 201819113371

60 mg/m³(@18@ O_2)

CMA certified measurement for **Staged combustion+SNCR+SCR**

采样日期	检测点位	频次及均值	检测项目及结果					
			二氧化硫			氮氧化物		
			实测浓度（mg/m³）	折算浓度（mg/m³）	排放速率（kg/h）	实测浓度（mg/m³）	折算浓度（mg/m³）	排放速率（kg/h）
2024.11.10	118A 喷淋塔后	第一次	ND	ND	2.85×10⁻²	22	21	0.419
		第二次	ND	ND	2.87×10⁻²	22	20	0.420
		第三次	ND	ND	2.88×10⁻²	24	23	0.461
		均值	ND	ND	2.87×10⁻²	23	21	0.433
标准限值			/	30	/	/	100	/
评价			/	达标	[illegible]	[illegible]	[illegible]	/

备注：1、检测值“ND”表示检测结果小于方法检出限，当检测结果为 ND 时，以该方法检出限的 1/2 参与排放速率计算；
2、检测结果执行广东省地方标准《陶瓷工业大气污染物排放标准》(DB44/2160-2019)表1 企业大气污染物排放浓度限
3、排放速率（kg/h）由实测浓度（mg/m³）×标干流量(m³/h)×10⁻⁶ 所得；
4、检测结果仅对此次采样样品负责。

CMA 201819113371

21 mg/m³(@18@ O_2)

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Is ammonia fuel safe?

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佛山仙湖實驗室
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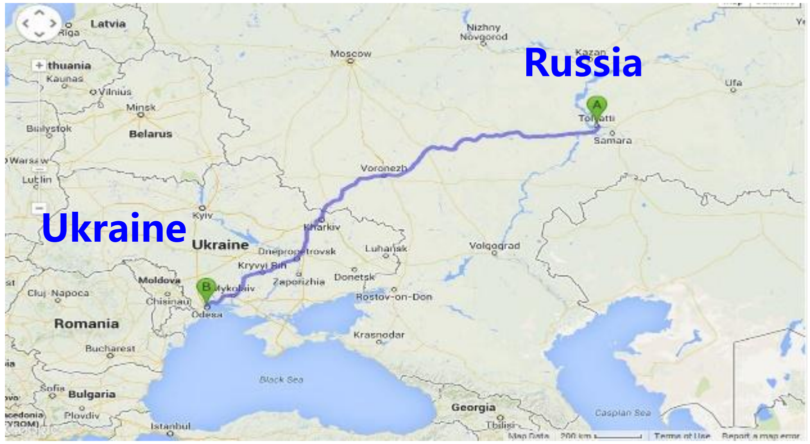
Gas name	Explosive limit (V%)	Ignition energy (mJ)	Autoignition temp (°C)
Hydrogen	4 - 75	0.02	571
Natural gas	5 - 15	0.29	600
Petrol fume	1.4 – 7.6	0.20	350
Ammonia	**15 - 28**	**8**	**651**

- Ammonia is a commonly used chemical, and it's **flammable**, **corrosive** and **health-hazardous.**
- Ammonia has strong smell that is easily recognizable.
- Odor detection thresholds by human: **5-50ppm**
- **> 500mg/m³ (650ppm)**, causing severe respiratory poisoning symptoms
- **> 3500mg/m³ (4600ppm)**, resulting in death

- Ammonia has a narrower explosive limit, higher ignition energy than hydrogen and is **relatively safer** compared to hydrogen as a fuel.
- Very **high solubility in water**, 1L water can dissolve ~700L ammonia gas at room temperature.

Existing technologies and infrastructure for anhydrous ammonia storage and transportation



2400km pipeline, operation since 1981

By tracks

2,000m³ (1200tons) spherical tanks

Ammonia transportation pipes

By ships, 22,000 tons

By trains

Risk of using ammonia fuel controllable

Ammonia station

- There are existing regulations for design, materials selection, installation and operation.
- Equipped with ammonia buffering, emission, absorption systems, leak alarms and sprinkler system

Pipes and valves

- There are existing regulations for design, materials selection, installation and operation.
- Using stainless steel pipes and corrosion-resistant sealing rings.
- Obtaining certificates from special safety institution

Kiln combustion systems

- No existing regulations for installation and operation in industrial combustion systems
- New standards are needed.

Establishing new standard for ceramic kilns

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佛山仙湖实验室
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全球首个陶瓷行业氨燃料应用标准通过审查

来源：广东陶瓷协会　　　发布时间：2024年06月26日

摘要:

2024年6月20日，由广东陶瓷协会组织的《陶瓷行业氨燃料应用规范》团体标准审查会在佛山仙湖实验室召开。

2024年6月20日，由广东陶瓷协会组织的《陶瓷行业氨燃料应用规范》团体标准审查会在佛山仙湖实验室召开。广东陶瓷协会会长陈环，佛山仙湖实验室战略科学家、学术委员会副主任、澳大利亚工程院院士程一兵教授，广东陶瓷协会名誉会长吴一岳，佛山仙湖实验室靳世平教授，华中科技大学煤燃烧国家重点实验室副主任、全国燃烧节能净化标准化技术委员会副主任委员向军教授等组织单位负责人、审查专家委员会成员、标准起草单位相关负责人、编写组成员等参加会议。

ICS 27.060.20

Q94

T/GDTC

团　体　标　准

T/GDTC 00x—2024

Code for application of ammonia fuel in ceramic industry

陶瓷行业氨燃料应用规范

Code for application of ammonia fuel in ceramic industry

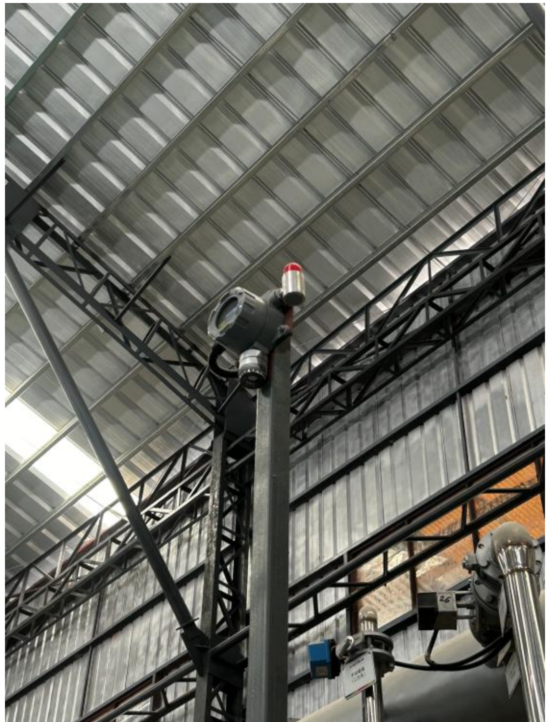
报批稿

××××－××－××发布　　××××－××－××实施

广东陶瓷协会

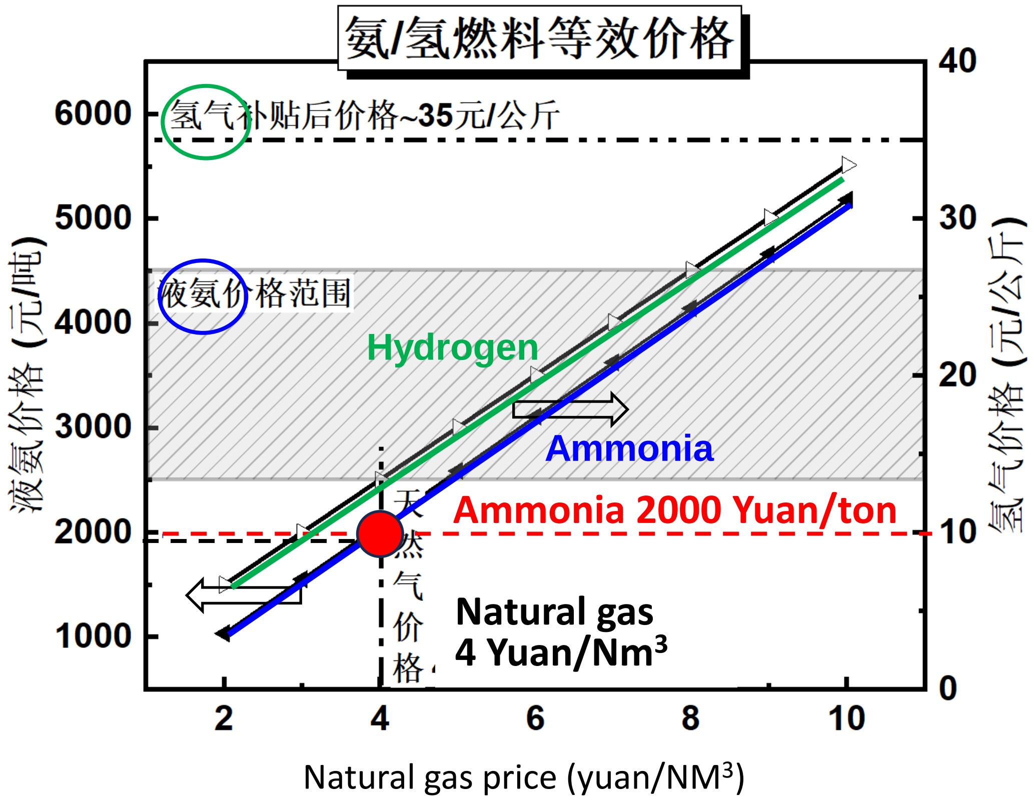
Xianhu Lab and the Guangdong Ceramic Society jointly drafted a "Code for application of ammonia fuel in ceramic industry", which has been endorsed by an expert panel and is within the National Standard Management Committee for recording.

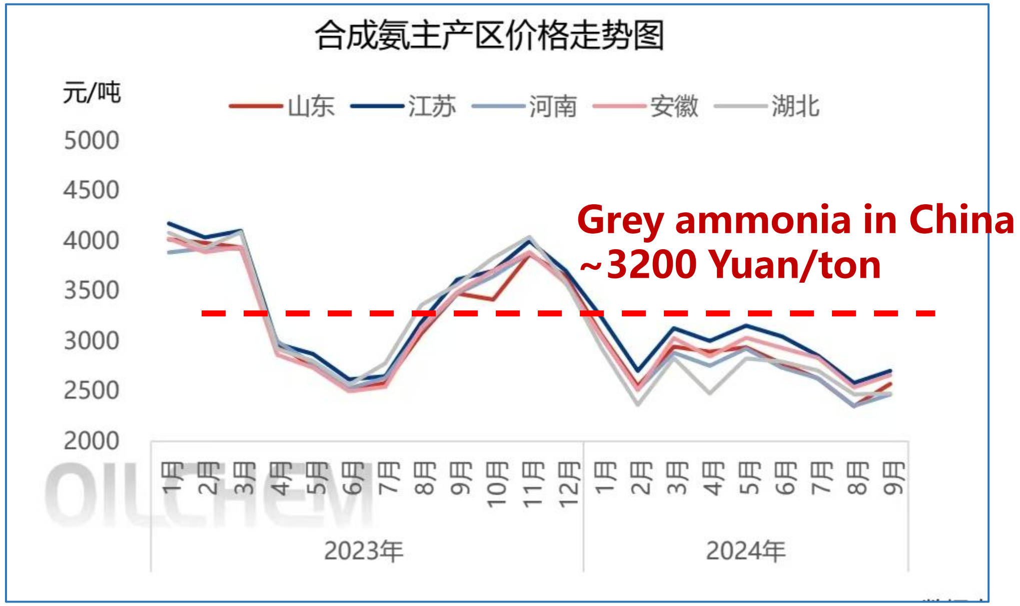
Strict health and safety regulations and trainings



Grey ammonia economical analysis

	Ammonia	Hydrogen	Natural gas
Heat value（kcal/Nm³）	3200	2390	8000
For equivalent heat value：1Nm³ Natural gas=2.5Nm³ Ammonia=1.93kg Ammonia=3.35Nm³ Hydrogen			
Carbon emission：1Nm³ Natural gas→1.97 kg Carbon dioxide			
Equivalent price：After consideration of carbon emission and carbon tax			





Average prices of anhydrous ammonia in Chinese market（2023-2024年）

There is limited space for a significant price reduction for grey ammonia.

Green ammonia economical analysis

- Green electricity price is the determining factor.
- Synthesis of green ammonia requires 12,000 kWh/ton green electricity
- Green electricity price reduction will result in green ammonia price reduction in the future

	Green ammonia			Grey ammonia（produced from coal）		
No	Green electricity price (Yuan/kWh)	Green hydrogen price (Yuan/kg)	Green ammonia price (Yuan/ton)	Coal price (Yuan/ton)	Hydrogen price from coal (Yuan/kg)	Grey ammonia price (Yuan/ton)
1	0.3	18.9	5070	/	/	/
2	0.2	13.6	3600～4500	1500～1800	16.2～18.8	＞3000
3	0.1	8.2	2190	700～900	7.6～8.2	1900～2200

Very large quantity of green ammonia required

High temperature industry has very high demand for low cost green ammonia.

	Foshan city	Guangdong province
Ceramic（Tile)	3.5 million tons	8.1 million tons
Metal（Aluminum)	0.7 million tons	1.8 million tons
Power generation	39.6 million tons	187 million tons
Total	43.8 million tons	197 million tons

- Current ammonia production in China: ~65 million tons/year
- Current world ammonia production: ~200 million tons/year
- Economies of scale would result in reduction of ammonia cost.

Summary

- We have for the first time demonstrated a **zero-carbon combustion technology** for the high-temperature manufacturing industries.
- **Ammonia safety** can be controlled and managed, providing that strict health and safety regulations and trainings are applied.
- **Nitrogen oxides** (NOx) produced in industrial combustion of ammonia can be controlled and well managed.




Thank you for your attention!

先进能源科学与技术广东省实验室佛山分中心
佛山仙湖实验室
FOSHAN XIANHU LABORATORY

FOSHAN XIANHU LABORATORY

佛山仙湖实验室

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Zero Carbon Smart Manufacturing - Green Development

World's First Ammonia-Hudrogen Zero-Carbon Combustion Technology Demonstration Production Line for the Ceramics Industry

Foshan Xianhu Laboratory × Monalisa Group × De LI Tai Technology × Anqing Technology × Oceano Ceramics -- Joint Release

Publisher: **Zhang Qikang**

Monalisa | A Practitioner of Green Transformation in China's Ceramics Industry

A-share listed company, nationally recognised enterprise technology centre, commit to achieving green and sustainable development of enterprises and the industry.

Monalisa's Three Core Environmenta Protection Principles

- To become a leading enterprise in resource conservation and environmental-friendly
- Maintaining continuous environmental management without any pause or compromise.
- Alming at ultra-low emissions and establishing stringent internal control standards.

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Environmental protection for **20 years**

Cumulatively input **500000000+**

- Environmental protection treatment technology is voluntarily upgraded from 1.0 to 5.0. Become the green benchmark of the industry with ultra-low emission. In-depth promotion of photovoltaic, ammonia-hydrogen new energy technology applications. Promote the transformation of energy cleanliness and low carbonisation. Has four national green factories

26 September 2024

The world's first ammonia-hydrogen-zero-carbon combustion technology demonstration line for the ceramic industry was put into production by Monalisa.

Monalisa has successfully achieved the world's cutting-edge technological breakthroughs from 0 to 1 and gradually built the industry's *six-zero demonstration factory* from 1 to 0.

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World-leading zero-carbon combustion technology

Breakthroughs in six of the world's leading-edge technological challenges

1

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World A breakthrough in six cutting-edge technologies.

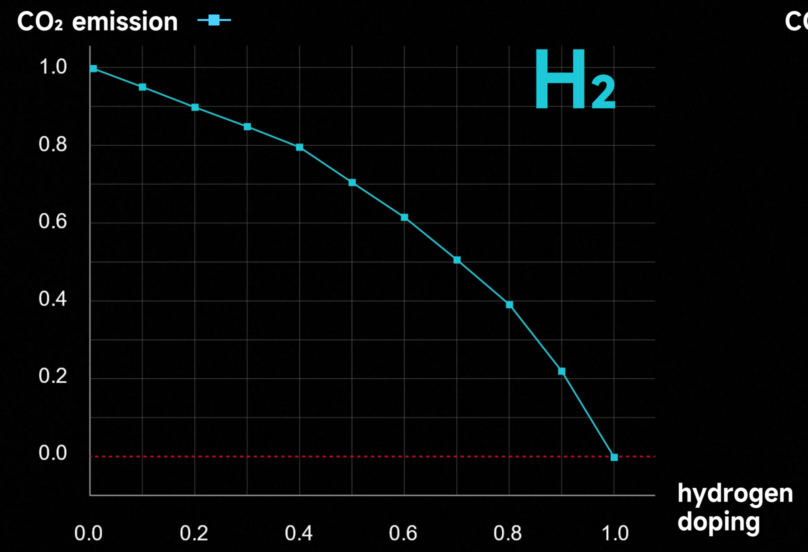
- Low calorific value: 3200°C kcal, difficult to ignite and burn
- Turbulent rotating lance and multi-stage combustion technology
- Reliable high-energy ignition, complete and full combustion and continuous stable combustion.

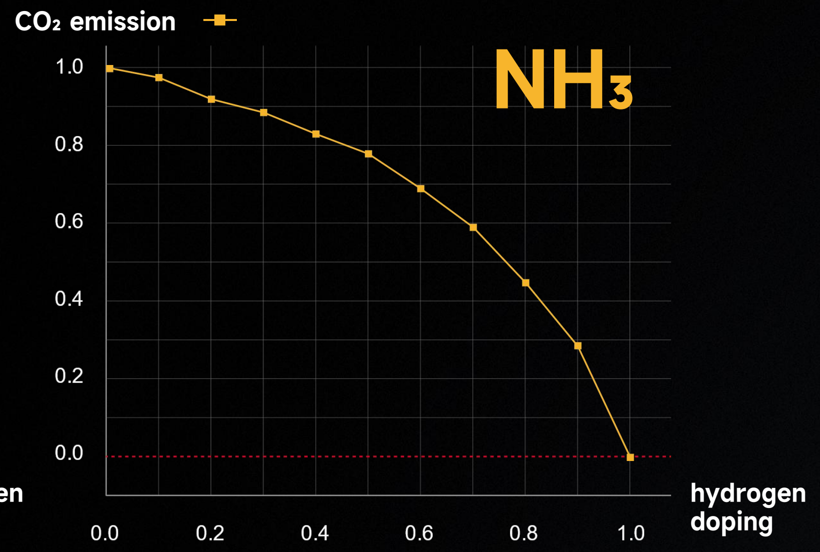
2

MONALISA

Zero CO_2 emission in combustion process

- Post-combustion products: nitrogen and water
- The most direct, fundamental and effective technology pathway to zero carbon emissions





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3

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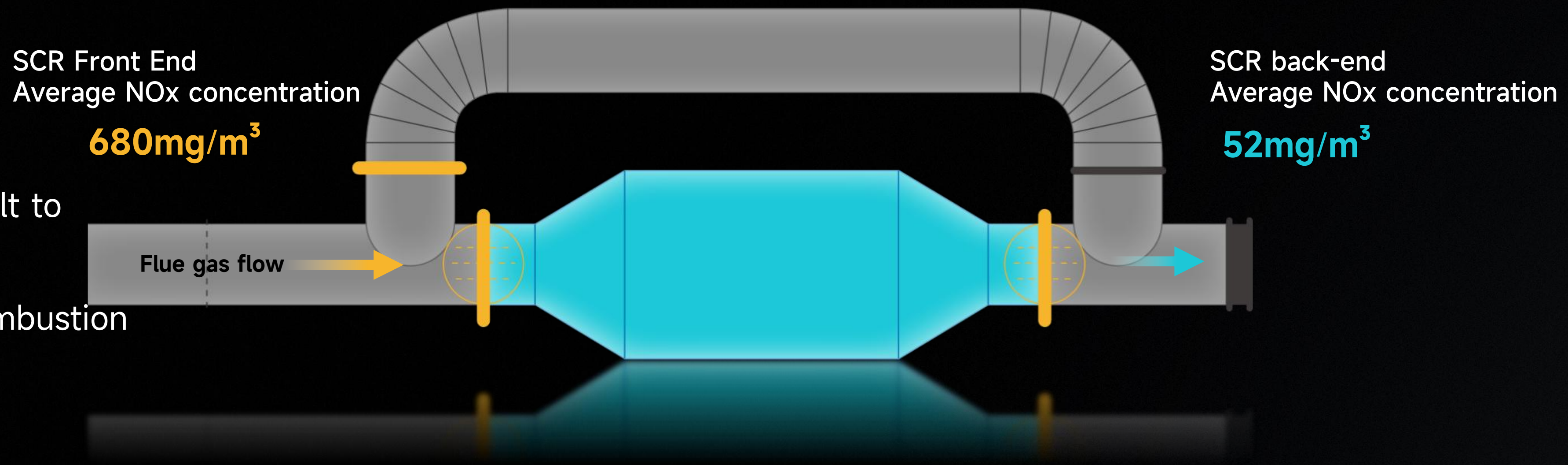
Controlled NOx emissions

- Ammonia combustion: fuel type NOx combustion is insufficient and difficult to control
- Deep zoned grading - flue gas internal circulation synergistic low NOx combustion
- Multi-stage synergistic purification and treatment of NOx.
- NOx emission converted value <60mg/m³, much stricter than GB25464.



4

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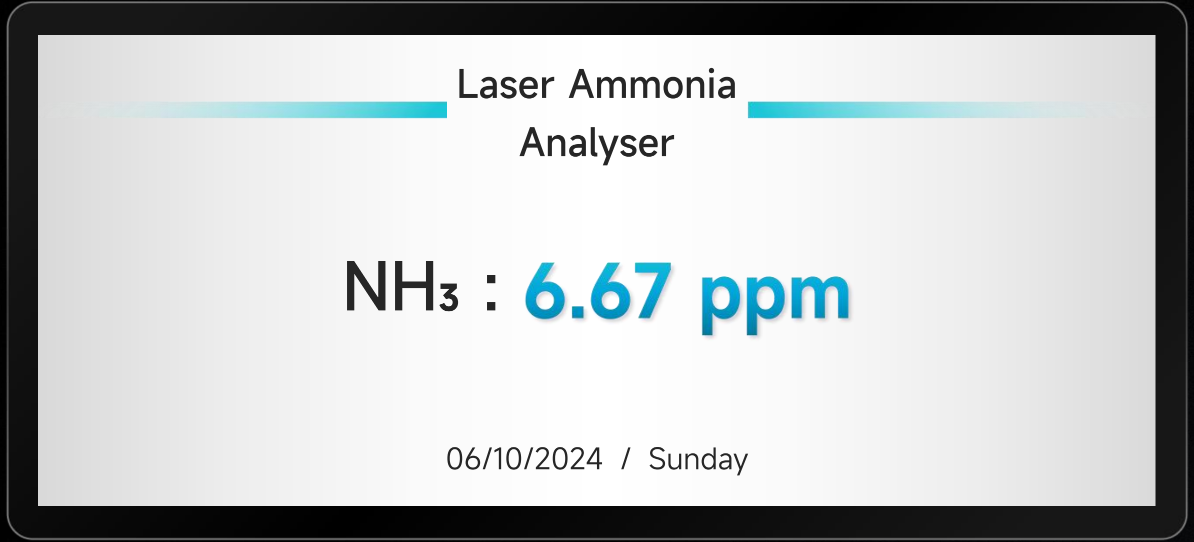
Less ammonia escape

- Traditional SCR and SNCR denitrification incomplete, resulting in ammonia escape
- Laser spectroscopy advanced testing and diagnostic methods, applied optical online monitoring technology
- High temperature, high humidity complex flue gas: ammonia leakage and ammonia escape sensors
- NH_3 control at lower levels: <5mg/m^3



5

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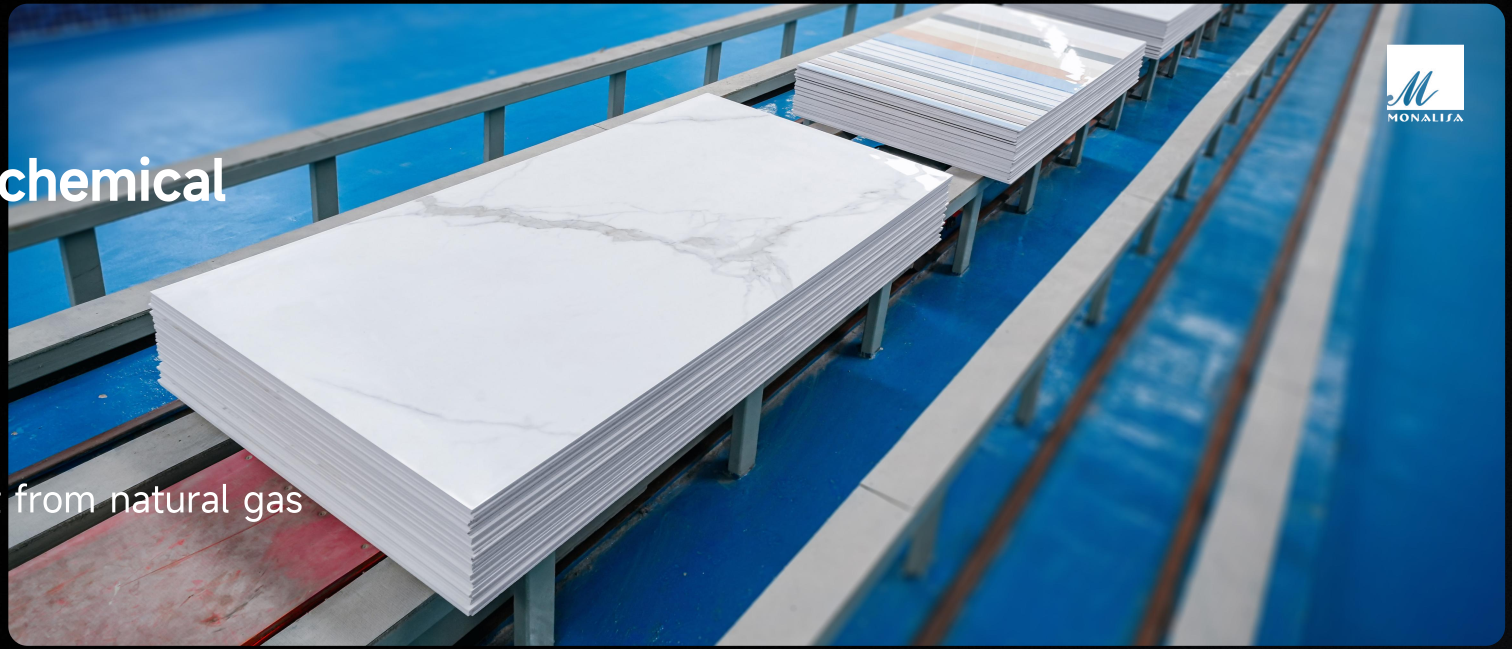
Ceramic slate tiles with colour and physical and chemical indicators not different from natural gas firing

- Fuel substitution and new technology application, serving product quality
- Modulus of rupture, breaking strength, chemical resistance, etc. are no different from natural gas
- Ammonia-hydrogen zero-carbon combustion is fully feasible



6

MONALISA

Completion of fuel-based liquid ammonia gasification station and supply system for non-chemical enterprises

- Completion of a three-stage ammonia station and green energy supply system
- Sound safety system: precautionary measures, safe storage, operation norms, accident response
- Double bottoming of technology and system

- While our peers are still watching and waiting, Monalisa is taking action to realise mass production of high temperature fired 0 carbon.
- Similar demonstration projects at home and abroad remain at the laboratory or pilot stage.

- The demonstration line of ceramic tile mass production line annual output of 1.5 million m²
- Achieve carbon reduction of 5200 tonnes/year after 100% pure ammonia combustion in roller kiln.
- The national building materials industry can directly reduce carbon by 8 tonnes/year.

26%

Monalisa

800M Tonnes

Nationwide

A major breakthrough in ammonia-hydrogen zero-carbon combustion technology

Achievement of Peak Carbon Neutrality for Ceramics in Buildings

Six-zero factories in the building materials industry

Monalisa has explored a [practical] path of technology

If all high-carbon emitting industries work together to promote the development of a new ammonia-hydrogen energy industry, the whole country and all of humankind will be able to gradually free themselves from their dependence on fossil fuels.

[Moving Towards Carbon Neutrality Together]

High | temperature | industry

Ammonia-Hydrogen Combustion

| A Zero-Carbon Future

MONALISA DLT德力泰 安清科技 OCEANO 欧神诺瓷砖