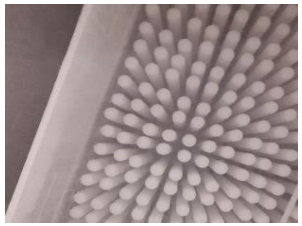
Ceramic Fiber Filter



CHOKO CO., LTD.

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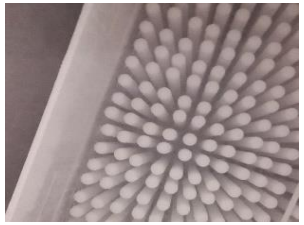
Product Introduction



Innovate Maker of Ceramic Filter

The products are mainly used in industrial waste gas filtration, removal of harmful substances and high-temperature powder recovery. We help industries around the world effectively reduce air pollution emissions and energy consumption.

Products:

T-01 Series Ceramic Fiber Filter

H-01 Series High-temperature Catalytic Ceramic Fiber Filter

M-01 Series Mid-temperature Catalytic Ceramic Fiber Filter

L-01 Series Low-temperature Catalytic Ceramic Fiber Filter

Catalytic/Ceramic Fiber Filter

Ceramic Fiber Filter

250~750˚C

High-temp Catalytic Ceramic Fiber Filter

330~420˚C

Mid-temp Catalytic Ceramic Fiber Filter

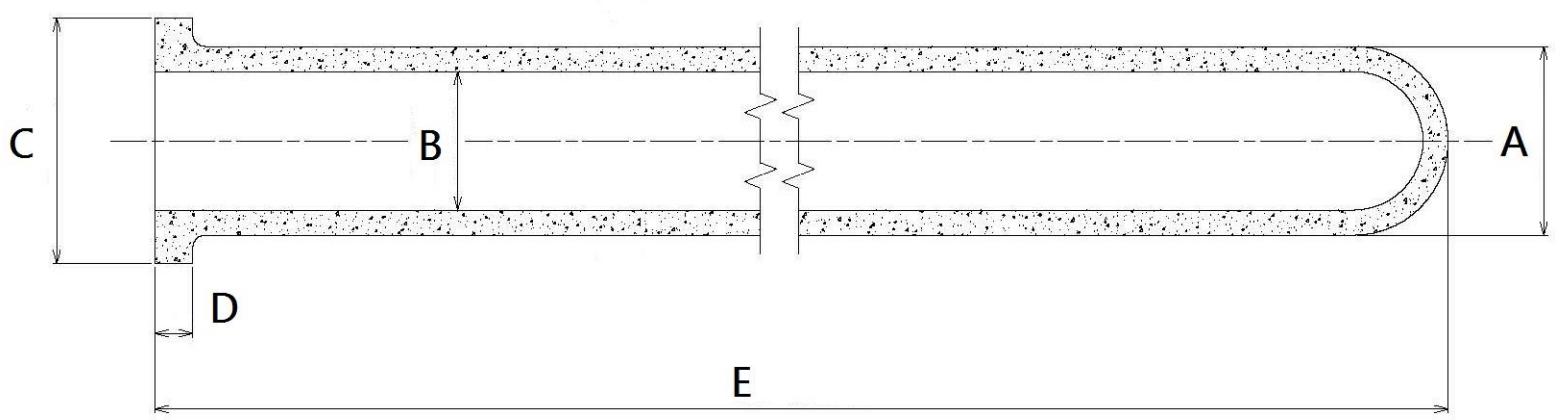
250~350˚C

Low-temp Catalytic Ceramic Fiber Filter

175~250˚C

- **Replace Traditional Bag Filter**: Compatible with standard bag filter design concepts.
- **High Temperature & Corrosion Resistance:** Better performance than traditional filter bag.
- **Long Lifetime:** Longer lifetime than traditional filter bag.
- **All-in-one low emission design:** Integration design system meets requirement of low emission and operation cost.
- **Thermal Recovery:** After removal of dust & acid, the clean exhaust can improve the value of thermal recovery.
- **Low temperature-free energy consumption:** the system in the 175-250°C state can remove dust and nitrate, free of the operation cost reduction of the human.
- **Low-temperature competitive advantage:** the system in low-temperature, small gas expansion, low equipment prices, good competitive power.

Specification



Code	Description	Unit	Size							
A	O.D. of element	mm	150						60	
B	I.D of element	mm	110						40	
C	O.D. of flange	mm	195						80	
D	height/thickness of flange	mm	30						20	
E	length of element	mm	4000	3000	2500	2000	1500	1000	1500	1000
F	filtration surface of element	m^2	1.7	1.3	1.07	0.83	0.6	0.36	0.24	0.145

[1] Size can be customized.

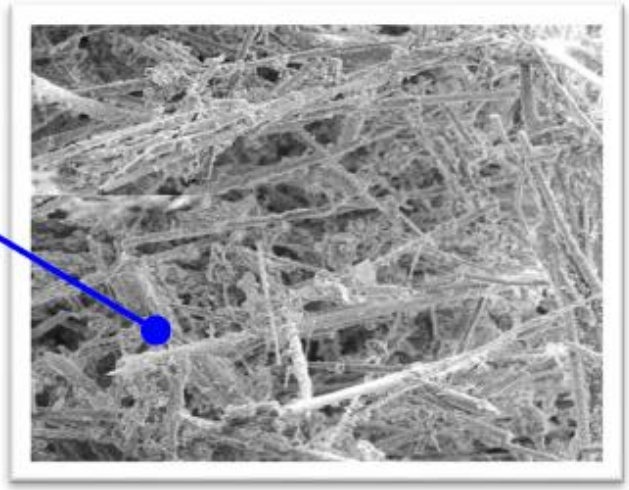
Material Properties

- Composed of aluminum silicate fibers and inorganic adhesive
- High porosity
  - Porosity: 65~85%
  - Low density: 0.4 g/cm^3
  - Heat & shock resistance

  (It won't break due to thermal expansion and contraction.)
- High removal efficiency comes from very fine ceramic fiber (Φ about 2-3μm)
- Chemically almost inert
- High temperature resistance
- Rigid structure
- High porosity
  - Self-supporting, no frame required
  - Cylinder

Ingredients:
Ceramic fiber
(Aluminum silicate fiber)

Filter element:
Fiber structure
SEM pic



Ceramic Fiber Filter

High-temp Filtration
Heat Recycle

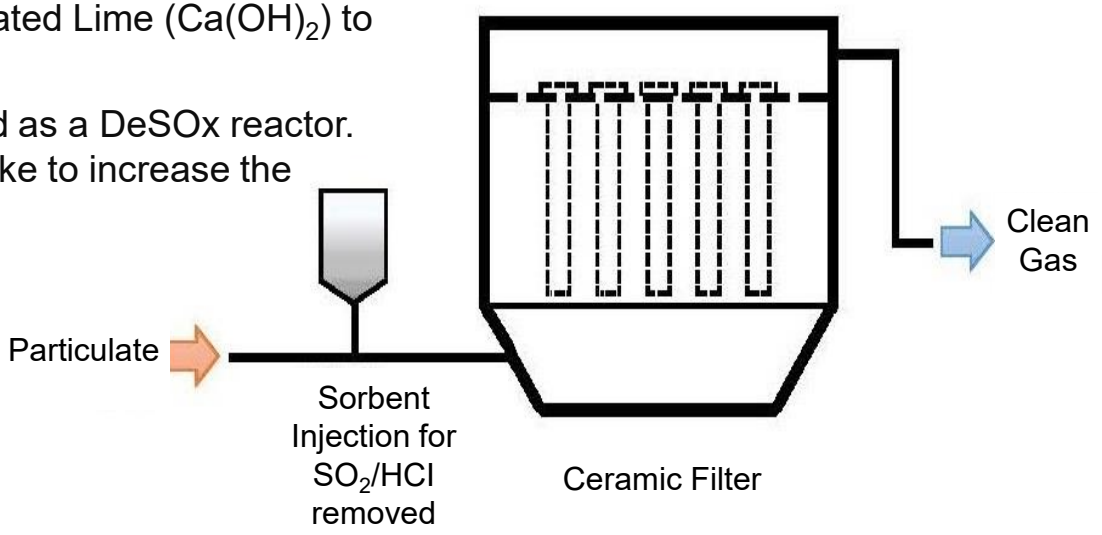
Target Pollutants: Dust
Dust generated from deSOx process

1. The ceramic fiber filter are installed on the plates of dust collector directly and can be operated under high temperature. The solid structure provides high filtration efficiency and stability under long-run operation.

2. Assist to DeSOx: Use dry or semi-dry FGD and variety of alkali sorbents such as Sodium Bicarbonate ($NaHCO_3$), Sodium Hydroxide (NaOH) or Hydrated Lime ($Ca(OH)_2$) to remove acid gas (SO_2, HCl, HF…)

   Filter dust collector can be regarded as a DeSOx reactor. The surface of filter is full of lime cake to increase the reaction efficiency.

3. Operating Temperature: 750°C
   Instant Peak Temperature: 900°C
   (within a short time)



Filtration Mechanism

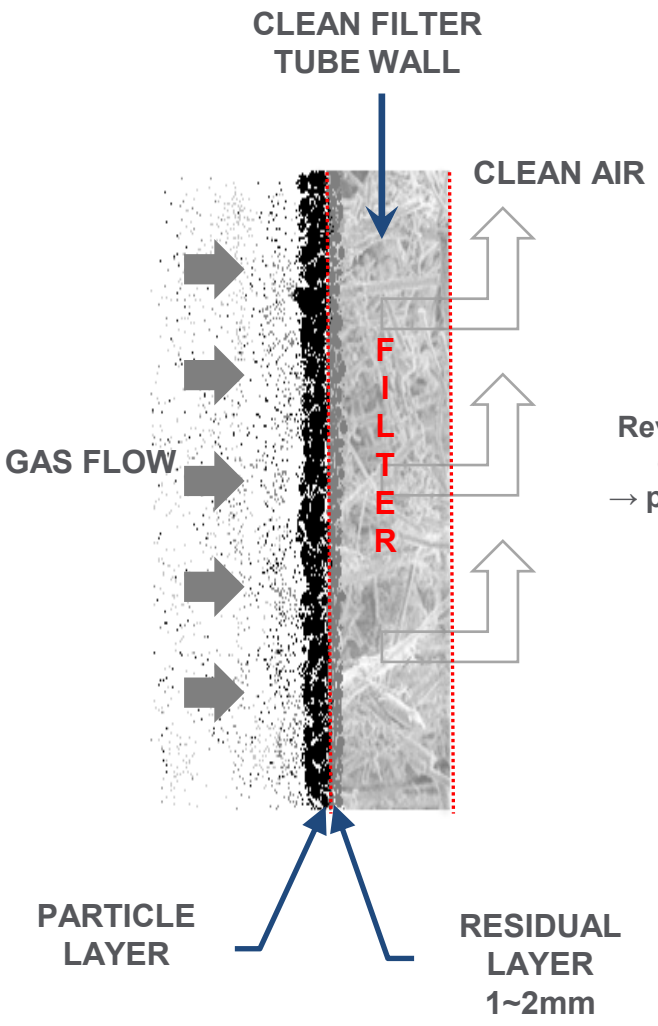


Figure (1)

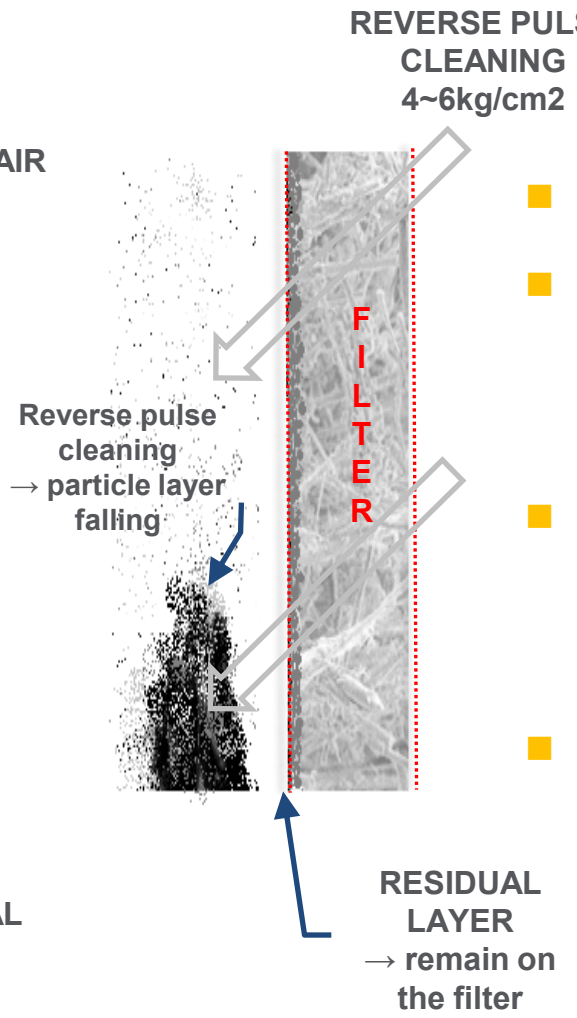
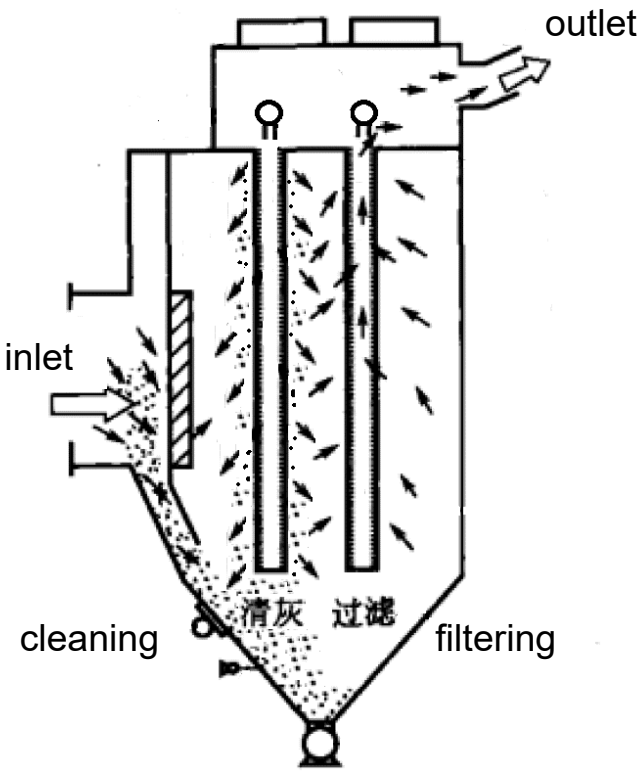


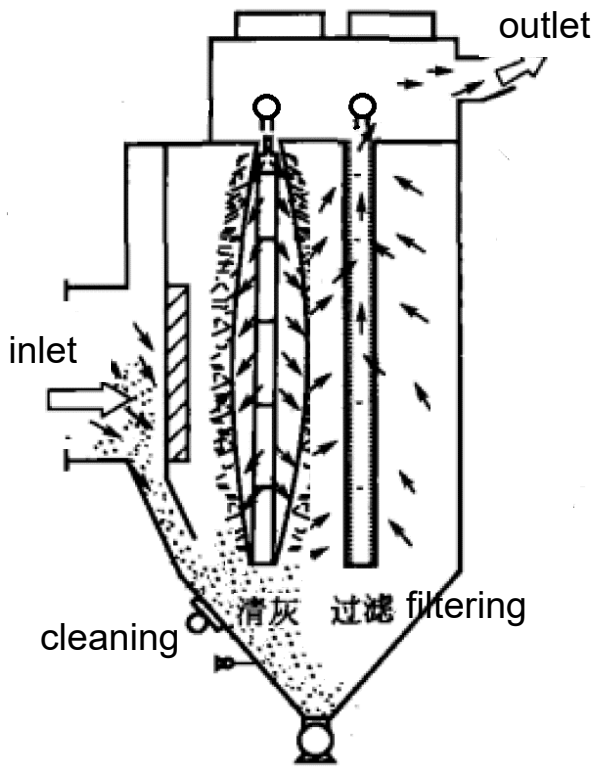
Figure (2)

- 1. Pre-spraying – slaked lime.
- 2. Residual Layer – dust permeating to 1-2mm depth. Prevent dust penetrate into filter body.
- 3. Form a particle layer(dust cake) – periodically removed with a reverse pulse of air
- 4. High filtration efficient – can filtrate dust of different particle sizes to the standard of HEPA.

Comparison of Filtration Mechanism



Ceramic Fiber Filter



Traditional Filter Bag

- Traditional filter bag is flexible which the dust cake will entirely be peeled off during reverse pulse cleaning and then let the dust penetrate into it.
- Solid ceramic fiber filter can keep residual layer to uprate filtration effect of fine particles.
- Longer lifespan than traditional filter bag.

High / Mid / Low temp. Catalytic Ceramic Filter

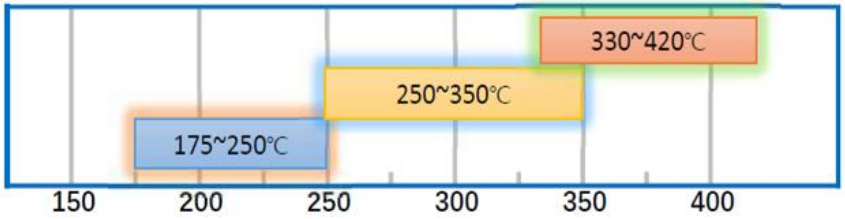
Multi Functional Filtration

Removal of :
Particulate /
Dust generated from SOx and Acid Gas removal process/
Nitrogen Oxides / Dioxins

1. In addition to dust filtration, it can remove acid gas(SO_2, HCl, HF…) by injection of alkali reactants and remove NOx by adding ammonia and urea.

2. Catalyst distributed throughout filter element structure to accelerate the reaction of NOx removal.

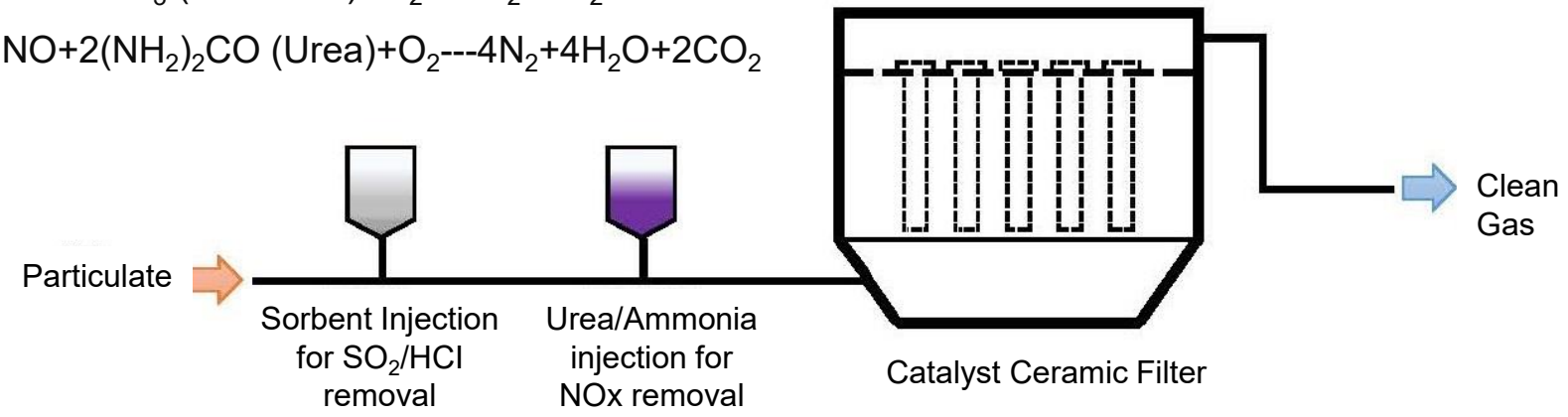
3. **High-Temperature Catalyst**
   Mid-Temperature Catalyst
   Low-Temperature Catalyst



SCR
Selective Catalytic Reduction

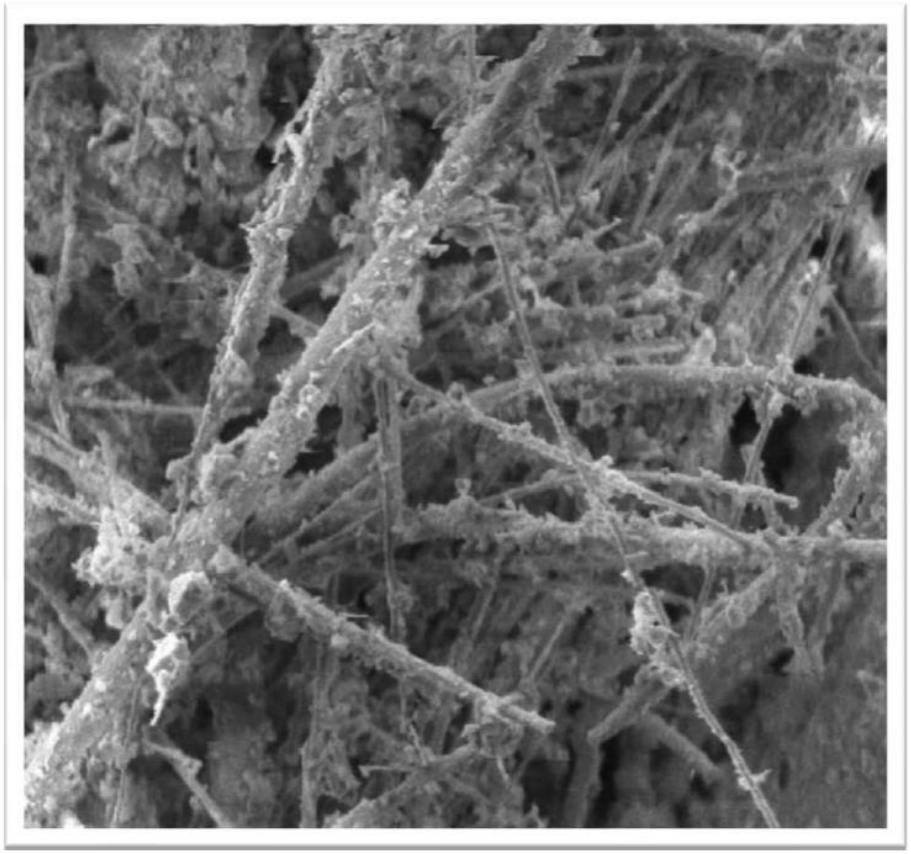
$4NO+4NH_3$ (Ammonia)$+O_2$---$4N_2+6H_2O$

$4NO+2(NH_2)_2CO$ (Urea)$+O_2$---$4N_2+4H_2O+2CO_2$



Catalytic Ceramic Fiber Filter Technology

The distribution of catalyst on the ceramic fiber filter



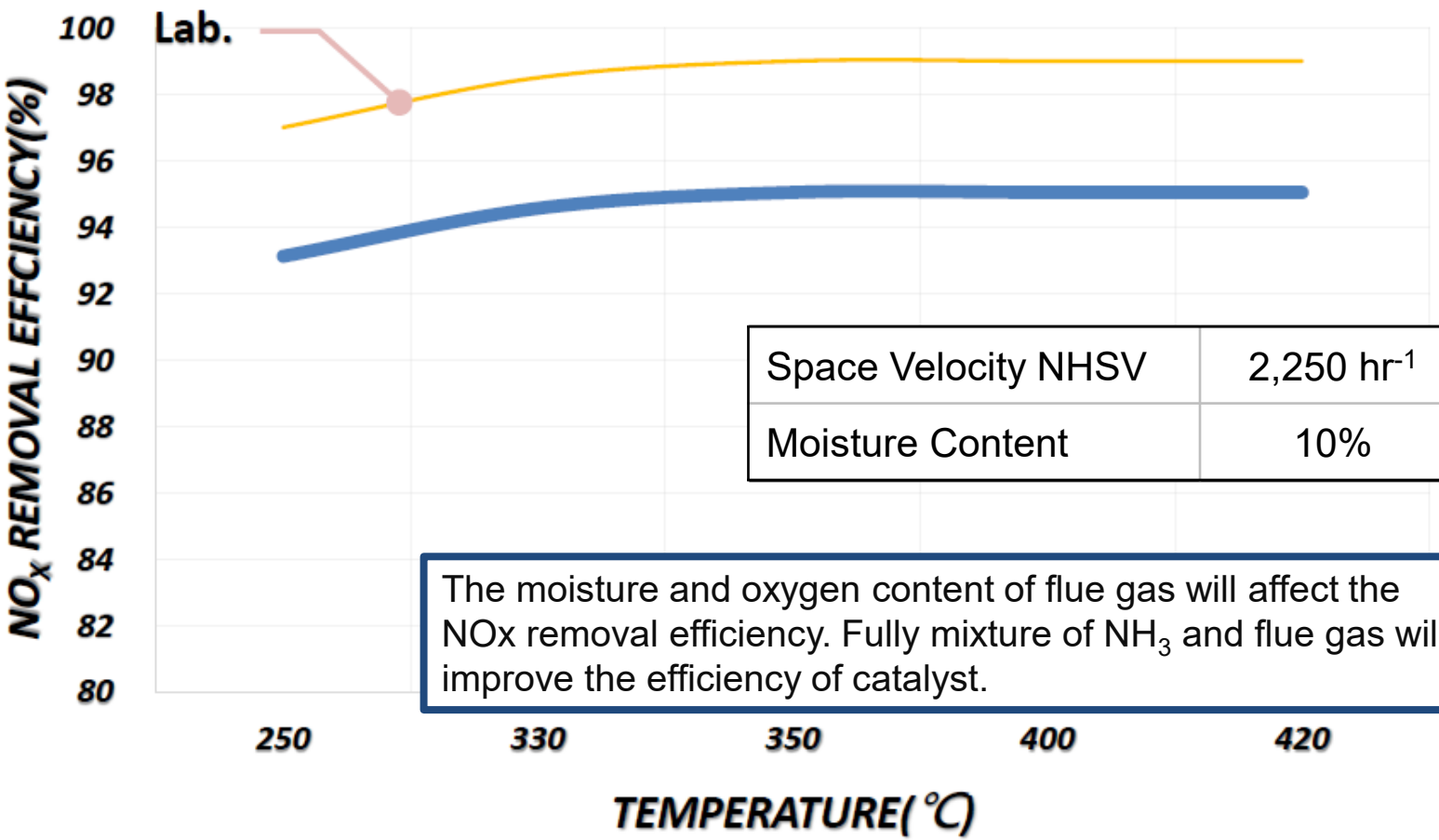
SEM

The irregular elongated fiber on the left is catalyst nanoparticles, this nanolization makes

- Expand the contact area of catalyst.
- Increase reaction time.
- Increase removal efficiency.
- The labyrinth structure of irregular fiber helps increase the contact frequency when the flue gas pass through.

High-temp Catalyst- DeNOx Efficiency

High-Temperature Catalyst- NO_X REMOVAL EFFICIENCY

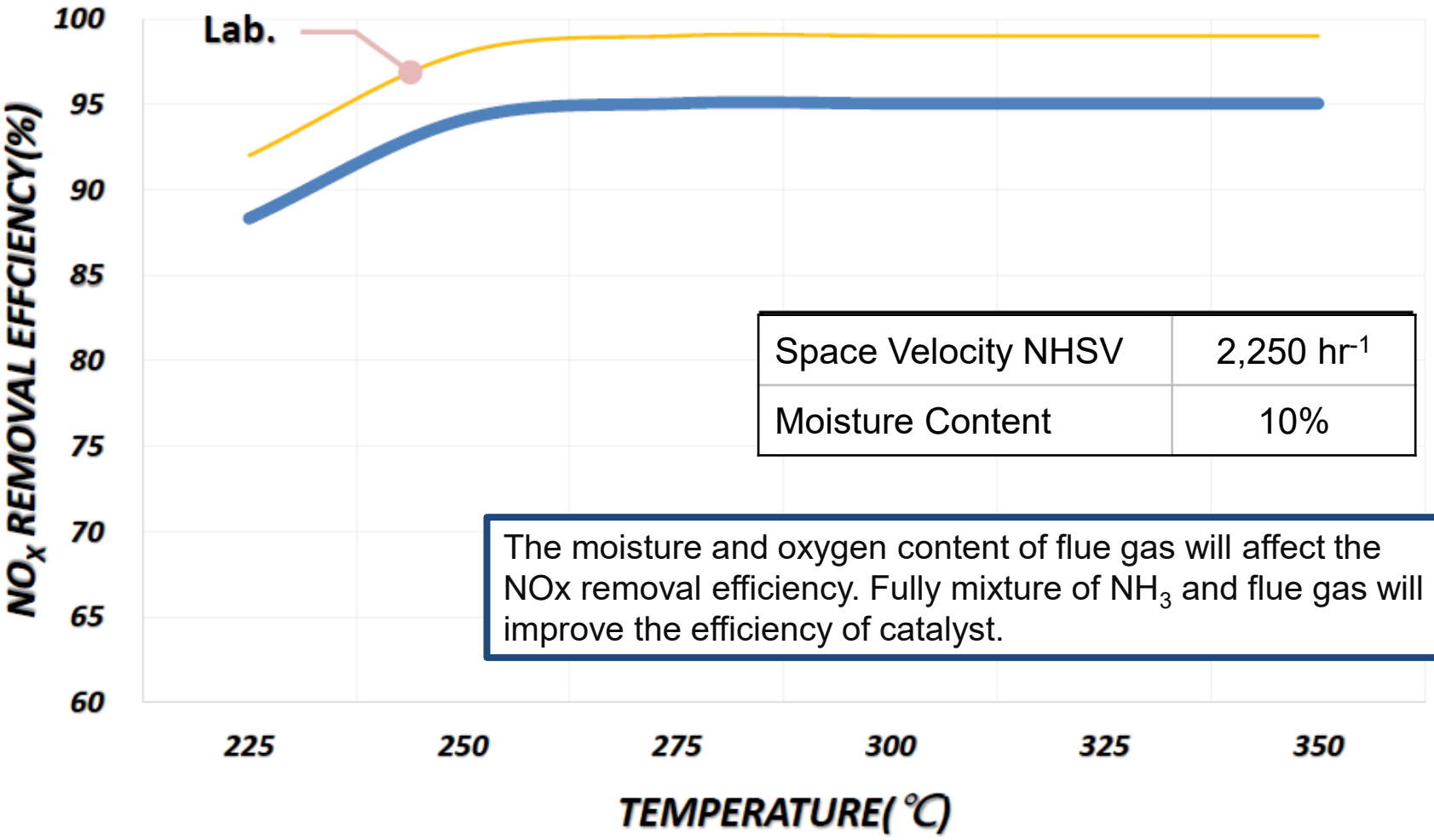


Space Velocity NHSV	2,250 hr^{-1}
Moisture Content	10%

The moisture and oxygen content of flue gas will affect the NOx removal efficiency. Fully mixture of NH_3 and flue gas will improve the efficiency of catalyst.

Mid-temp Catalyst- DeNOx Efficiency

Mid-Temperature Catalyst- NO_X REMOVAL EFFICIENCY

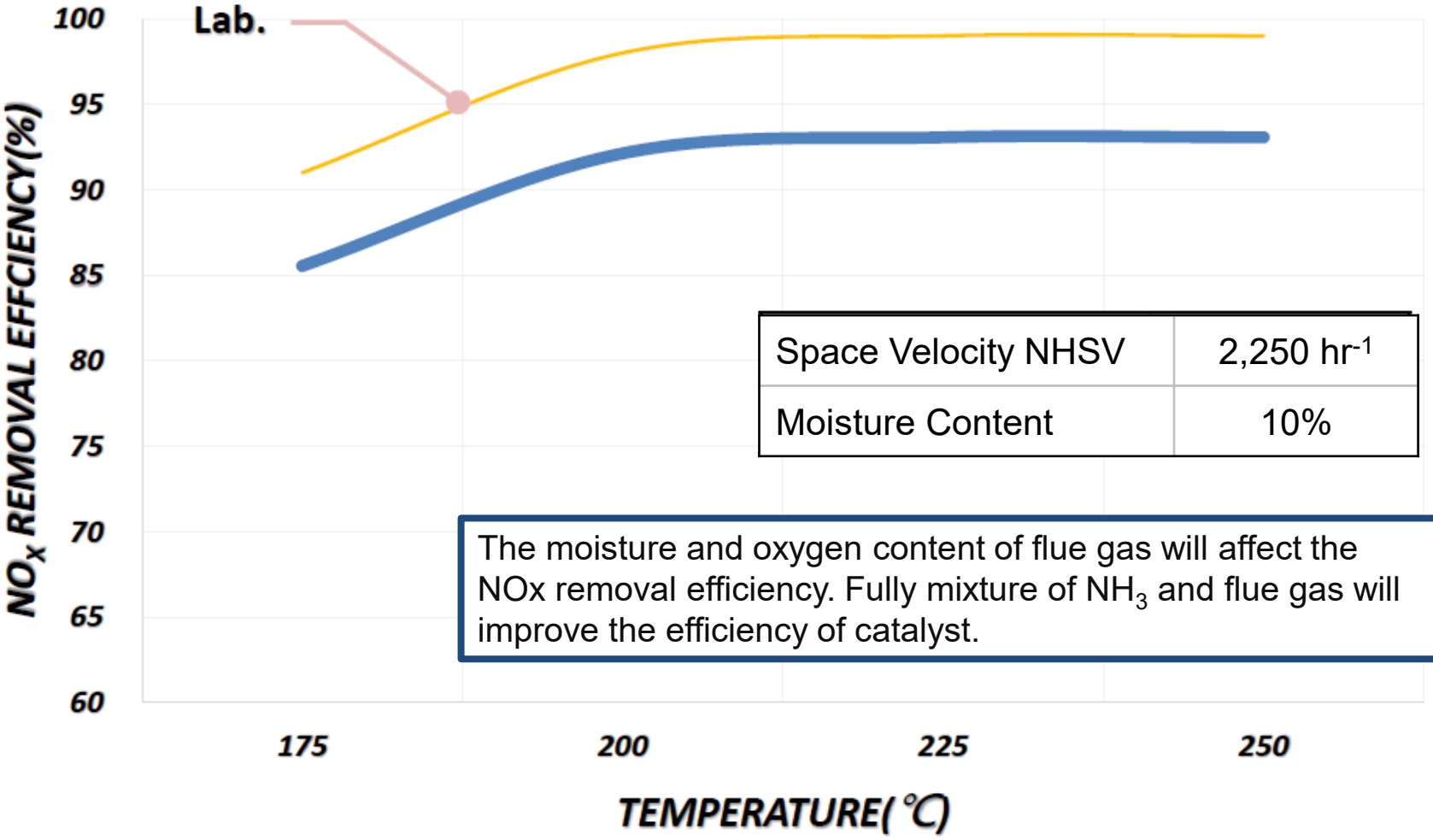


Space Velocity NHSV	2,250 hr^{-1}
Moisture Content	10%

The moisture and oxygen content of flue gas will affect the NOx removal efficiency. Fully mixture of NH_3 and flue gas will improve the efficiency of catalyst.

Low-temp Catalyst- DeNOx Efficiency

Low-Temperature Catalyst- NO_X REMOVAL EFFICIENCY

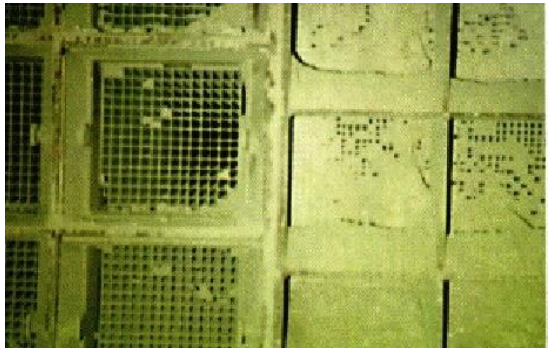


Space Velocity NHSV	2,250 hr^{-1}
Moisture Content	10%

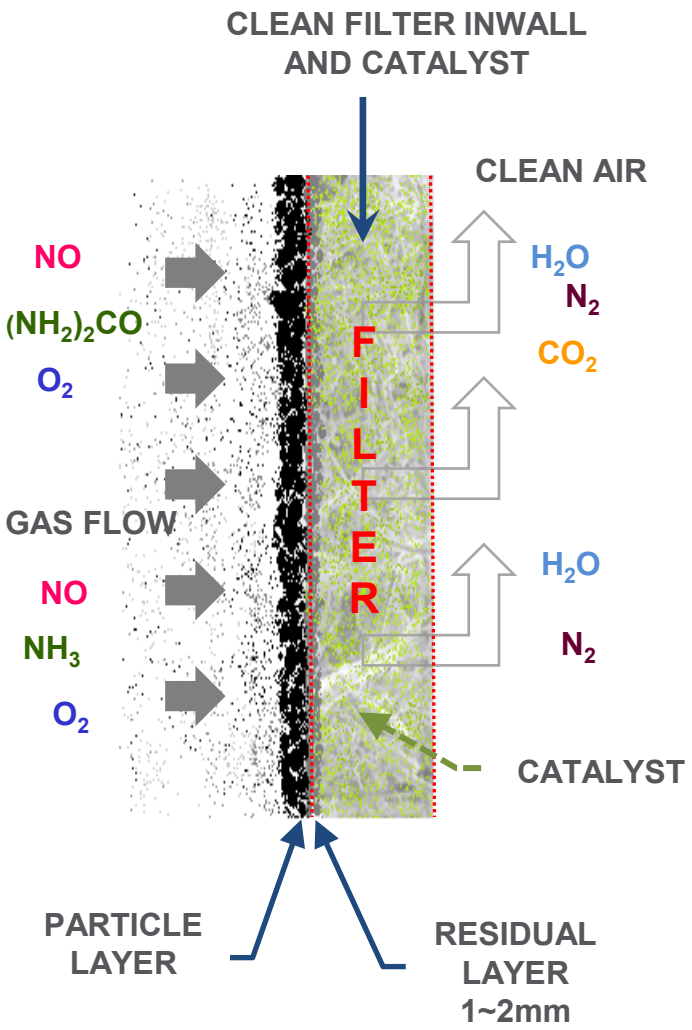
The moisture and oxygen content of flue gas will affect the NOx removal efficiency. Fully mixture of NH_3 and flue gas will improve the efficiency of catalyst.

Avoid Catalyst Failure / Dry DeSOx

- Due to the formation of dust cake on the surface of the filter element, catalyst is protected against heavy metals like As, Se, and Hg and alkali metals like Na_2O and K_2O.
- Catalyst distributed throughout filter element can avoid dust clogging.
- As the catalyst is distributed throughout ceramic filter element, the lifetime of catalyst can be longer and which also help catalyst maintain high activity.
- The even distribution of catalyst helps improve the efficiency of reaction.
- Install dry deSOx at front end can reduce the generation of ABS [$(NH_4)_2SO_4$, NH_4HSO_4]. Incompatible with beehive type device.



Dust Clogging and wear-out of catalyst



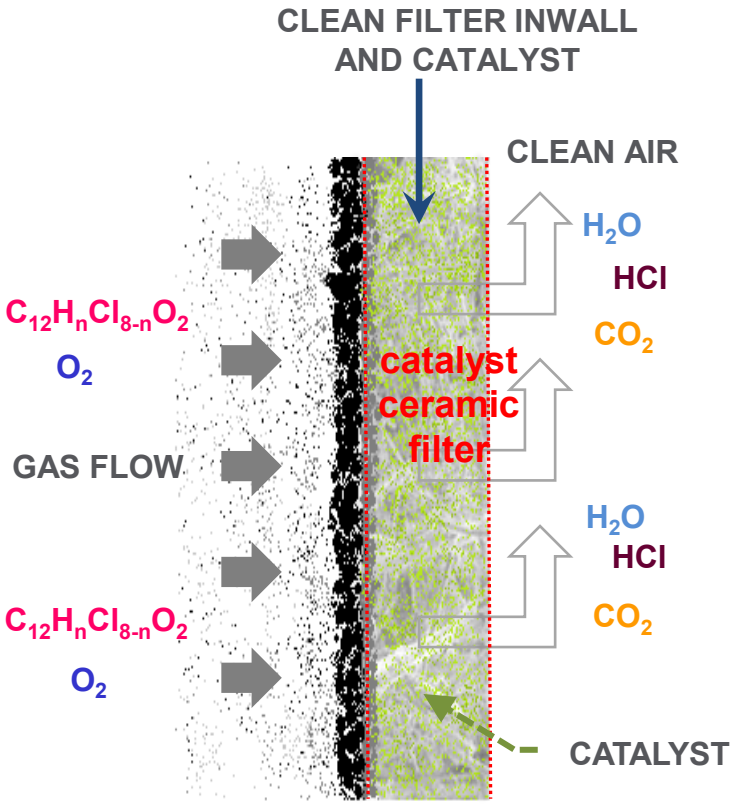
Catalyst – Removal of Dioxins

Catalyst is mainly used to remove NOx, but it can remove dioxins as well. With the function of vanadium-based catalyst, dioxins react with oxygen and be decomposed into nontoxic materials like CO_2, H_2O, and HCl.

General chemical equation of dioxins removal:
$C_{12}H_nCl_{8-n}O_2+(9+0.5n)O_2=(n-4)H_2O+12CO_2+(8-n)HCl$

The disadvantages of removing dioxins from exhaust with activated carbon are as follows:

1) Activated carbon requires expensive spraying devices, and the removal efficiency is affected by fluctuation in feeding work.
2) The adsorption of dioxins by activated carbon is only transferring the dioxins to fly ash, the total amount does not decrease.
3) The adsorption efficiency of activated carbon is closely related to the surface area of the activated carbon and the degree of mixture with the exhaust. Stability and complete control is difficult to achieve.
4) Fly ash containing dioxins must be transported to a hazardous waste treatment plant for processing to prevent dioxins from escaping once more.
5) The existence of carbon increases the risk of a fire occurring naturally in the dust collector.
6) Activated carbon adsorbs dioxins, but not break down dioxin. Thus, workers are situated in a dangerous environment.



Catalyst – Removal Efficiency of Dioxins

Cheng Shiu University
Dioxins removal efficiency
Test Datum

Selection catalyst decomposition through extensive research and factory verification. The commercialization NOx control catalyst can also effectively reduce PCDD/Fs emissions

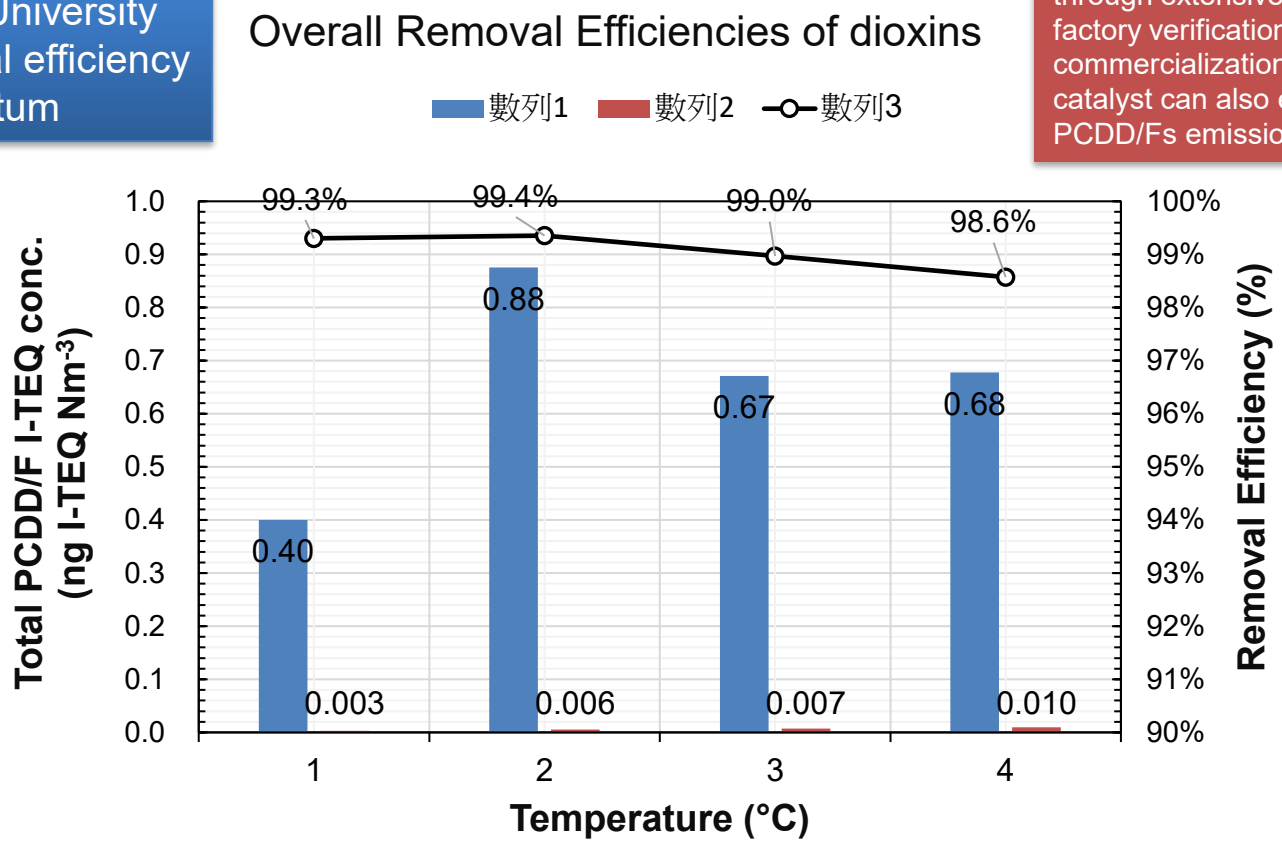


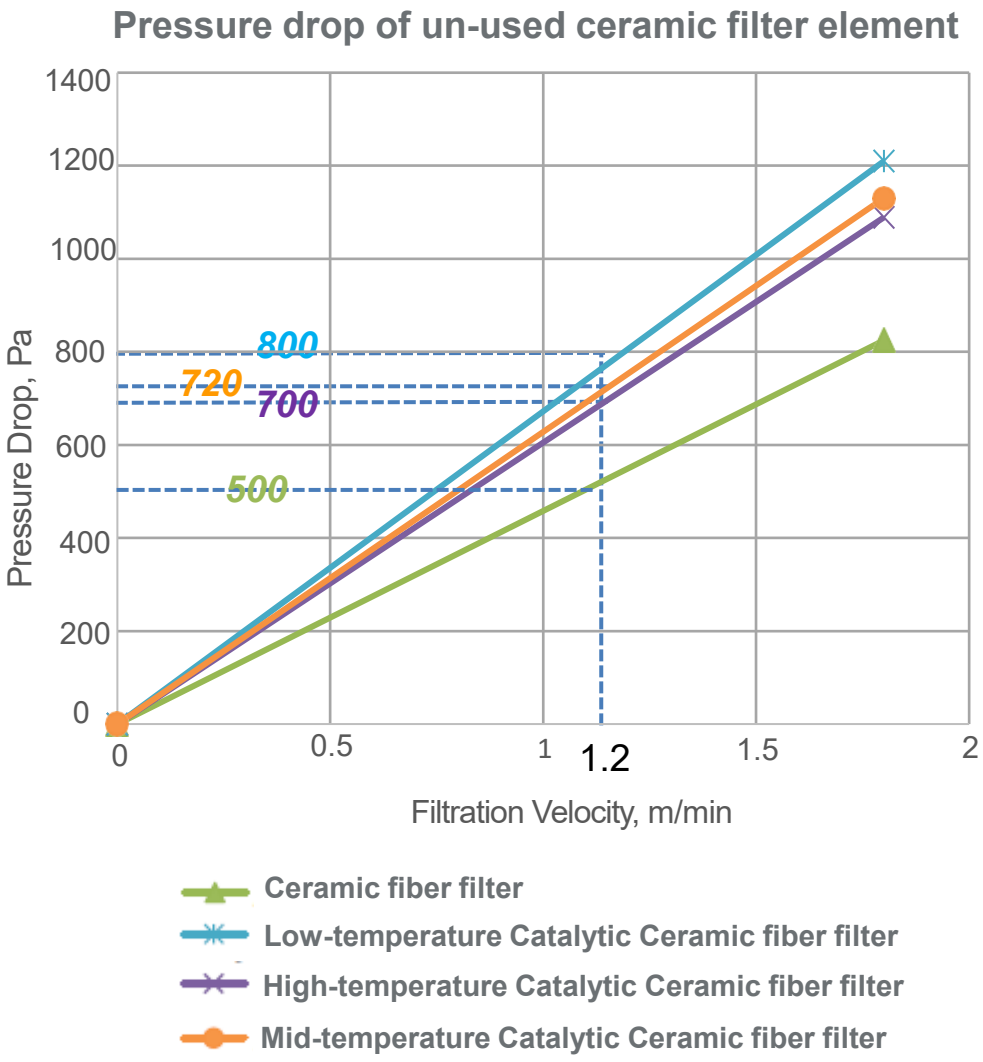
Chart of PCDD/Fs TEQ **TEQ**(I-TEQ Nm^{-3}) Removal Efficiency and Temperature

Remark: TEQ (Toxic Equivalents Quantity)：TEQs are used to report the toxicity-weighted masses of mixtures of dioxins in medium like soil, air, water, living body and foods. Dioxin compounds are given equal or lower numbers, with each number roughly proportional to its toxicity relative to that of 2,3,7,8-TCDD. I-TEQ: including 7 dioxins and 10 furfurans.

Operating Pressure Drop & Filtration Efficiency

Operating Pressure Drop Control

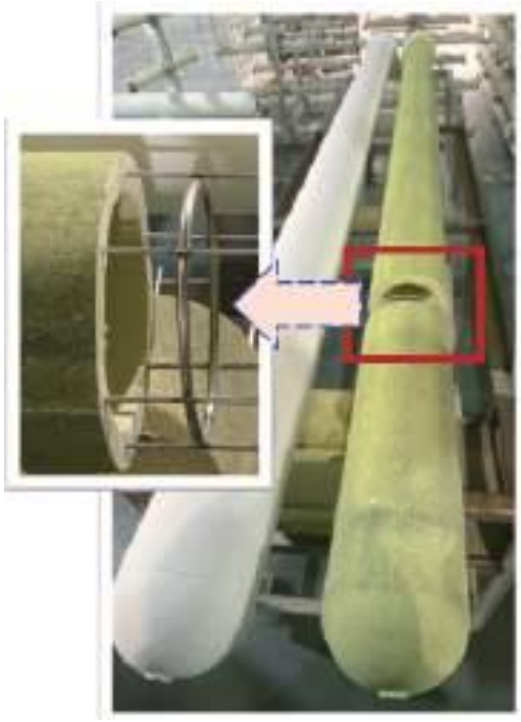
- The picture on the right is the pressure difference between the unused filter and the filter at different filtration speeds at room temperature.
- The initial pressure drop of the dust collector is about 950~1200Pa.The pressure drop in use depends on cleaning parameters, gas composition, gas temperature and filtration properties of the particles. The control during the initial operation is generally 1300-1600Pa.
- **Efficiency of Particulate Filtration**: the typical emission condition is lower than the standard working condition 5mg/Nm^3, usually less than 2mg/Nm^3.



Seismic-Resistant Ceramic Fiber (Catalytic) Filter – Design Concept

By combining the heat resistance of ceramic fibers with the toughness of metal reinforcement materials…

- **Improved Seismic Resistance:**
  The stainless-steel framework embedded inside the filter forms an elastic support structure.When severe vibrations such as earthquakes occur, deformation of the metal frame absorbs energy and reduces the direct impact force applied to the ceramic filter layer.
- **Prevention of Falling Damage:**
  Even if cracks occur in the ceramic layer during an earthquake, the metal frame holds the ceramic components together, preventing complete breakage and falling while maintaining basic filtration performance.
- **Stress Dispersion Design:**
  The lattice-shaped framework evenly disperses structural stress caused by earthquakes and prevents rapid crack propagation.



Why is seismic resistance required?

Ceramics are inherently brittle. When conventional ceramic-only filters are used, earthquakes may often cause instantaneous brittle fracture, which can lead to total failure of the filter.
By adding a metal framework, damage becomes localized and controllable rather than catastrophic, significantly improving earthquake safety and overall system reliability.

Seismic-Resistant Ceramic Fiber (Catalytic) Filter – Main Advantages

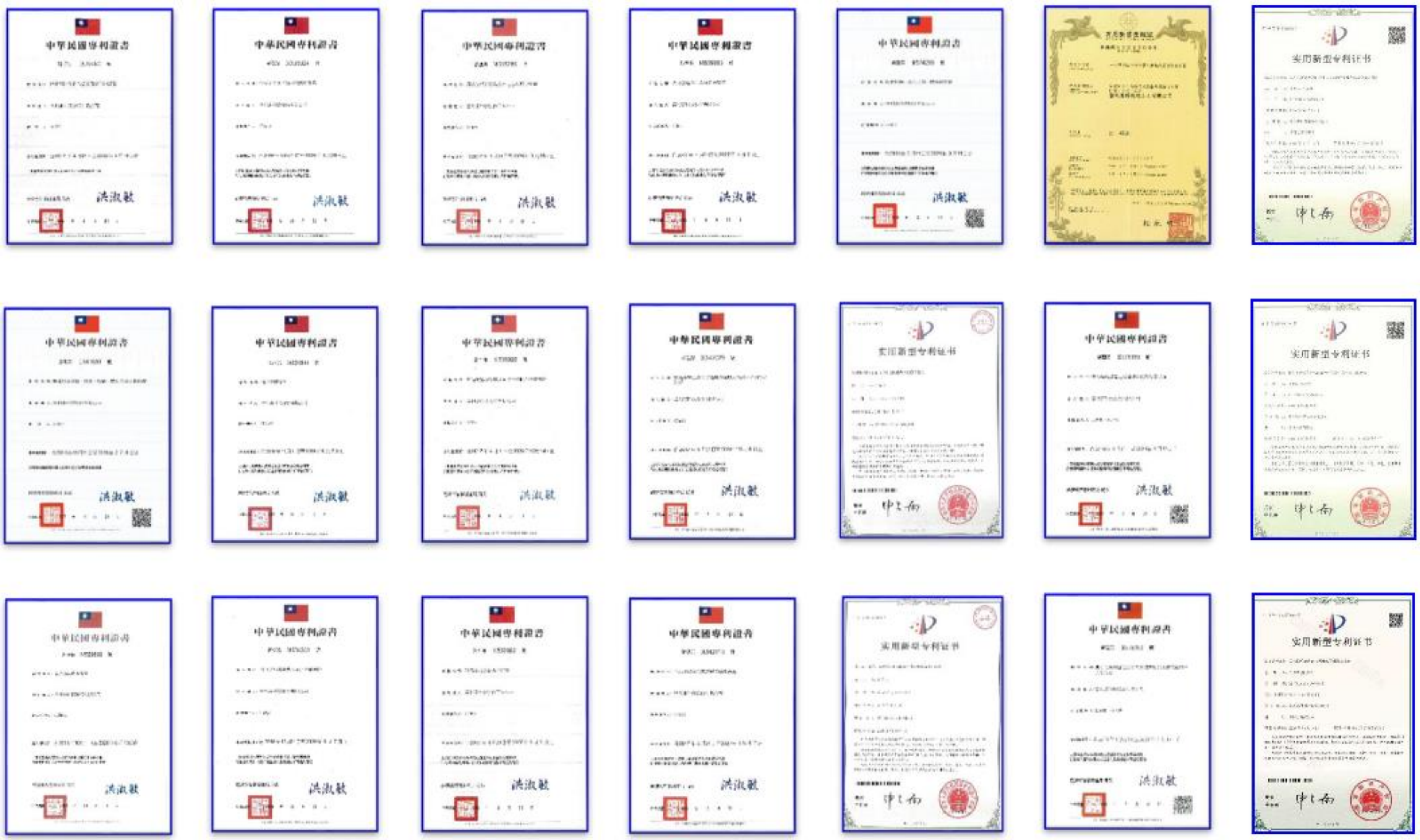
1. **Enhanced Seismic Resistance:**
   The stainless-steel framework disperses stress through ductile deformation, preventing brittle fracture of the ceramic material.
2. **Improved Safety in Case of Damage:**
   Even if localized cracks occur in the ceramic section, the metal framework maintains the filter shape and prevents sudden total collapse.
3. **Cost Effectiveness:**
   Unexpected downtime losses caused by earthquakes or vibrations can be reduced.Long-term operation and maintenance costs can be reduced by more than 40%.

Item	Conventional Ceramic Filter	Seismic-Resistant Ceramic Filter
Main Material	Pure ceramic fiber	Ceramic fiber + stainless-steel framework
Structure	Self-supported by the strength of ceramic fiber	Reinforced with three-dimensional metal lattice
Seismic Performance	Highly brittle; microcracks are likely to occur under long-term vibration	Metal framework absorbs impact energy; seismic resistance improved by more than 30%
Effect of Cracks	Crack propagation often leads to complete breakage and falling (domino effect)	Metal framework maintains overall shape, limiting damage to partial breakage
Maintenance Cost	Frequent replacement may be required in areas with frequent earthquakes	Service life may become 2–3 times longer
Suitable Environment	Static or low-vibration environments	High airflow environments and earthquake-prone areas
Failure Risk	Filter damage may cause failure of the entire area or system shutdown	Progressive failure allows continuous and stable system operation

Patent & Certificate

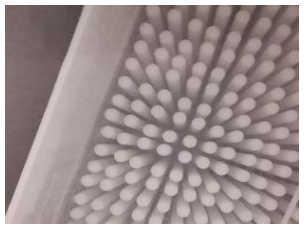
File No.	Date	Title	Status
I579480	2016/5/19	Method for strengthening ceramic fiber filter tube and strengthened ceramics fiber filter tube	Granted
M531544	2016/6/8	Enhanced ceramic fiber filter candle	Granted
M529558	2016/6/17	High temperature exhaust gas treatment equipment	Granted
M530924	2016/6/29	Sludge incineration and air pollution control device	Granted
M534301	2016/9/8	Ceramic fiber tube for decomposing and removing dioxin	Granted
M535785	2016/12/2	Refuse incineration device for decomposing and removing dioxin	Granted
M542029	2016/12/7	Device having functions of high temperature waste gas treatment and heat energy recycling for metallurgy industry	Granted
M539026	2017/1/25	Ceramic fiber filter tube capable of filtering suspending aerosol and gaseous pollutants	Granted
M539982	2017/1/4	Waste gas treatment device for glass industry	Granted
M539983	2017/1/6	Waste gas treatment device for thermal power generation	Granted
M542115	2017/1/6	Waste gas treatment device for cement & brick kiln	Granted
CN6941042	2017/7/1	Ceramic fiber filter used for decompose and remove dioxins	Granted
CN7162871	2017/8/29	Ceramic fiber filter used for aerosols and gaseous pollutants filtration	Granted
I641693	2018/2/7	Method of dedust, deSOx, deNOx for coke oven and the device	Granted
M578189	2019/5/21	Ceramic fiber filter system used for removal of dust, Nox with low-temp catalyst	Granted
M578359	2019/5/21	Ceramic fiber filter system used for removal of dioxins in industrial waste incineration	Granted
JP3224309	2019/9/9	Ceramic fiber filter system used for removal of dust, Nox with low-temp catalyst	Granted
CN9744845	2019/12/10	Ceramic fiber filter system used for removal of dioxins in hazardous industrial waste incineration	Granted
M587563	2019/12/11	Ceramic fiber filter equipped with water-resistant low-temp catalyst for NOx removal	Granted
CN9846165	2019/12/27	Ceramic fiber filter system used for removal of particulates and N2O	Granted
I683697	2020/2/1	Ceramic fiber filter system used for removal of particulates and N2O	Granted
CN10274369	2020/4/10	Ceramic fiber filter system used for removal of dust, Nox with low-temp catalyst	Granted
CN3776644	2020/4/28	Method for strengthening ceramic fiber filter tube and strengthened ceramics fiber filter tube	Granted

Patent & Certificate



System Design & Engineering



Criteria of System Operation

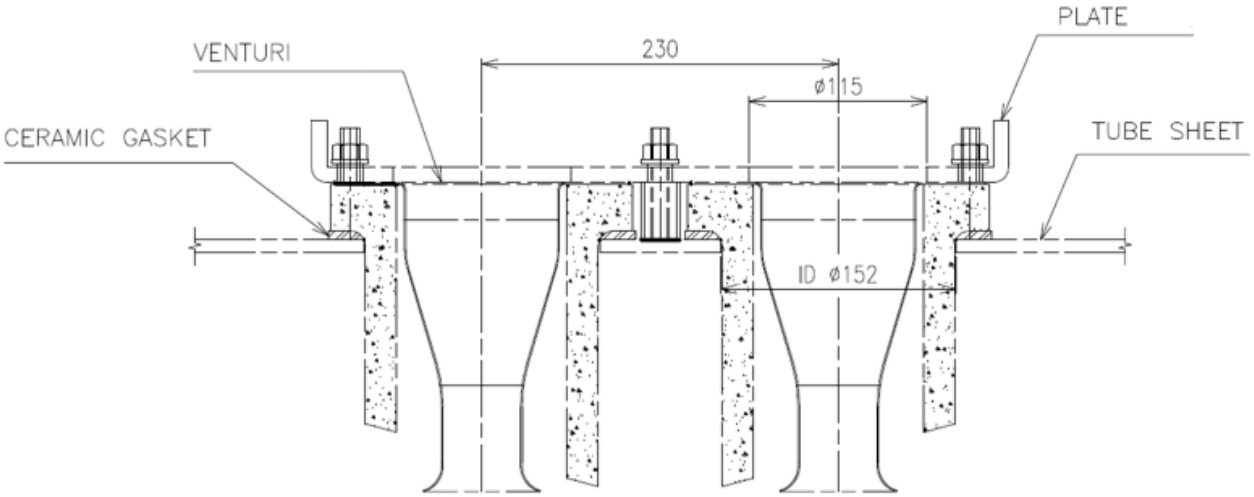
Product	Description	Temperature
T-01 Ceramic fiber filter	Max. working temp.	750˚C
	Min. working temp.	Acid dew point+20˚C
H-01 High-temp catalytic ceramic fiber filter	DeNOx max. temp.	420˚C
	DeNOx working temp.	330~420˚C
M-01 Mid-temp catalytic ceramic fiber filter	DeNOx max. temp.	350˚C
	DeNOx working temp.	250~350˚C
	DeNOx min. temp.	ABS dew point (usually at 240~270˚C)
	Dioxins	180~230˚C
L-01 Low-temp catalytic ceramic fiber filter	DeNOx working temp.	175~250˚C

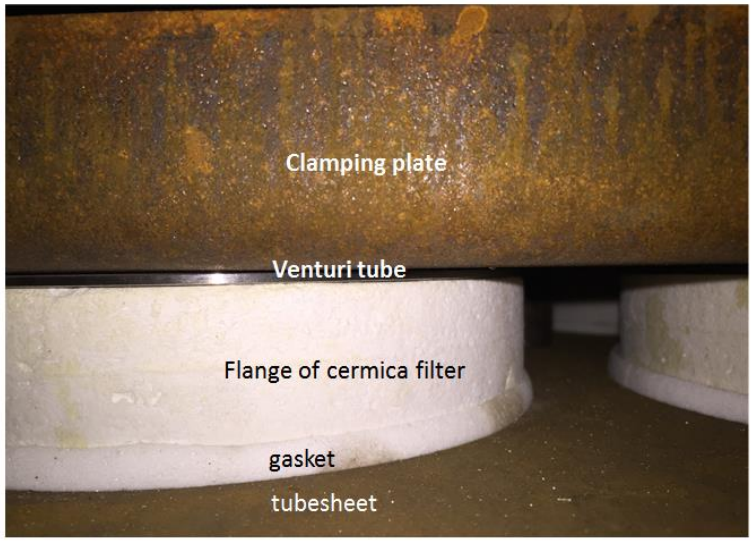
Design Criteria: backwash system

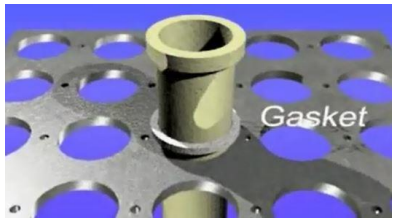
- CDA: eliminates the oil/water/dust
- Pulse pressure: 4~6kg/cm^2
- Air consumption 15L/time-pc, the duration between each blast about 15~30 seconds.

- Dust collector shall be designed with good heat insulation and engineering quality to prevent 1) too much heat loss and 2) affecting NOx removal efficiency.
- Before turn on the system, please initiate the hopper heating system in advance to preheat dust collector.
- Shutdown is not available due to operating conditions or other reasons, the dust collector shall be designed as different chambers separately to install offline valve (strangler) to perform offline cooling-down maintenance.
- During operation, the hopper heating system shall activate automatically when the temperature is below 120°C (acid dew point +30°C).

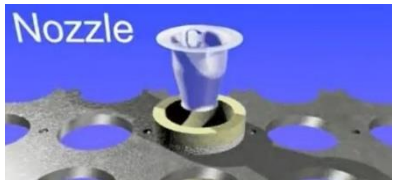
Installation of Ceramic Filter



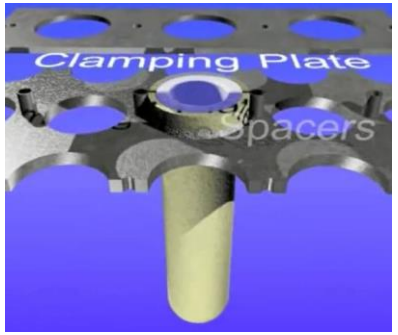




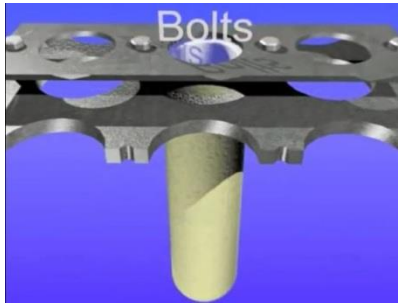
gasket filter



venturi



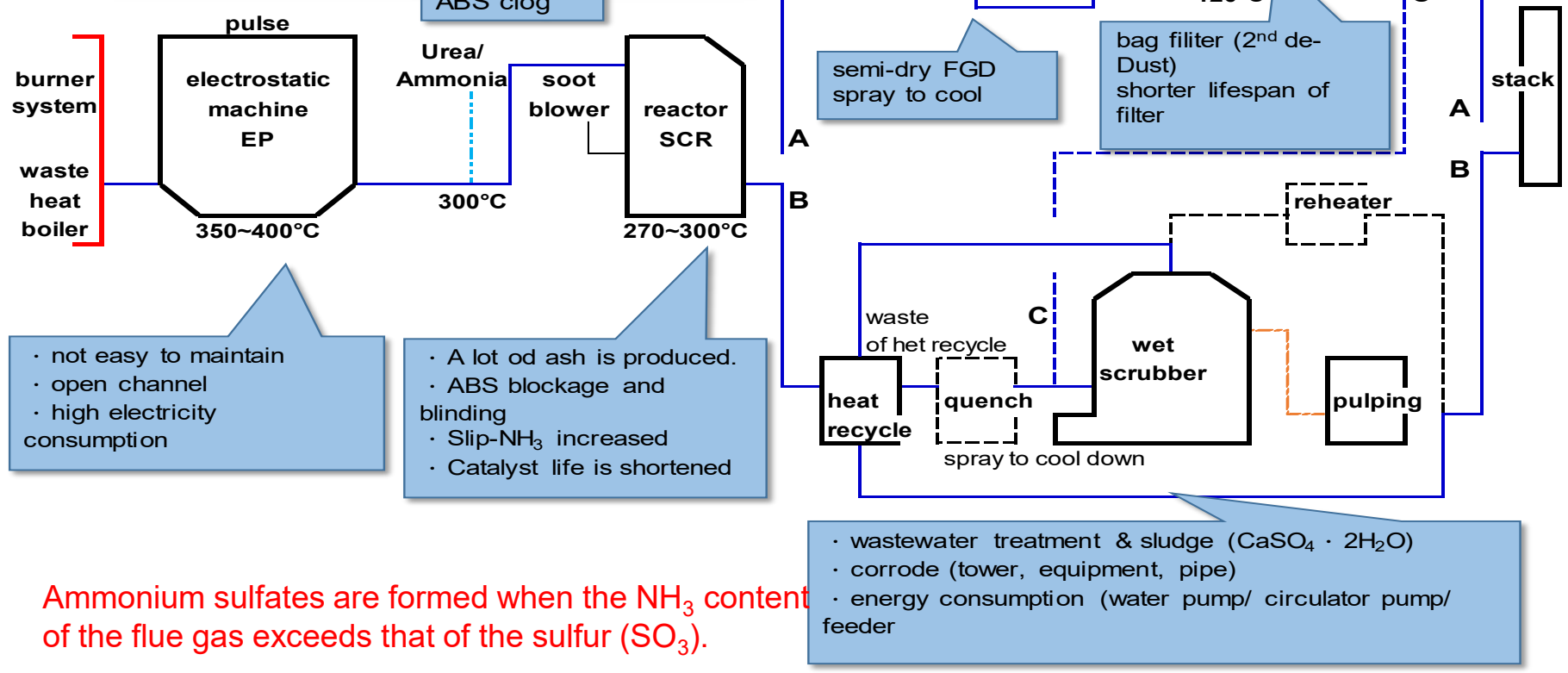
cover it with clamping plate



Screw it with bolts

Traditional System (EP / SCR / Wet-Scrubber)

ABS clog



semi-dry FGD spray to cool

bag filiter (2nd de-Dust)
shorter lifespan of filter

- not easy to maintain
- open channel
- high electricity consumption

- A lot od ash is produced.
- ABS blockage and blinding
- Slip-NH_3 increased
- Catalyst life is shortened

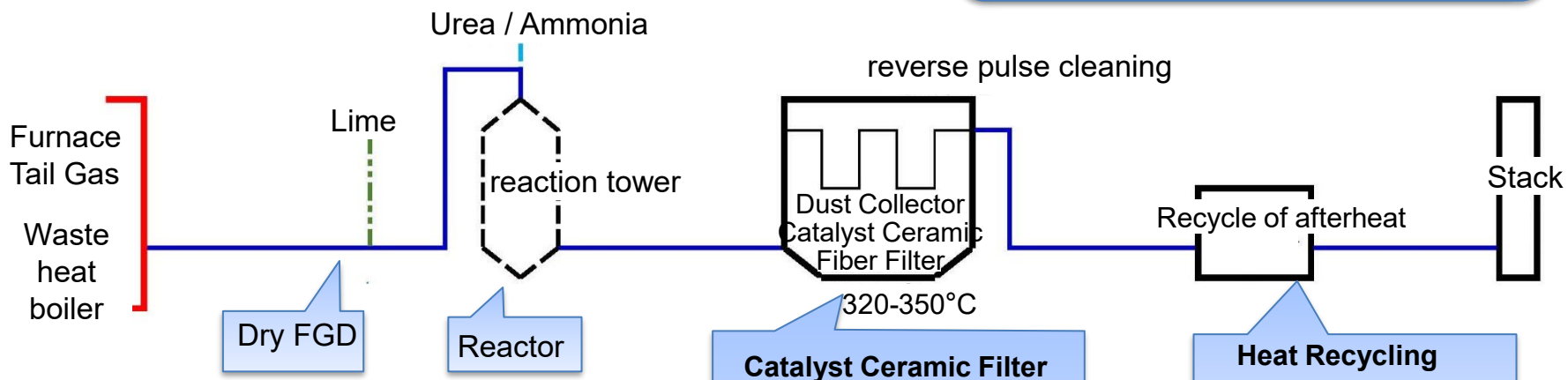
- wastewater treatment & sludge ($CaSO_4 \cdot 2H_2O$)
- corrode (tower, equipment, pipe)
- energy consumption (water pump/ circulator pump/ feeder

Ammonium sulfates are formed when the NH_3 content of the flue gas exceeds that of the sulfur (SO_3).

Compare: Dry FGD + deDust /deSOx /deNOx / HEX

Simple Syetem
ALL IN ONE DESIGN

- ✓ Reduce catalyst failure: ABS↓
- ✓ Energy saving: Heat recovery
- ✓ No wastewater: dry/semi FGD



Catalyst Ceramic Filter

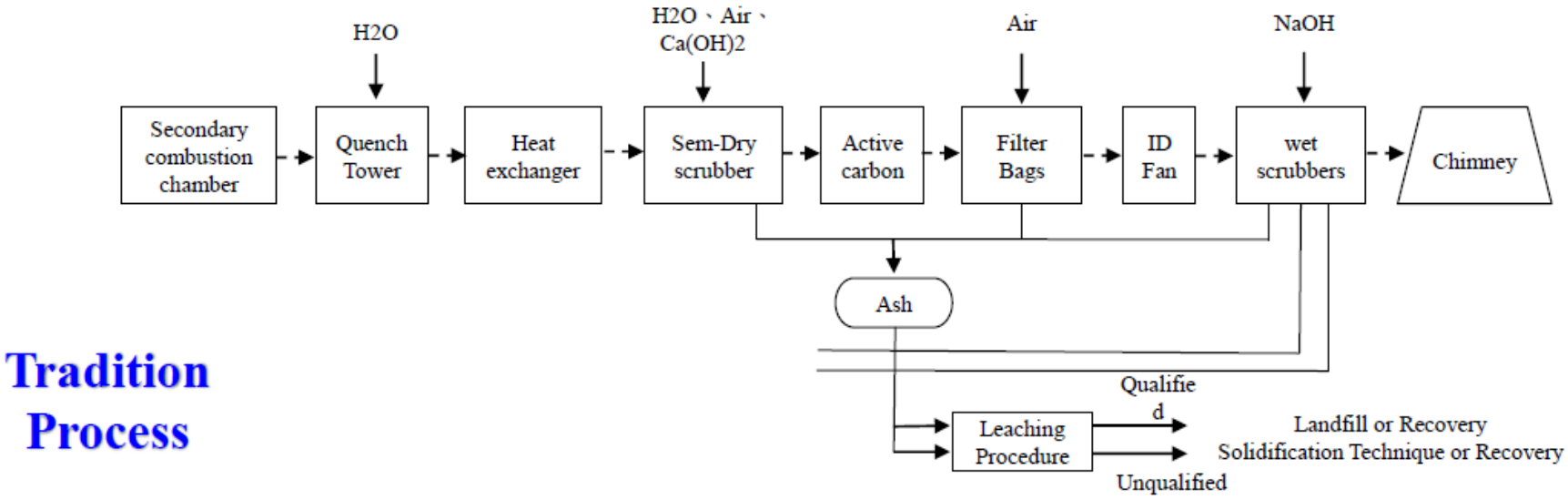
(1) SOx
(2) NOx
(3) Particulates

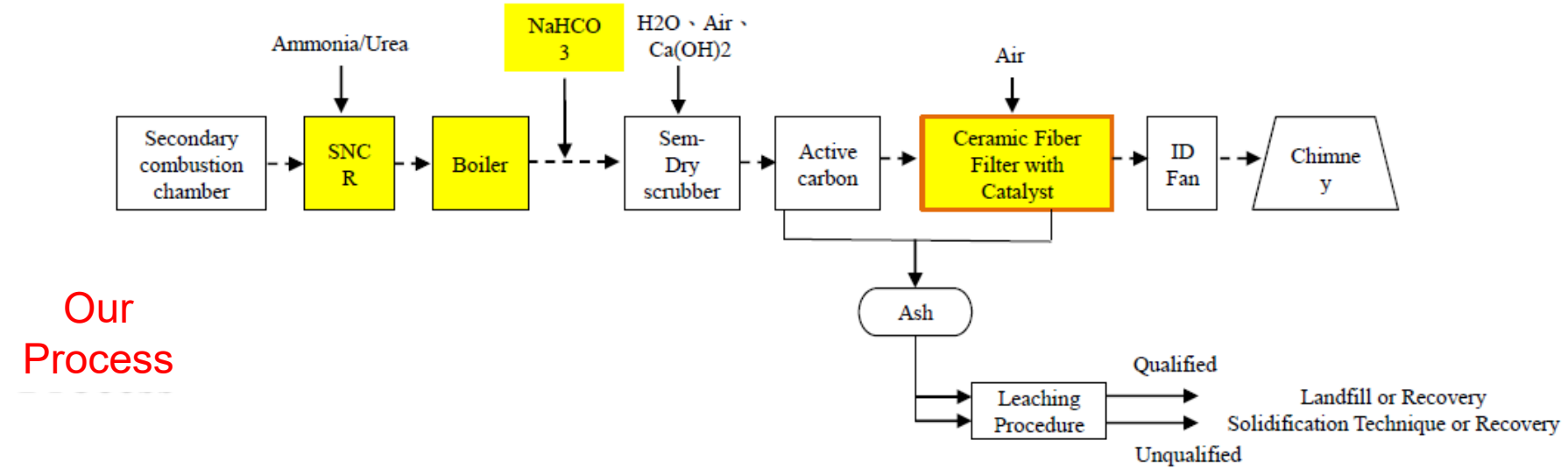
Advantages:
- simple system
- reduced running costs
- excellent performance

Heat Recycling

- Energy saving
- Corrosion reduction
- Ash Reduction

Description of the process in hazardous waste





Comparison of desulfurization control technology

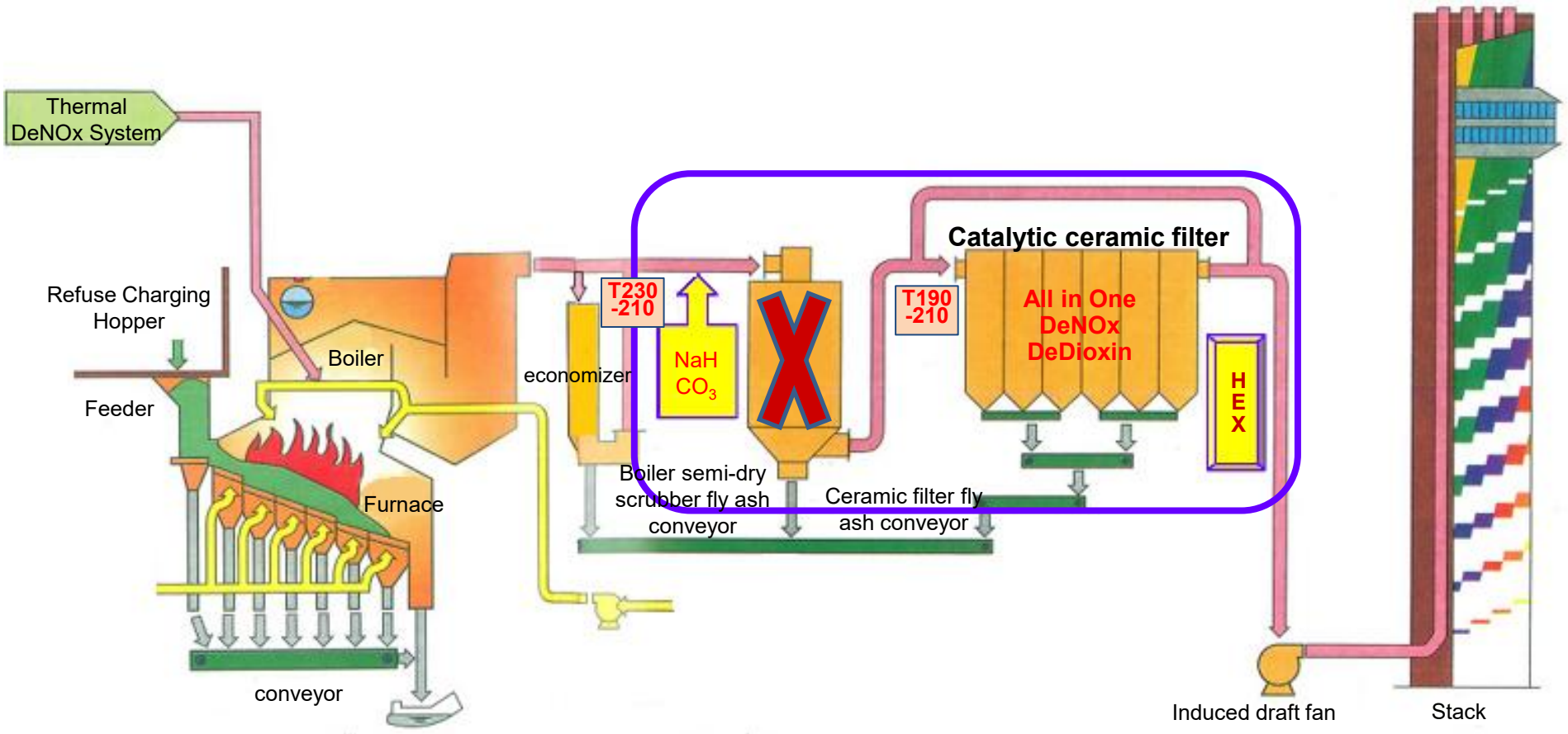
Performance	Wet Process	Dry Process	Semi-Dry Process
Type	Gypsum	Alkalizer	Limestone Liquid
Process	Complicated	Simple	Complicated
DeSOx (%)	95-99%	70-97%	80-98%
Ca/S	1.1	1.5-5	1.5
Removing white smoke and reheating	Yes	No	Few
Occupy land	More	Few	Few
Electricity consumption	High	Low	Few
Technology maturity	Popular	Popular	Popular
Maintain	Complicated	Simple	Normal
Secondary actinides	Waste water	Ash	Ash
Cost	High	Mid.	Mid.
Cost performance	Low	High	Mid.

Acceptance report

Dry Process $Ca(OH)_2$

Monitoring items			Monitoring Results				Regulated Limit	Pass/ Not Pass	Remark
			1	2	3	Average			
Inlet	SO_2	Measured concentration (mg/m3)	708	746	668	707	/	/	/
		Converted concentration (mg/m3)	736	782	700	740	/	/	/
Outlet	SO_2	Measured concentration (mg/m3)	18	17	18	18	/	/	/
		Converted concentration (mg/m3)	21	19	21	20	400	Pass	**97.6%**

Applications – City Refuse Incineration Plant

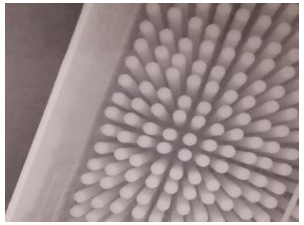


Modification by catalyst ceramic fiber filter (waste treatment system in purple area) :

1. Semi-dry scrubber and atomizer are no longer needed.
2. Install a injector of dry $NaHCO_3$.
3. A heat recovery device can be installed after filter.

Key Markets & Advantages



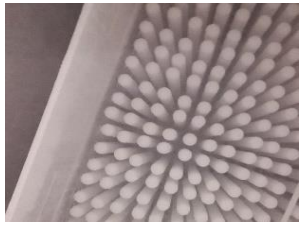



Key Markets

- Glass Industry
- Glass fiber
- Cement Industry
- Boiler
- Gasification Process
- Soil Remediation
- Ship/Harbor APC
- Coking
- Incineration (waste/hazardous waste/medical)
- Metallurgical Smelting
- Steel (converter, electric furnace, chark, sintering)
- Power plants & WHB
- Catalyst/ HM Recovery
- Product Collection in High-temp process
- Ceramics Industry
- Expired Ammunition Incinerator
- Waste Liquid Incinerator
- RDF Power Plant
- Roasting furnace
- Sludge Incinerator
- Lime kiln
- Low-temp NOx removal

Applications & Case Studies



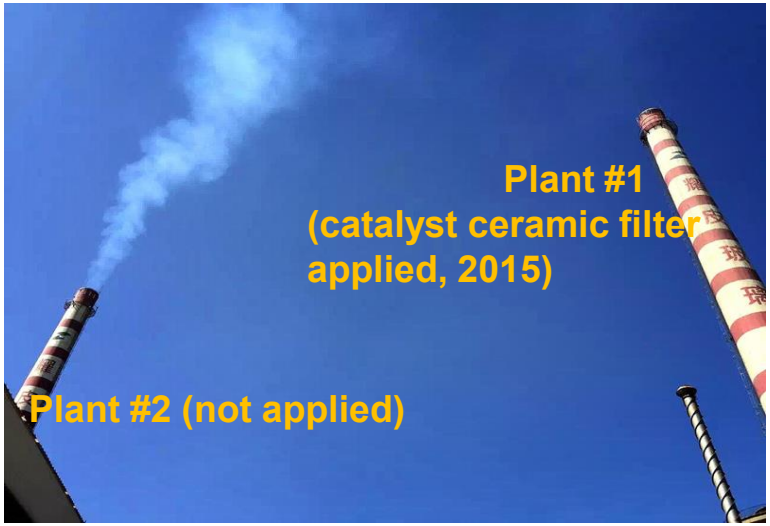
Customer Performance (from 2016-2020)

Area	Industry	Product	End user	Year	Area	Industry	Product	End user	Year
Japan	Sludge incineration	Non-catalyst	Sanki	2014-2016	Taiwan	Waste incineration	Catalytic	Revivegen Environmental Technology	2017
Japan	Sludge incineration	Non-catalyst	Nihon Spindle	2015-2016	Taiwan	Waste incineration	Catalytic	Super Max Engineering	2017
China	Glass industry	Catalytic	TSYPE	2015	China	Glass industry	Catalytic	CSYPE	2017
Japan	Sludge incineration	Non-catalyst	TSK	2015	Taiwan	Wood fuel boiler	Non-catalyst	Feng Tian Industry	2017
Japan	Sludge incineration	Non-catalyst	Hosokawa	2015	China	Glass industry	Catalytic	Flat Glass, Anhui	2017
Japan	Tea baking	Non-catalyst	ACO	2015	China	Glass industry	Catalytic	Fuya Grop. Benxi	2017
Japan	Sludge Incineration	Catalytic	Motoi	2015	Japan	Waste incineration	Catalytic	Nihon Fiber	2017
China	Glass industry	Catalytic	CSYPE	2016	China	Coking plant	Catalytic	LinHuan Chemical, Anhui	2017
China	Glass industry	Catalytic	Xi'an Thermal Power Research Institute Co	2016	Taiwan	Abandoned ammunition incineration	Catalytic	Taiwan Supertex Bauen manufacturing	2017
China	Non-ferrous metals	Non-catalyst	The China ENFI Engineering	2016	Japan	Waste incineration	Catalytic	Shigeyoshi	2017
Taiwan	Sludge Incineration	Non-catalyst	LUH YIH Technology	2016	Taiwan	Sludge incineration	Catalytic	WanJia	2018
Japan	Waste incineration	Catalytic	E-san	2016	Japan	Sludge incineration	Non-catalyst	KUBOTA	2018
EU/USA	Glass industry	Catalytic	Durr	2016	China	Biomass power	Catalytic	Shandong Qiquan Grop	2018
EU/USA	Cement industry	Catalytic	FLSmidth	2016	China	Glass industry	Catalytic	Fuyao Glass, Benxi	2018

Customer Performance (from 2016-2020)

Area	Industry	Product	End user	Year	Area	Industry	Product	End user	Year
Japan	Sludge incineration	Non-catalyst	KUBOTA	2018	China	Glass industry	Catalytic	Qingyuan CSG	2019
Taiwan	Wood fuel boiler	Catalytic	Hua Zhen	2018	China	Coking plant	Catalytic	Benxi Steel	2019
China	Coking plant	Catalytic	Anhui Chemical Industry	2019	China	Biomass power	Catalytic	Shangdu, Henan	2019
China	Glass industry	Catalytic	Asahi Glass in Suzhou	2019	Japan	Sludge incineration	Non-catalyst	Sanki	2019
China	Glass industry	Non-catalyst	Henan Huaxing Glass	2019	Japan	Sludge incineration	Non-catalyst	Nikko Techno	2019
Taiwan	Sludge Incineration	Non-catalyst	GPDC Green Technology	2019	Malaysia	Glass industry	Catalytic	Jinjing Corp.	2019
China	Biomass power	Catalytic	Shandong Qiquan Group.	2019	Taiwan	Wood fuel boiler	Catalytic	Top-Comment Technology	2020
China	Waste incineration	Catalytic	Xian Guang	2019	China	Ion gasification treatment	Catalytic	Pu Lin	2020
China	Glass industry	Catalytic	Asahi Glass in Suzhou	2019	China	Fiber glass	Catalytic	Chengzhiyuan Environmental Protection Technology	2020
China	Coking plant	Catalytic	Laiwu Steel	2019	Taiwan	Crematorium	Catalytic	SanPeng	2020
China	Glass industry	Catalytic	Jiafu Glass, Zhejiang	2019	China	Glass industry	Catalytic	Huaxing Glass	2020
China	Glass industry	Catalytic	Flat Glass, Anhui	2019	China	Regeneration of activated carbon	Catalytic	Wuan Coking	2020
China	Glass industry	Catalytic	Gongjian Glass, Nanjing	2019					

Applications-Tianjin SYP Glass



Items	Unit	550t/d	600t/d
Fuel type		Natural Gas	
Flowrate	Nm3/h-wet	62000	70000
Vapor	%	10	10
Oxygen	%	8.3	8.3
Inlet Temp.	°C	350	350
Filter	pcs	1,800	2,160
Velocity	m/min	0.94	0.88
Inlet			
Particle	mg/Nm3-dry 8%O_2	200	200
NOx	mg/Nm3-dry 8%O_2	≤2,500	≤2,500
SOx	mg/Nm3-dry 8%O_2	≤640	≤640
Outlet		Pass	Pass
Particle	mg/Nm3-dry 8%O_2	≤30	30
NOx	mg/Nm3-dry 8%O_2	≤500	≤500
DeNOx Efficiency	%	≥80	≥80
NH_3 Slip	ppm	3	3
SOx	mg/Nm3-dry 8%O_2	≤50	≤50
DeSOx Efficiency	%	≥92.5	≥92.5

TSYP 550T/D Glass Furnaces– Gas Flow 62000Nm3/h, 2015
TSYP 600T/D Glass Furnaces– Gas Flow 70000Nm3/h, 2015

Provided by customer.

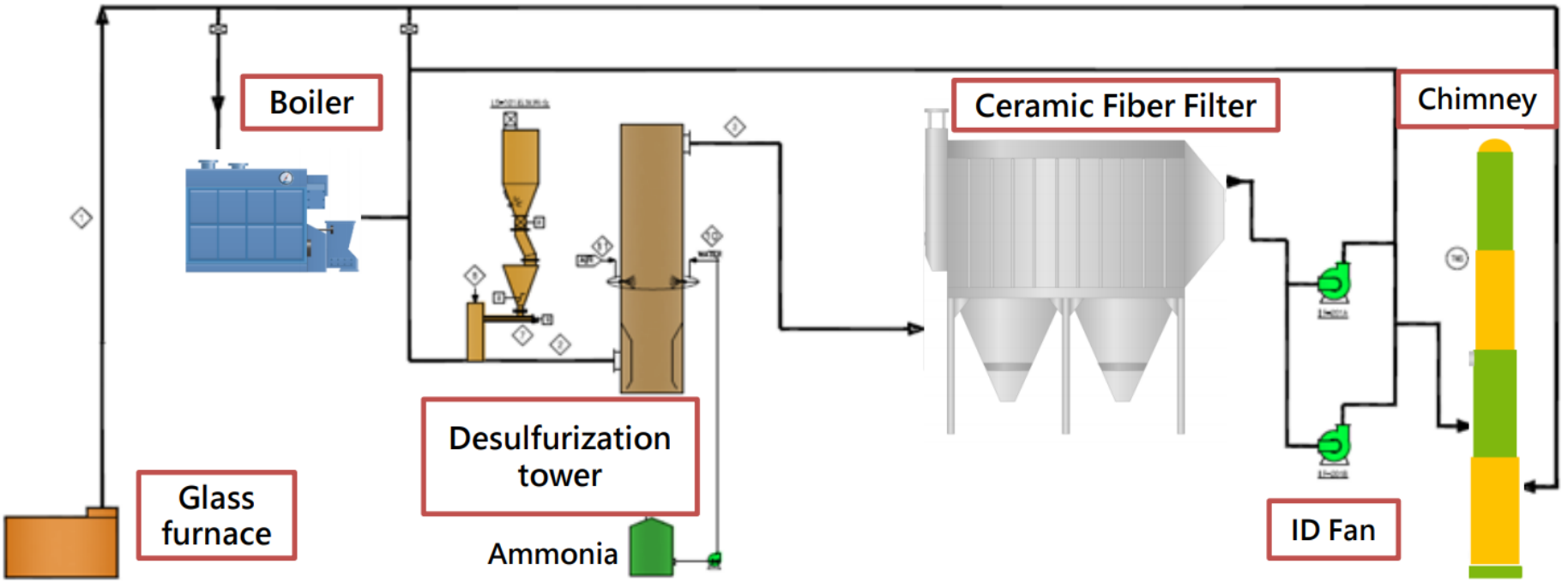
Applications-Tianjin SYP Glass

TSYP #1 Modify Process

TSYP #2 Process

TSYP #1 Process

Applications-Tianjin SYP Glass



The concentration of NOx in the flue gas of glass kilns is as high as 1,500~3,500ppm. There is a lot of dust, and it contains potassium, sodium, boron, and silicon. The fine dust harms the tradition SCR and cannot be collected by Electrostatic precipitator; it is difficult to use filter bags to remove dust; ABS hazards also cannot be improved.

Glass Industry – Cost reference of set & operation

#1 Process: 550T/d, Flow rate: 62,000 Nm3/h, #2 Process: 600T/d, Flow rate: 70,000 Nm3/h,

Specification：Temp. 350℃ ; SO_2 ≦640mg/Nm3; NO_2 ≦2,500mg/Nm3 ; O_2=8.3%; H_2O=10% ; Particle ≦200mg/Nm3

Performance requirement: SO_2 ≦50mg/Nm3; NO_X ≦500mg/Nm3 ; Particle ≦30mg/Nm3

Process Comparison		**Tradition Process**				**Our Ceramic Fiber Filter**
		KS Environment	RS	JSKT	Beijing HW	
		Waste heat boiler	Waste heat boiler	Waste heat boiler	Waste heat boiler	Waste heat boiler
		Flue gas conditioning		ESP	ESP	**Ceramic Fiber Filters with catalyst (All in One)**
		SCR	SCR	SCR	SCR	
		Waste heat boiler	Waste heat boiler	Waste heat boiler	Waste heat boiler	
		DeSOx	DeSOx	DeSOx	DeSOx	
		Filter Bags	Filter Bags	Filter Bags	Filter Bags	Waste heat boiler
		ID Fan	ID Fan	ID Fan	ID Fan	ID Fan
Cost Comparison		Chimney	Chimney	Chimney	Chimney	Chimney
Running Cost	Million RMB / Year	18	23	14	14	10
5yrs difference		35	63	17	19	0
Total Set Offer	Million RMB	49	43	35	37	42
Total difference (5yrs)	Million RMB	**84**	**106**	**52**	**56**	**42**

Provided by customer.

Applications – Gas Furnaces, CSYP China

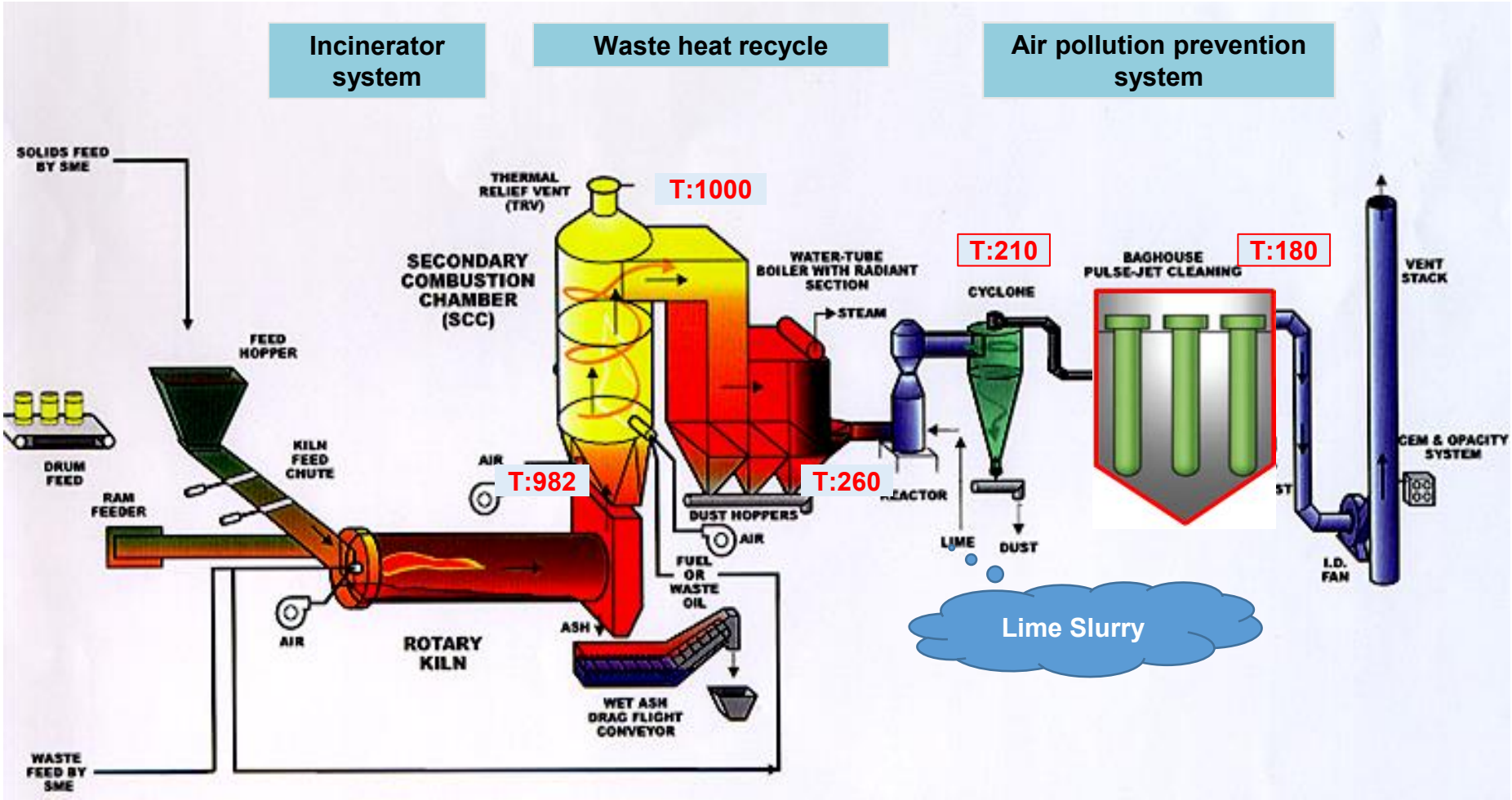
Ammonia Storage Tank

WHB

CSYP 3# 600T/D Glass Furnaces– Gas Flow 68000Nm3/h, 2016
CSYP 1# 600T/D Glass Furnaces– Gas Flow 68000Nm3/h, 2017

Applications – Waste Incineration Plant - Taiwan

Modified design – 270 candles/chamber X 4chamber **Super Max Engineering Taiwan**



Actual Dioxin monitoring values are far below emission level 0.1

2,640tons/month Hazardous Waste Incineration - deDust, deNOx, deDioxin, 2017

Applications – Waste Incineration Plant - Taiwan

Super Max Engineering Taiwan

2017/8~2019/6 Guanyin Plant- Emission Inspection Records

Pollutants	Unit/hr	Law Limit	2017/8/9-10 Autonomous inspection	2018/3/1-7 Autonomous inspection	2018/5/9-11 Annual inspection	2018/6/20-26 Autonomous inspection	2018/7/12-13 Autonomous inspection	2018/9/11-12 Autonomous inspection	2018/11/6 Autonomous inspection	2019/5/16-18 Annual inspection
Dioxins	Ng-TEQ/Nm3	0.1	**0.004 (0.006/0.002 /0.005)**	**0.007 (0.011/0.007 /0.004)**	**0.009 (0.0128/0.01 2/0.014)**	**0.051 (0.128/0.012 /0.014)**	**0.017 (0.035/0.010 /0.006)**	**0.031 (0.063/0.014 /0.017)**	**0.004 (0.005/0.005 /0.003)**	**0.006 (0.0038/0.00 72/0.0084)**
NOx	ppm	150	122	136	132	140	126	138	149	85
SOx	ppm	140	20	19	40	56	28	2	50	11
HCl	ppm	35	2.52	6	ND (<2)	2.675	1	1	<2	ND(<2)
CO	ppm	100	41	ND (<2)	4	8	4	-	<2	ND(<2)
Daily Average Opacity	%	10	3	1	3	3	3	2	3	2
Particles	mg/Nm3	68	N/A	1	2	1	<1	<1	1	1

Applications – Waste Incineration Plant - Taiwan

Super Max Engineering Taiwan

Applications – Contaminated soil treatment process- Taiwan

Cooled water Frozen water

Diagram of process equipment

GPDC Green Technology Corp.

Applications – Coking Plant in Huibei

Items	Unit	2.2 million Ton/Year
Fuel type		Coal gas
Flowrate	Nm3/h-wet	190,000
Vapor	%	10
Oxygen	%	11
Inlet Temp.	°C	250
Filter	pcs	3,600
Velocity	m/min	1.2
Inlet		
Dust	mg/Nm3-dry 11%O_2	<30
NOx	mg/Nm3-dry 11%O_2	≤650
SOx	mg/Nm3-dry 11%O_2	≤100
Outlet		Pass
Dust	mg/Nm3-dry 11%O_2	≤10
NOx	mg/Nm3-dry 11%O_2	≤50
DeNOx Efficiency	%	≥92.3
NH_3 Slip	ppm	3
SOx	mg/Nm3-dry 11%O_2	≤30
DeSOx Efficiency	%	≥70

Yearly production 2.2 million tons coking plant: All in One device, Operation on 2018/ 2019

Coking Industry – Cost reference of set & operation

Specification: Temperature: 250 ℃ ; Flowrate: 190,000m3/h, wet ; SO_2 ≦100mg/Nm3; NO_2 ≦650mg/Nm3 ; O_2=11%; H_2O=10% ; CO_2=9-12% ; Particle ≦30mg/Nm3

Performance requirement: SO2≦30mg/Nm3; NOX≦50mg/Nm3 ; Particle≦10mg/Nm3

Process Comparison		Tradition Process	Our Ceramic Fiber Filter
		EP/High temperature catalyst	
		EP	Heating
		GGH	**Dry deSOx**
		Heating	
		High temp. SCR	**Ceramic Fiber Filter with catalyst (All in One device)**
		DeSOx by wet process	
Cost Comparison		Chimney	Chimney
Running Cost	Million RMB / Year	16	13
5yrs difference		19	0
Total Set Offer	Million RMB	27	28
Total difference (5yrs)	Million RMB	**46**	**28**

Provided by customer.

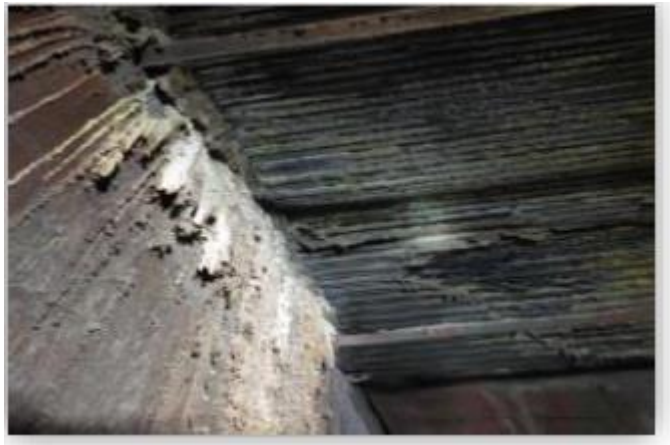
Applications – Biomass Powder Plant in Shangdong

Items	Unit	130 Ton/hr
Fuel type		Biomass Energy
Flowrate	Nm3/h-wet	380,000
Vapor	%	3.9
Oxygen	%	10.7
Inlet Temp.	°C	320
Filter	pcs	5,040
Velocity	m/min	0.9
Inlet		
Dust	mg/Nm3-dry 6%O_2	<120
NOx	mg/Nm3-dry 6%O_2	≤200
SOx	mg/Nm3-dry 6%O_2	≤150
Outlet		Pass
Dust	mg/Nm3-dry 6%O_2	≤10
NOx	mg/Nm3-dry 6%O_2	≤50
DeNOx Efficiency	%	≥75
NH_3 Slip	ppm	3
SOx	mg/Nm3-dry 6%O_2	≤35
DeSOx Efficiency	%	≥76.7

130 tons of Biomass Boiler power plant, All in One device, Operation on 2018/ 2019

Applications – Biomass Powder Plant in Shangdong

Economizer
Before & After



ABS sticks to and clog on the pipes due to polymer deNOx agent

Clean gas duct. The efficiency of heat exchanger is increased.

Air Preheater
Before & After

Gas duct clogged by ABS and dust

Clean gas duct. The efficiency of heat exchanger is increased.

Capacity of 130ton biomass boiler 30MW - deDust, deSOx, deNOx

Biomass Power Plant – Cost reference of set & operation

Specification: Temperature: 320℃ ; Flowrate: 174,000 m3/h, wet ; SO_2 ≦400mg/Nm3; NO_2 ≦800mg/Nm3 ; O_2=11%; H_2O=10% ; CO_2=7-10% ; Particle ≦16,000mg/Nm3

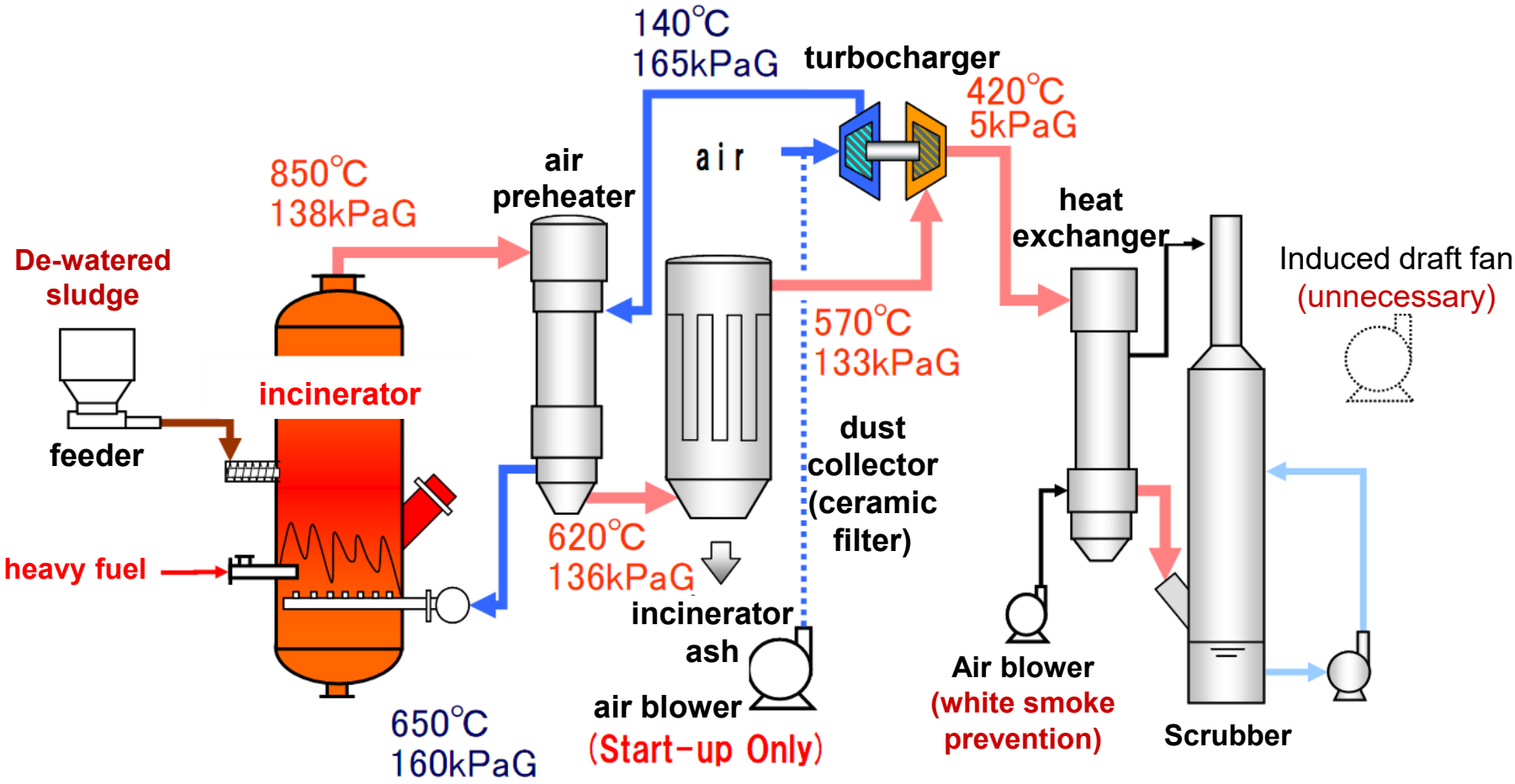
Performance requirement: SO_2 ≦35mg/Nm3; NO_X ≦50mg/Nm3 ; Particle ≦10mg/Nm3

Process Comparison		Tradition Process	Our Ceramic Fiber Filter
		Jinan Biomass Power	
		SNCR	Dry desulfurization
		Cyclone dust collection	
		Filter Bags	**Ceramic Fiber Filter with catalyst (All in One device)**
		Gypsum desulfurization	
Cost Comparison		Chimney	Chimney
Running Cost	Million RMB / Year	22	63
5yrs difference		77	0
Total Set Offer	Million RMB	25	35
Total difference (5yrs)	Million RMB	**102**	**35**

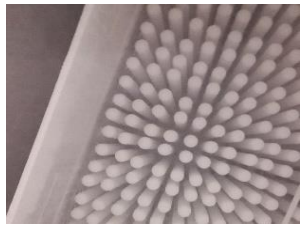
Provided by customer.

Applications – Sludge Incineration (CFB), Japan

Turbocharged Fluidized Bed Incinerator (new system)





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