

Semiconductor Abatement Systems

The image features a blue background with a circuit board pattern. On the left, a globe is partially visible. In the center and right, there are several industrial semiconductor abatement systems. The largest system on the right is a tall, white cabinet with a control panel and a digital display. It has the GST logo and the text 'DAS' on it. To its left are two smaller units, one of which is labeled 'GST' and 'AVIASS'. The GST logo is also prominently displayed in the bottom left corner of the image area.

GST

GLOBAL STANDARD TECHNOLOGY

Aug 2013

Jay Jung
VP of Marketing

What is the customer looking for?



Capacity, Capability & Commitment

Size

Engineering Capacity

Production Capacity

\$55M in 2012 Abatement Revenue

287 direct employees

>3,500 installed base



Head Quarters, Dongtan Industrial Complex



Jincheon Manufacturing Plant - 88,000 ft²

Engineering Capacity



Head Quarters

>5 concurrent development projects



Scrubber R&D Lab



Manufacturing Capacity



Manufacturing Plant

>100 scrubbers per month

Scalable to 300 units in 2 months



Scrubber Assembly Line

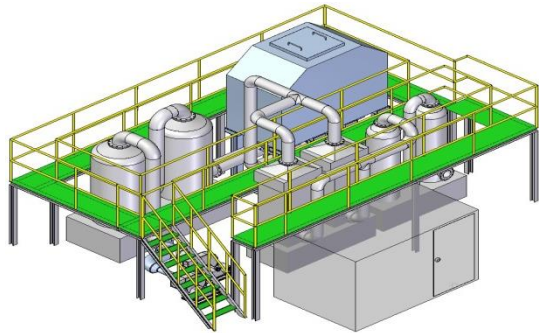


Final Test and Evaluation Unit Area

Wide Range of Technologies

Technology Innovations

GST Abatement Product Line



◆ FACILITY LEVEL
PFC ABATEMENT (CATALYST & RTO)
PROJECT RCO and Zone PFC Scrubber



◆ BURN-WET
DRAGON / DRAGON DUO



◆ HIGH CAPACITY
BURN-WET
GALLANT



◆ DRY
SDS-500



◆ PLASMA-WET
Durian



◆ PUMP & ABATEMENT
EXCELLION



◆ HEAT-WET
ISIS-I,II,III,IV



◆ WET & WET-EP
SWS-500 / AQUA EP

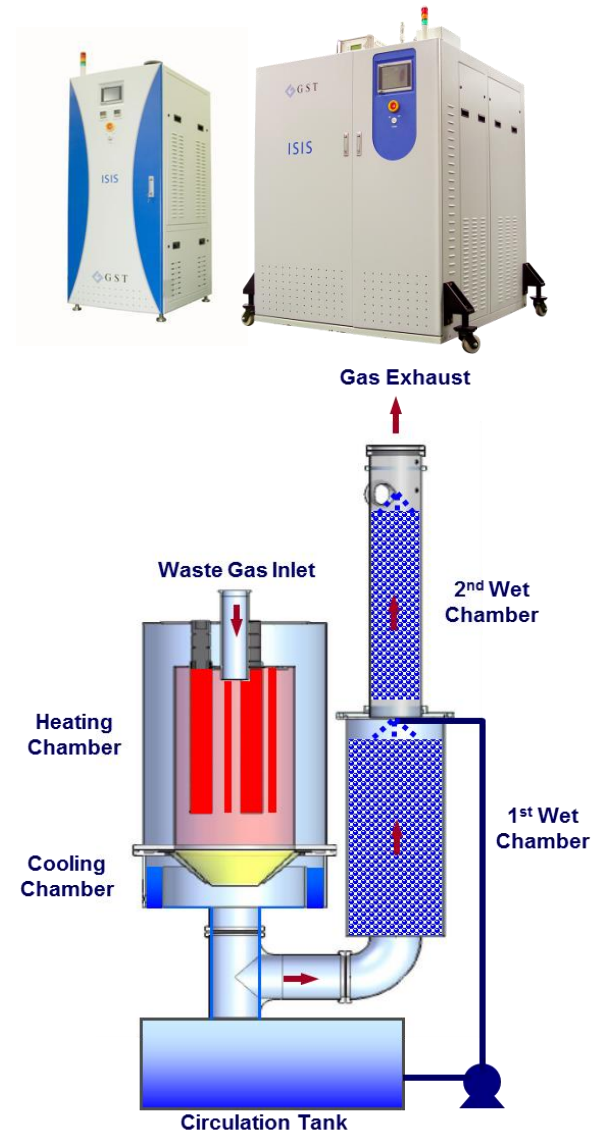
- ❑ GST strives to provide *best practical abatement solutions* to semiconductor industry

- ❑ GST Abatement Efficiency and Emissions Target
 - Toxic: < TLV
 - Flammable: < ¼ LEL
 - PFC DRE: > 95%
 - NOx Emissions: < 50 ppm
 - CO Emissions: < 50 ppm
 - Other parameters: THC, odor, etc.

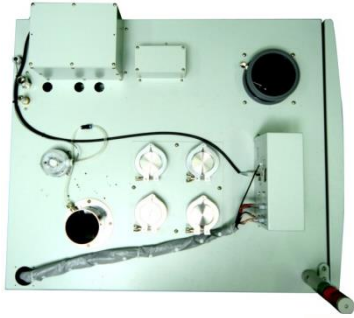
“Heat-Wet” Type: ISIS

ISIS-II

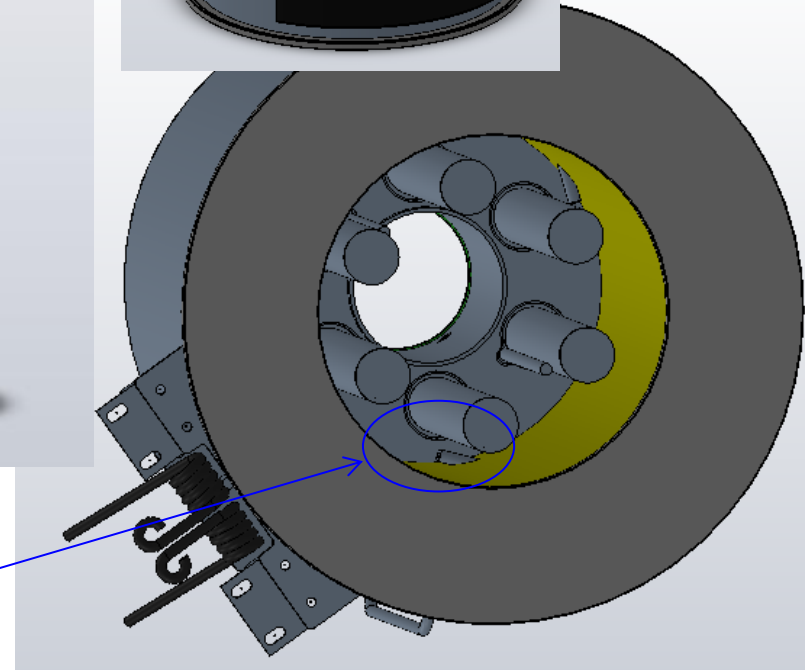
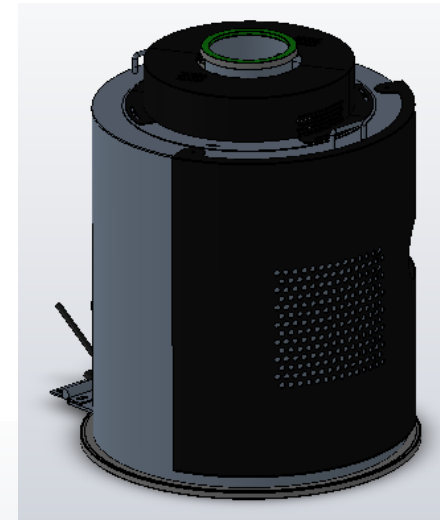
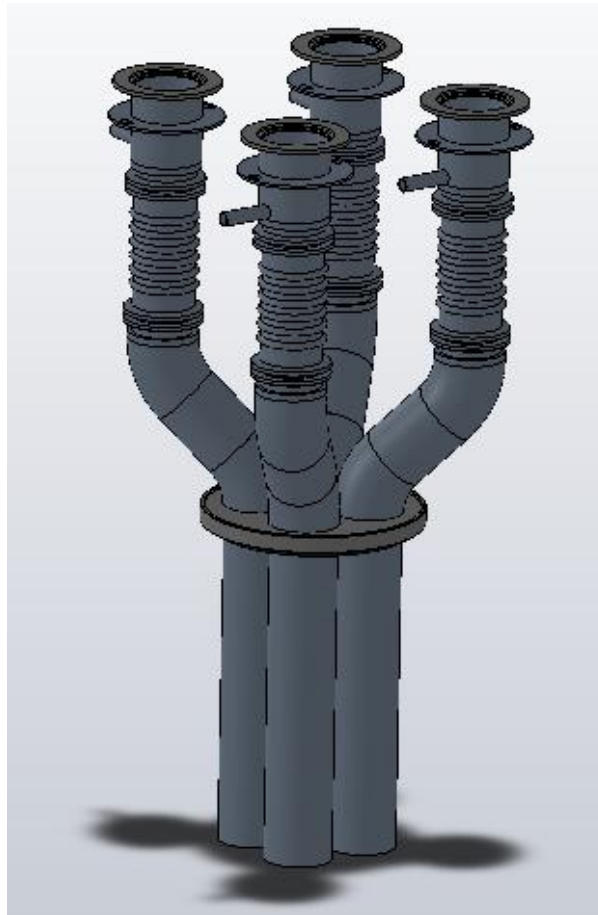
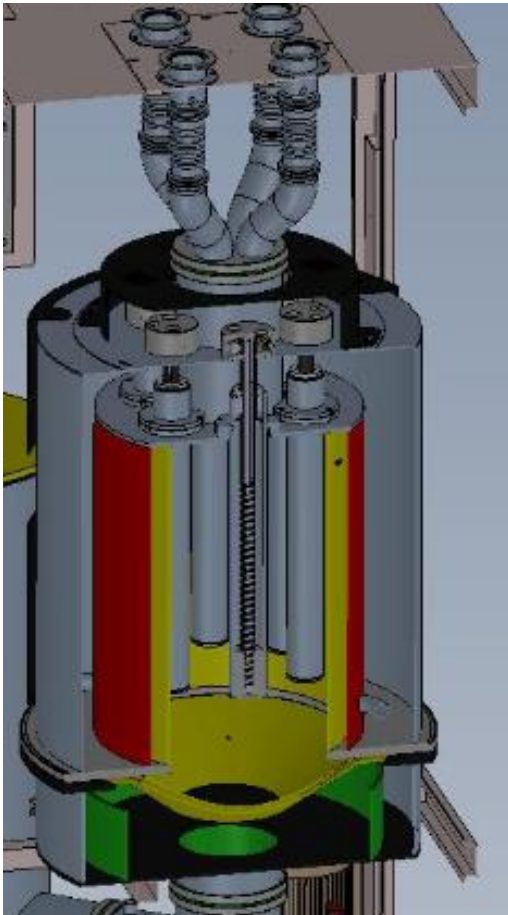
- ❑ HVM (high volume manufacturing) proven
 - Well suited for semiconductor deposition processes
 - Powder tolerant design with large reactor volume
- ❑ High abatement efficiency
 - Steam generator option for Cl_2 and F_2
 - SiC high temperature heaters
- ❑ Low NOx and CO
 - Lower operating temperature than “Burn-Wet” type
 - No fuel
- ❑ Various capacity models available
 - ISIS-I ~ ISIS-IV



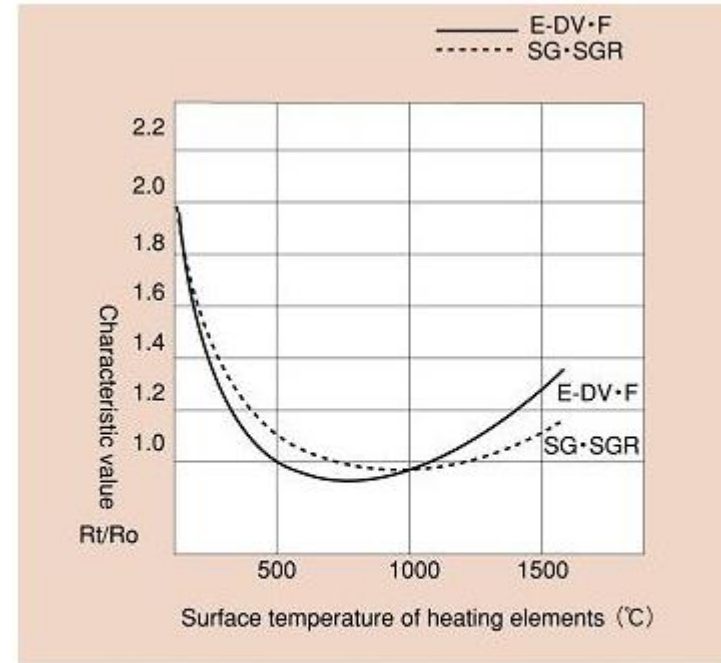
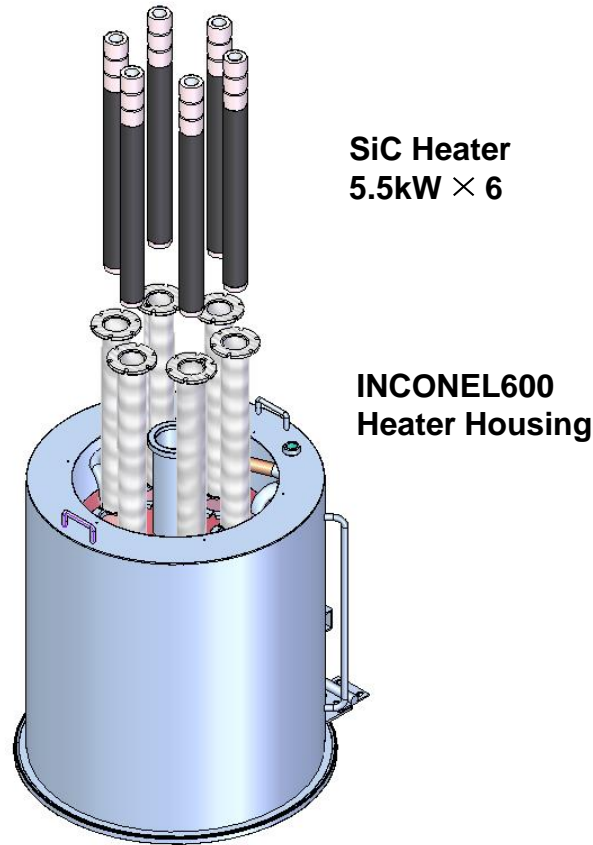
ISIS-I & II Hardware



ISIS Hardware – Entry & Reactor



- 4 independent inlets
- 4 x 40mm entry
- CDA / Steam



■ Fig. 1 Characteristics of resistance and temperature

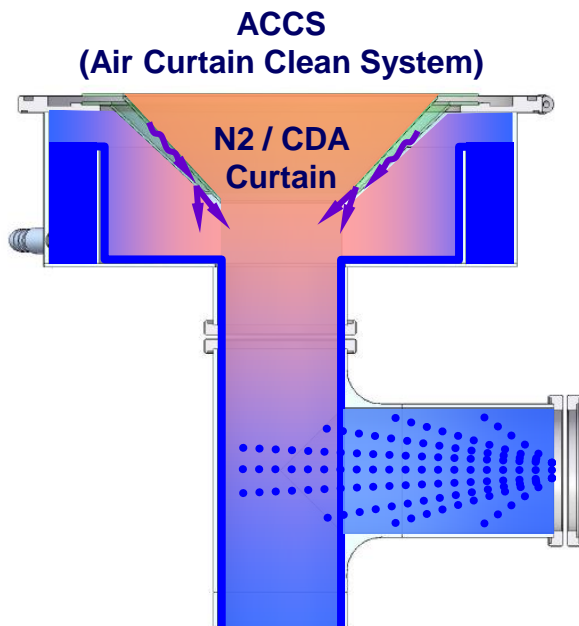
Characteristic value (Rt/Ro):

Ro.....Resistance value at 1000°C

Rt.....Resistance value at each temperature

□ High Performance SiC Heater

Quench section view between PM



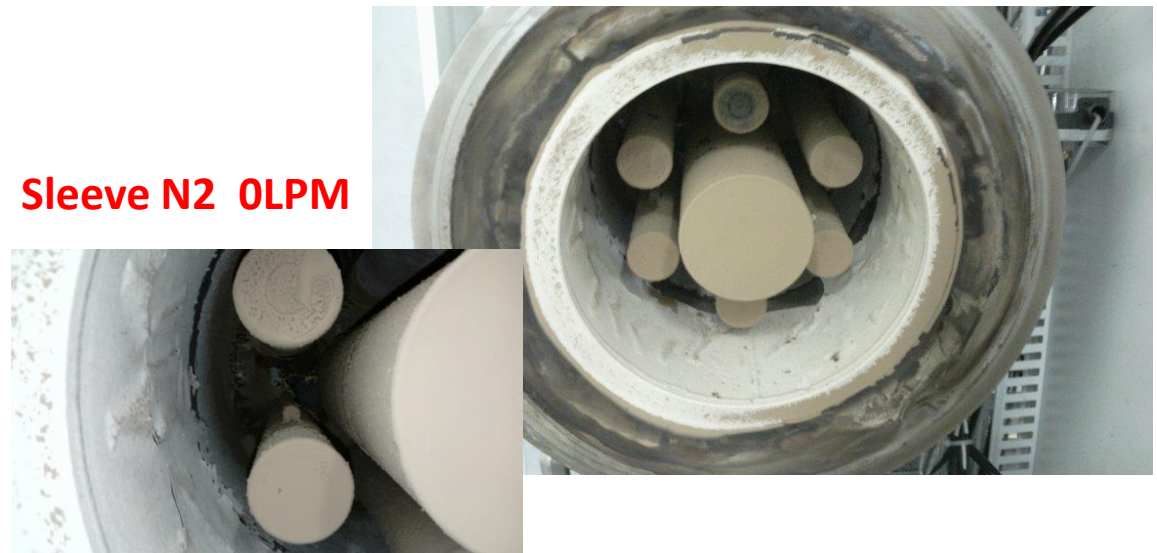
- Reactor side:
Inconel shield
- Wetted path:
Teflon coated stainless steel

Reactor view between PM

Sleeve N2 40LPM



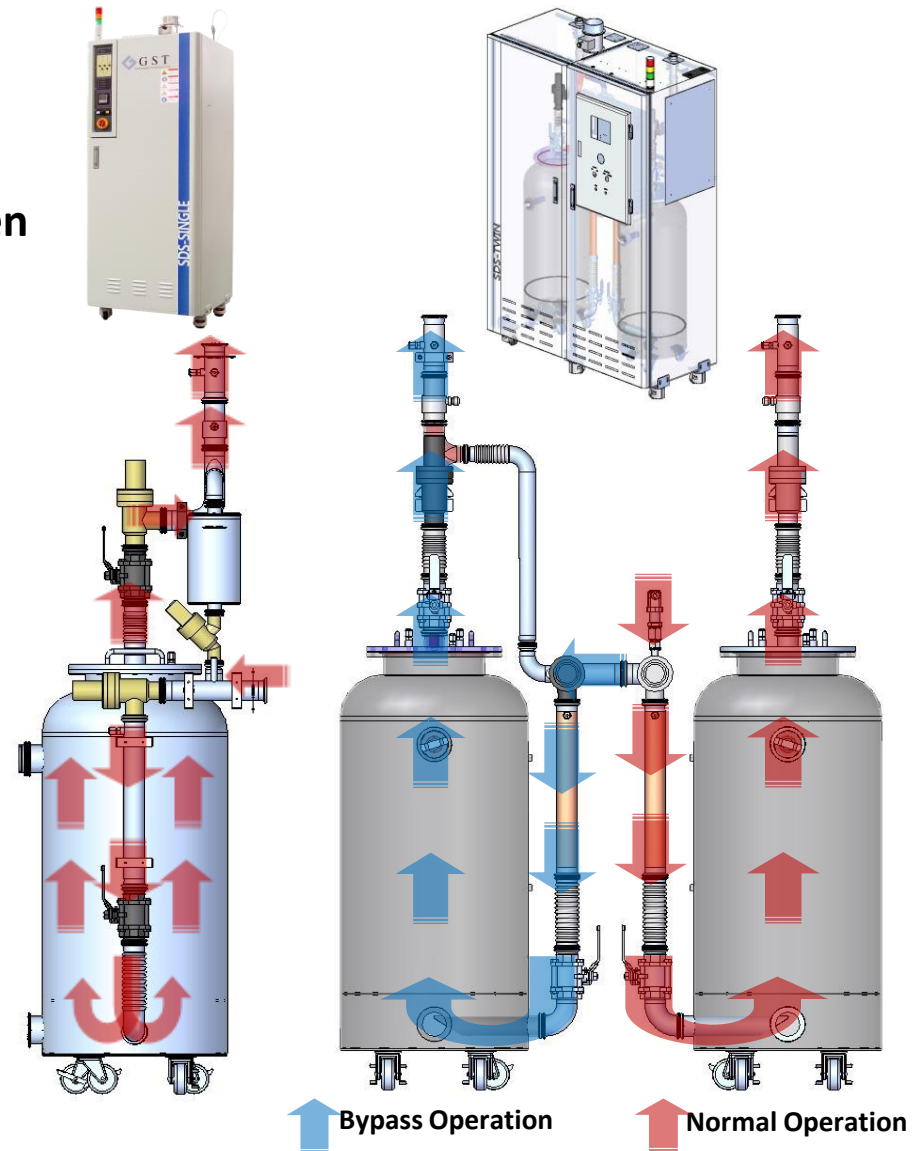
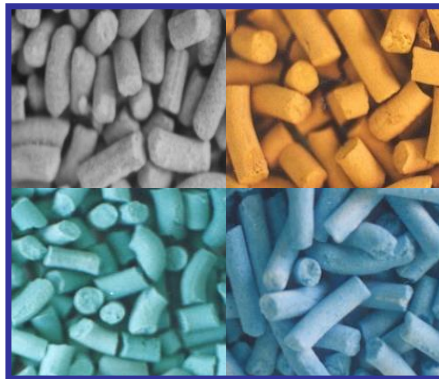
Sleeve N2 0LPM



“Dry” Type – SDS Single & Twin

SDS

- ❑ HVM (high volume manufacturing) proven
 - Implant application
 - Low utility consumption
 - Simple construction
- ❑ High abatement efficiency
 - Various **adsorbent media** available

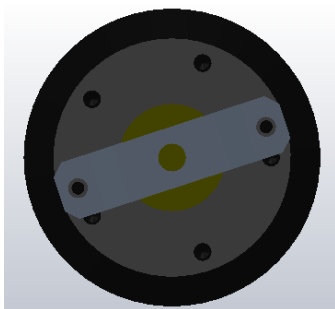
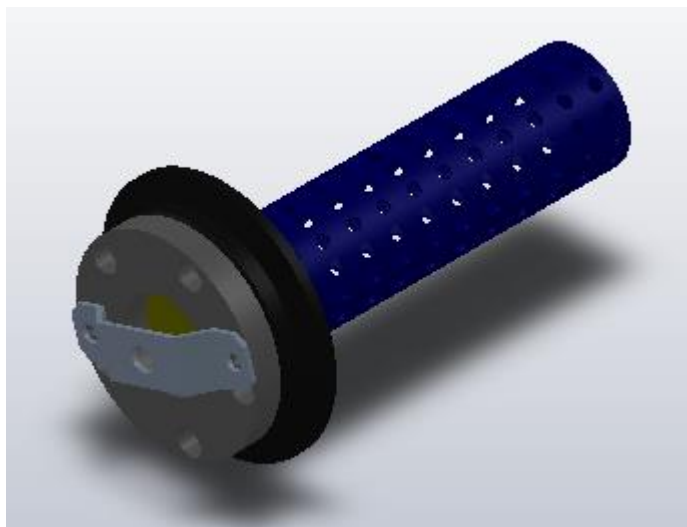


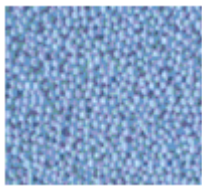
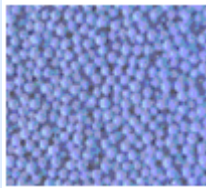
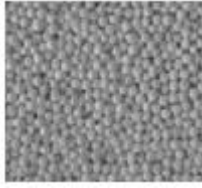

❑ Media Capacity & DRE

- Abatement efficiency: Effluent concentration to non-detection level
- Media operation limits for full capacity utilization:
 - ✓ Maximum 0.02 m/second (0.02 m/second at 150 slm)
 - ✓ Maximum 2% target gas concentration (typical operating range < 1%)

Media	Key Composition	Target Gas	Capacity
ULTIMA-Sorb	Cu(OH) ₂	AsH ₃	100 l/l
		PH ₃	100 l/l
Sorbent A-1	Ca(OH) ₂	BF ₃	55 l/l
		F ₂	40 l/l
Sorbent A-2	FeCl ₃	Cl ₂ , BCl ₃ , HBr, HCl, F ₂ , HF	50 l/l
Sorbent A-7	Ca(OH) ₂	HCl, HF	200 l/l

Break-through Detection

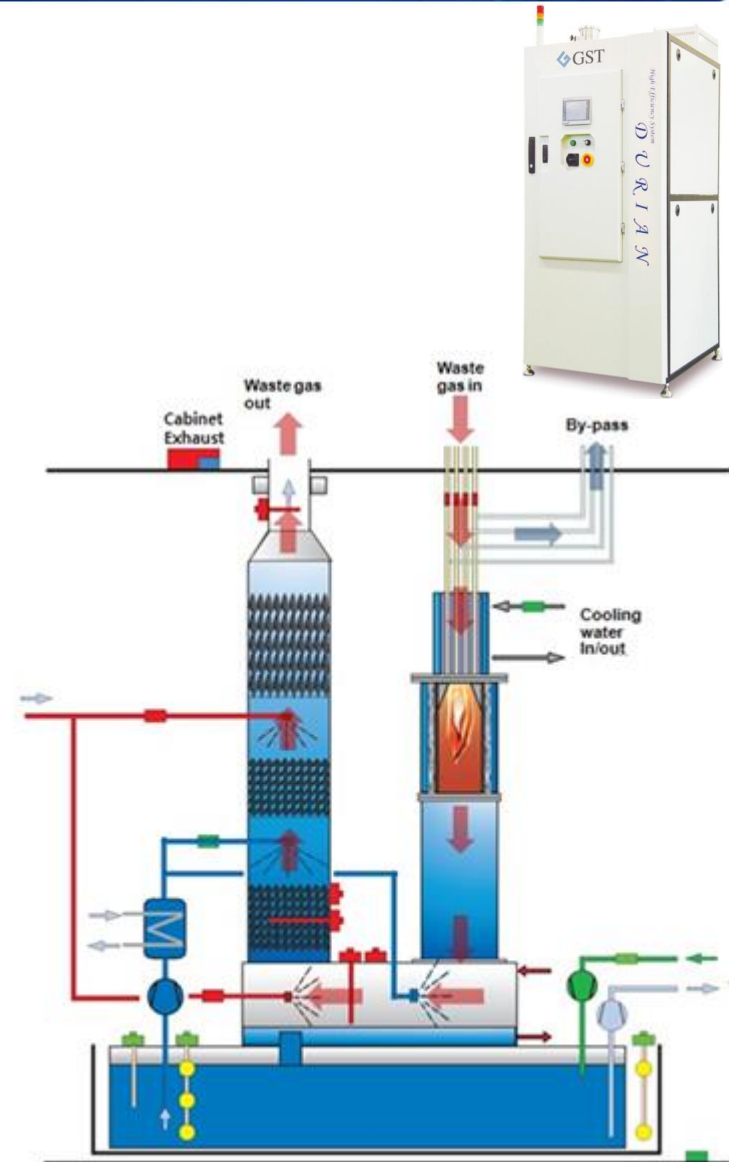


	Hydride Series	Acid Series
Target Gases	AsH ₃ , PH ₃ , etc.	Cl ₂ , F ₂ , BF ₃ , etc.
Composition	Metal Oxide & Salt	Metal Oxide & Salt
Before Exposure		
After Exposure		<p>Reaction with Chloride</p>  <p>Reaction with Fluoride</p>

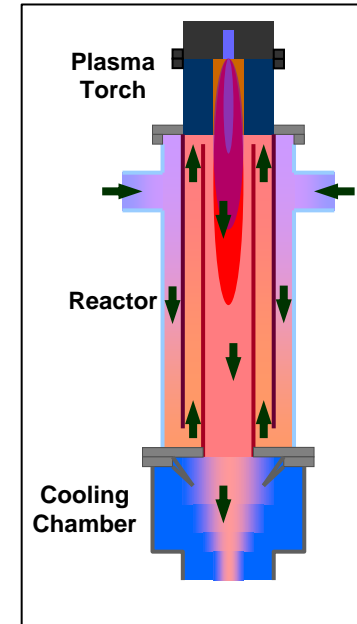
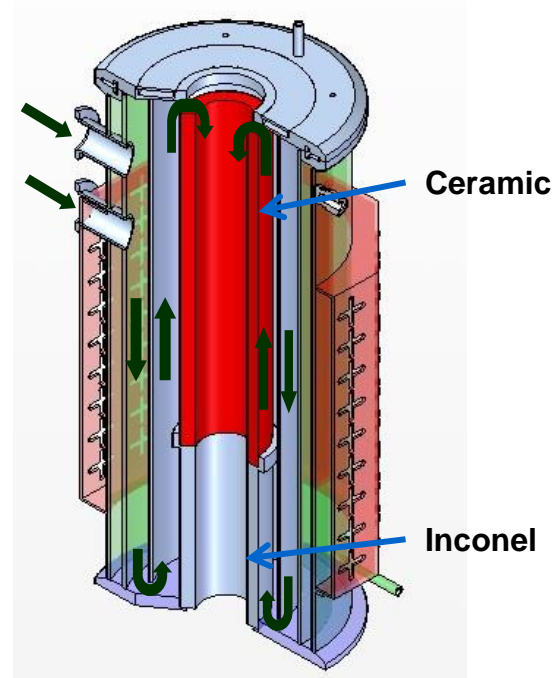
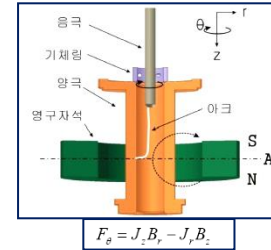
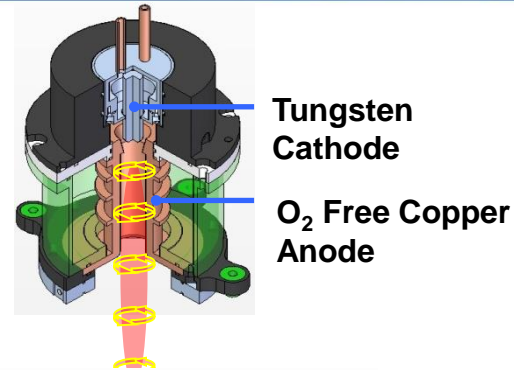
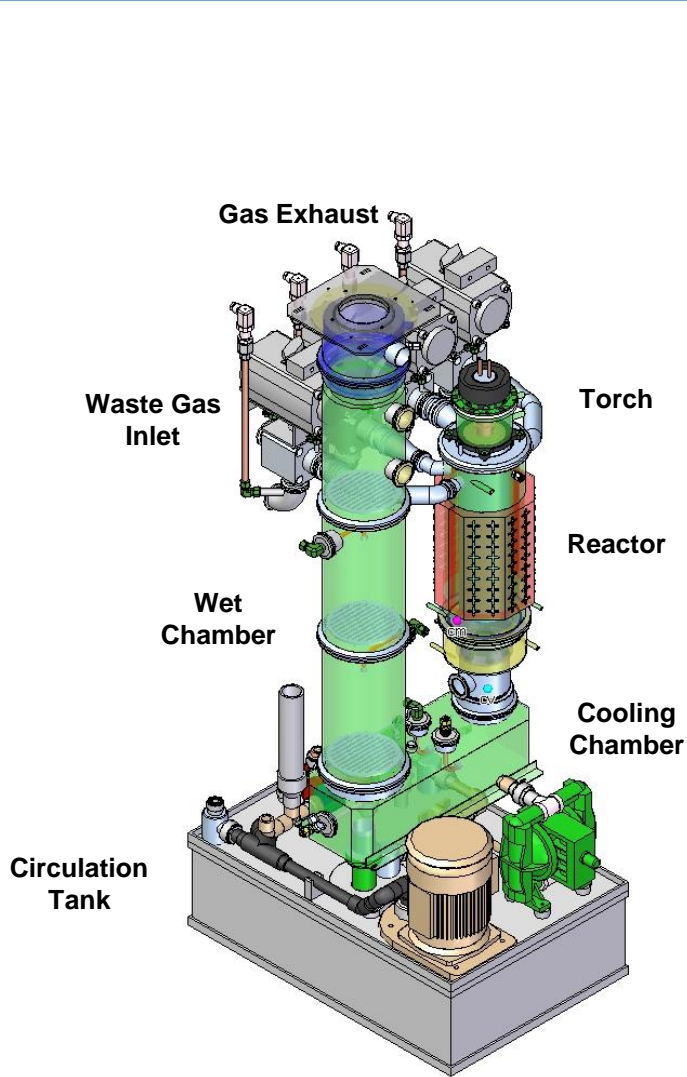
“Plasma-Wet” Type: Durian

Durian

- ❑ HVM (high volume manufacturing) proven
 - Ideally suited for semiconductor etch PFC abatement
 - Low utility consumption
- ❑ High abatement efficiency
 - **N₂ plasma**
 - Ceramic reactor
 - No fuel
- ❑ Energy savings operation ready



N2 Plasma

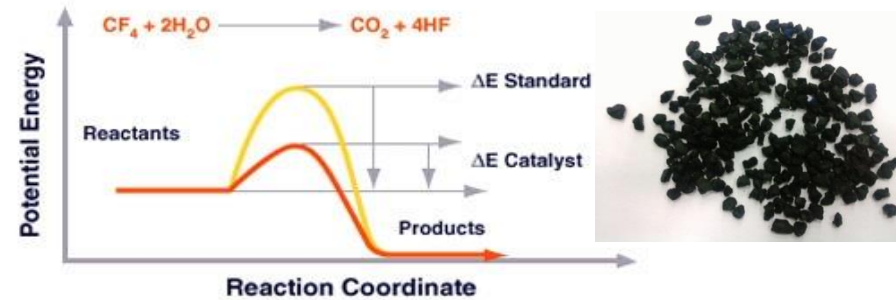


“Catalyst” Type: RCO & Zone Scrubber

Catalyst Aided

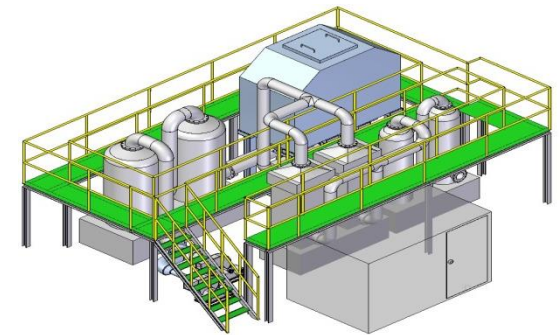
- ✓ GST exclusive PFC catalyst lowers the decomposition temperature

For example, CF₄ may be abated at <750°C



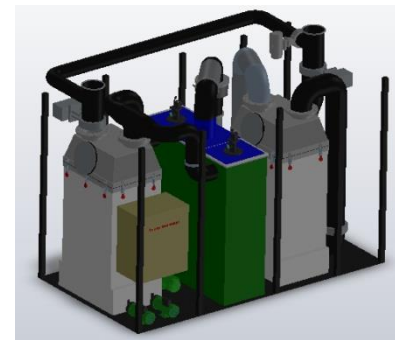
❑ RCO – Facility Level PFC Abatement

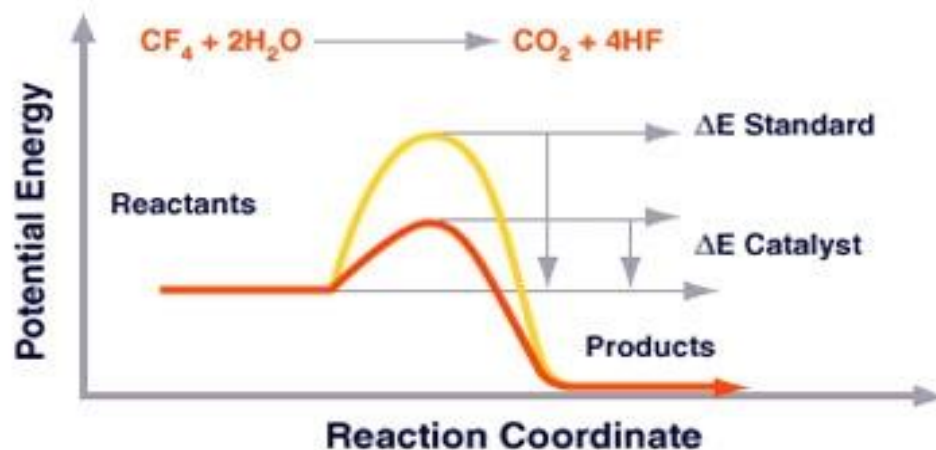
- Combination of heat recovery and catalyst technology
- Ultra-low energy consumption
- >20 process tool coverage



❑ Zone Scrubber – Subfab Level PFC Abatement

- Coverage for entire bay (10 etch tool effluents)
- Energy efficient
- <20 process tool coverage





Decomposition PFC's without Catalyst

$CF_4 > 1120^\circ C$

$C_2F_6 > 842^\circ C$

$SF_6 > 800^\circ C$

$NF_3 > 300^\circ C$

Decomposition PFC's with Catalyst

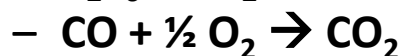
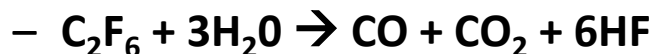
$CF_4 > 410^\circ C$

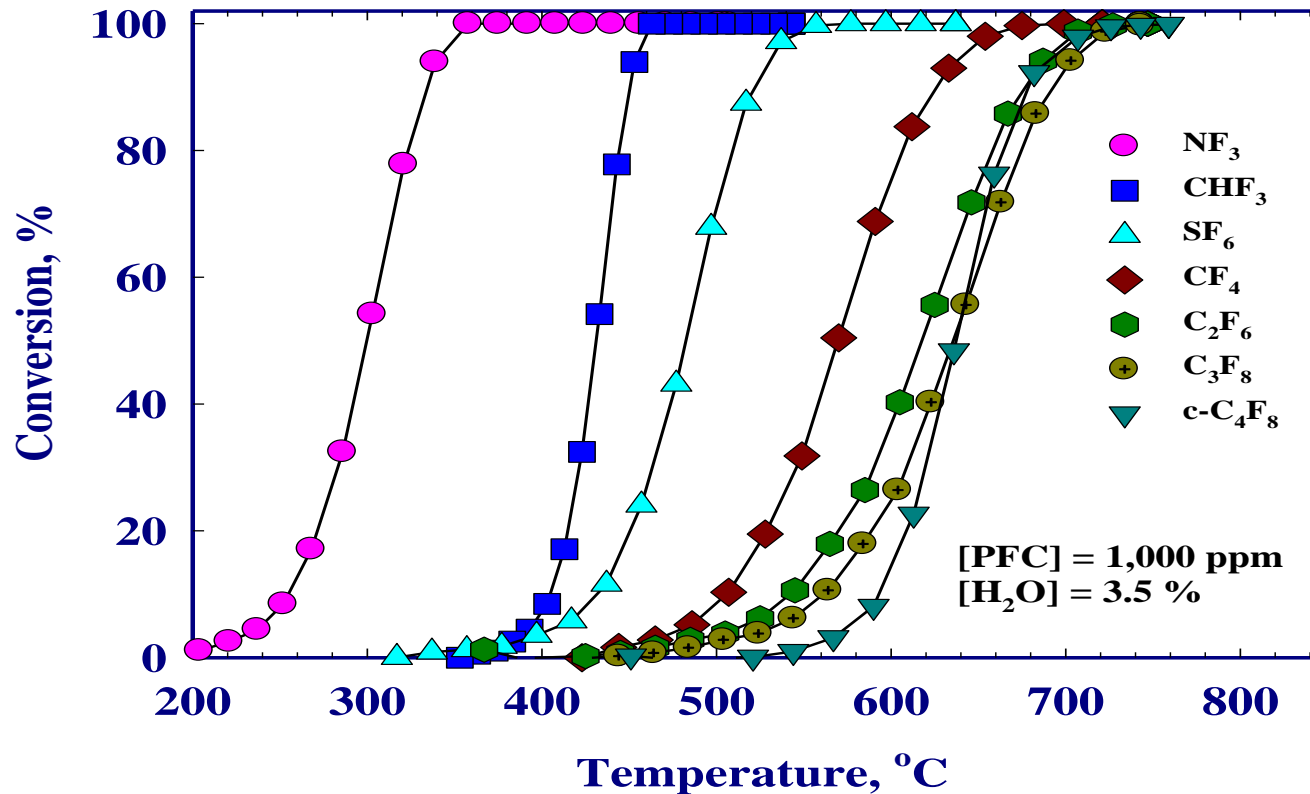
$C_2F_6 > 425^\circ C$

$SF_6 > 350^\circ C$

$NF_3 > 200^\circ C$

- Catalyst facilitates reaction by hydrolyzing PFC's to HF and CO_2 at temperatures well below typical thermal oxidation



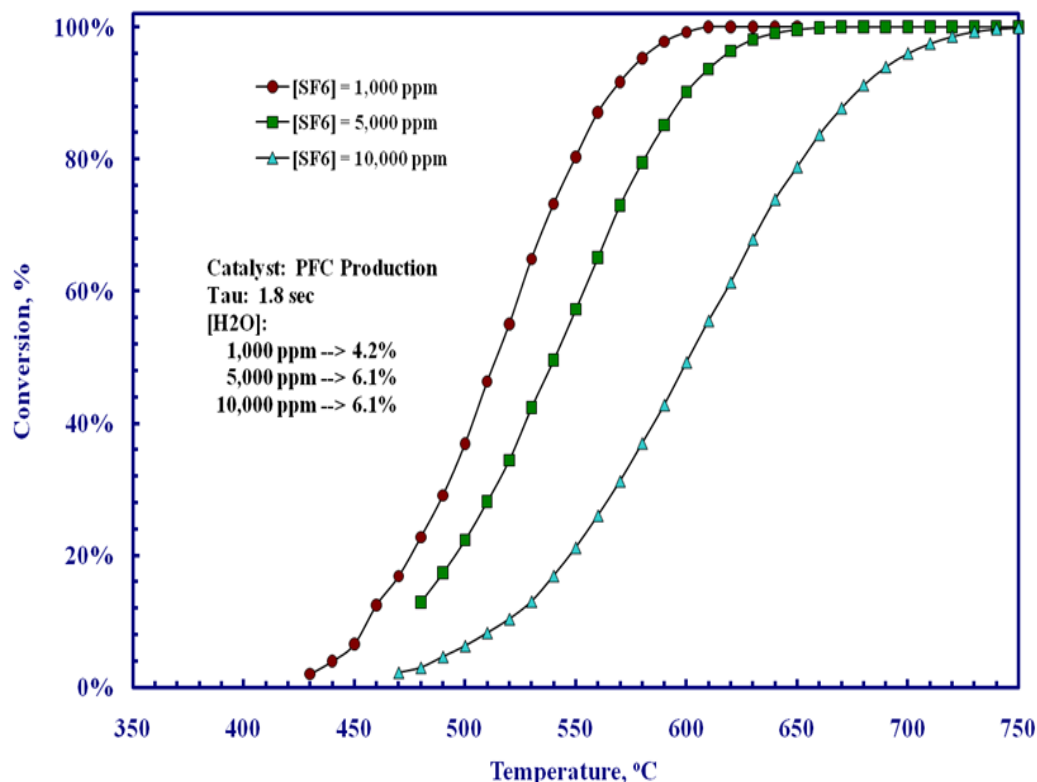


Applicable for semiconductor PFC gas species

Catalyst Performance (influent concentration)

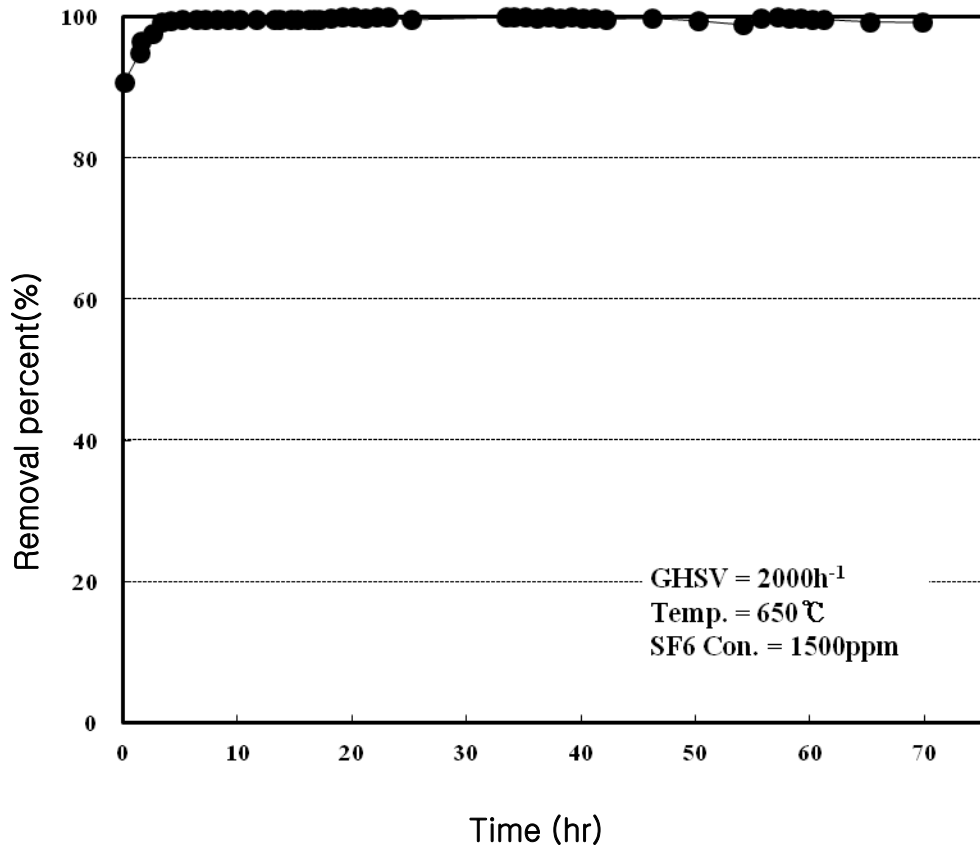
■ Al₂O₃ based catalyst (M/Al₂O₃)

■ Metal : Ti, Zr, Co, Ni additives



Effect of concentration on SF₆ Light-off curve.

Catalyst Performance (temperature & space velocity)



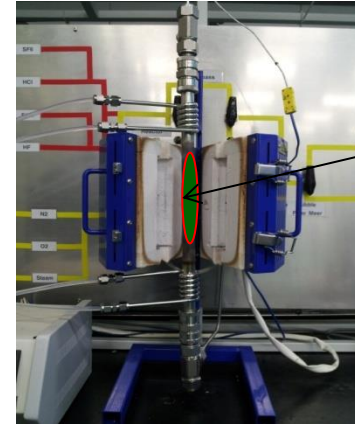
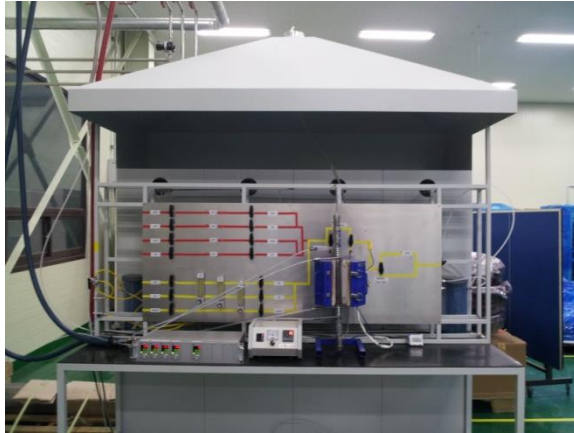
Temp.(°C)	Efficiency (%)
600	75.6
650	99.9
700	99.9

Space Velocity : 2500 h⁻¹, SF₆ : 1500ppm, TOS : 5hr

GHSV(h ⁻¹)	Efficiency (%)
1000	99.6
2000	99.9
3000	98.9

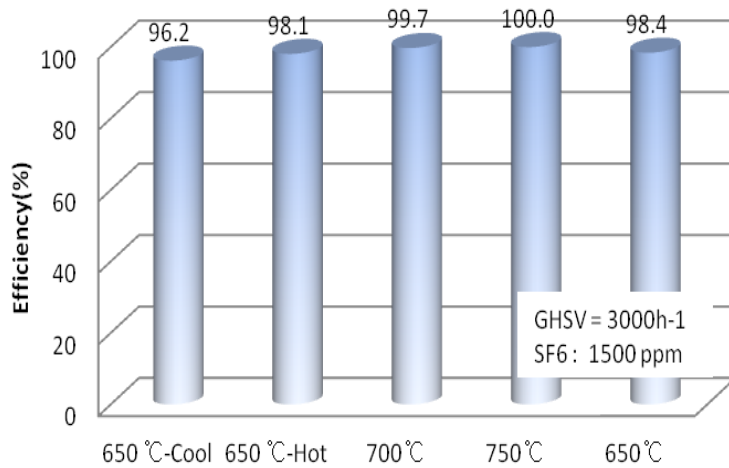
Temperature : 650°C, SF₆ : 1500ppm, TOS : 5hr

Lab - Catalyst Performance Testing

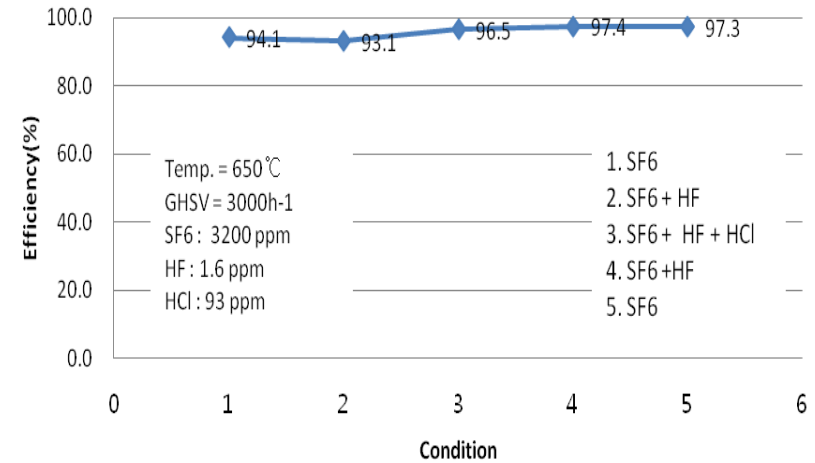


Catalyst

Temperature Effect



SF6 Removal efficiency

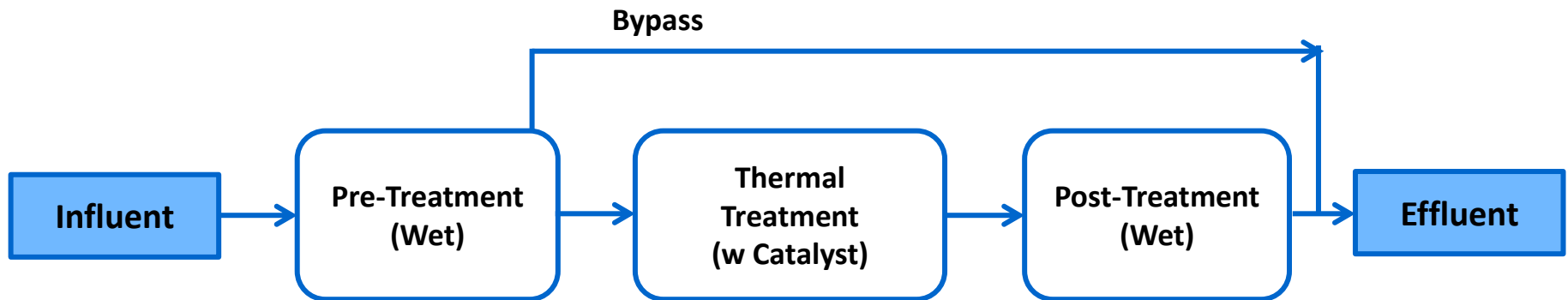


Pilot - Catalyst Performance Testing

Specification		Burn & Catalyst & Wet Type
Capacity		1CMM
Dimension		2500W X 2000D X 3000H
Utility	LNG	30LPM
	H ₂ O	2 LPM
	Power	220V, 8KW



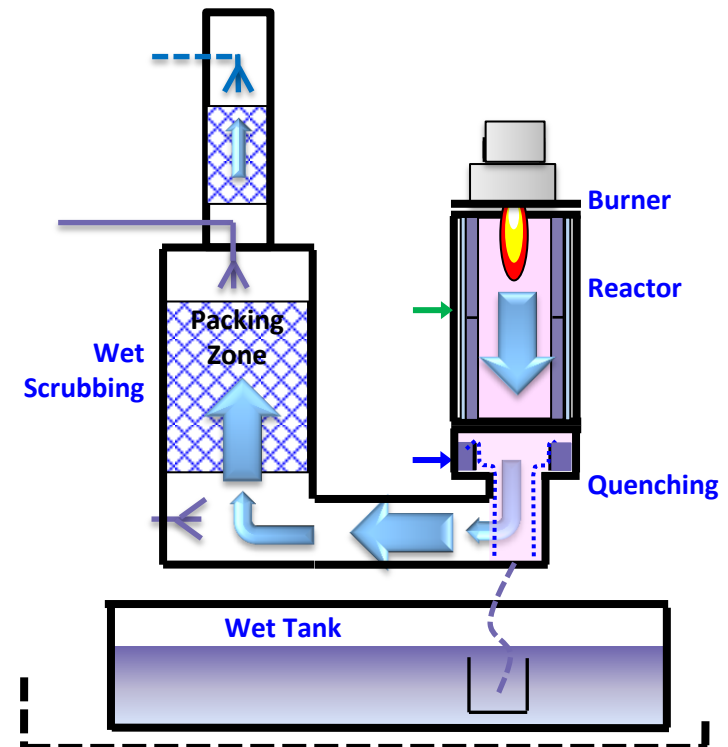
PFC RCO/Zone System Block Diagram



“Burn-Wet” Type: DRAGON

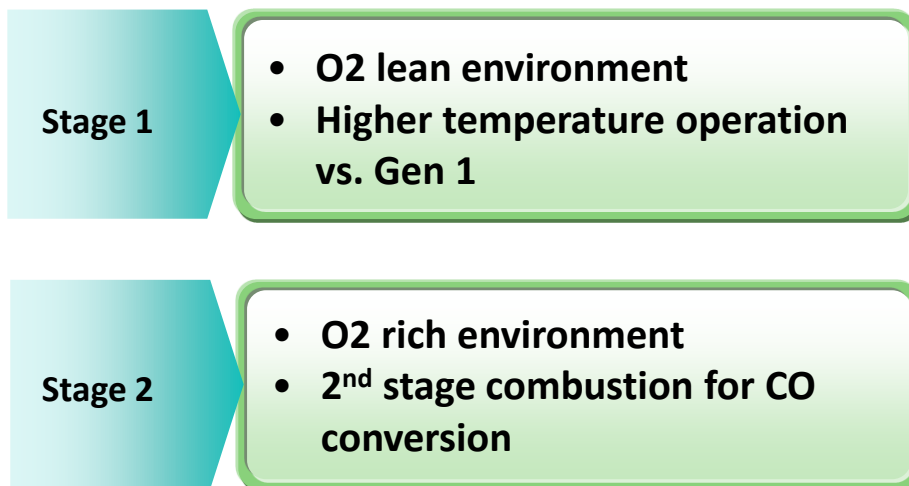
Dragon LE/HE/HEX

- ❑ HVM (high volume manufacturing) proven
 - Ideally suited for semiconductor deposition processes
 - Virtually zero unscheduled downtime with DUO
 - Low utility consumption
- ❑ High abatement efficiency
 - Fuel provides reagent
 - Higher temperature compared to “Heat-Wet” type
- ❑ Dual stage combustion for low NO_x and CO
 - Stage 1: Fuel rich for low NO_x and high CO
 - Stage 2: 2nd combustion for CO conversion
- ❑ Energy savings operation ready



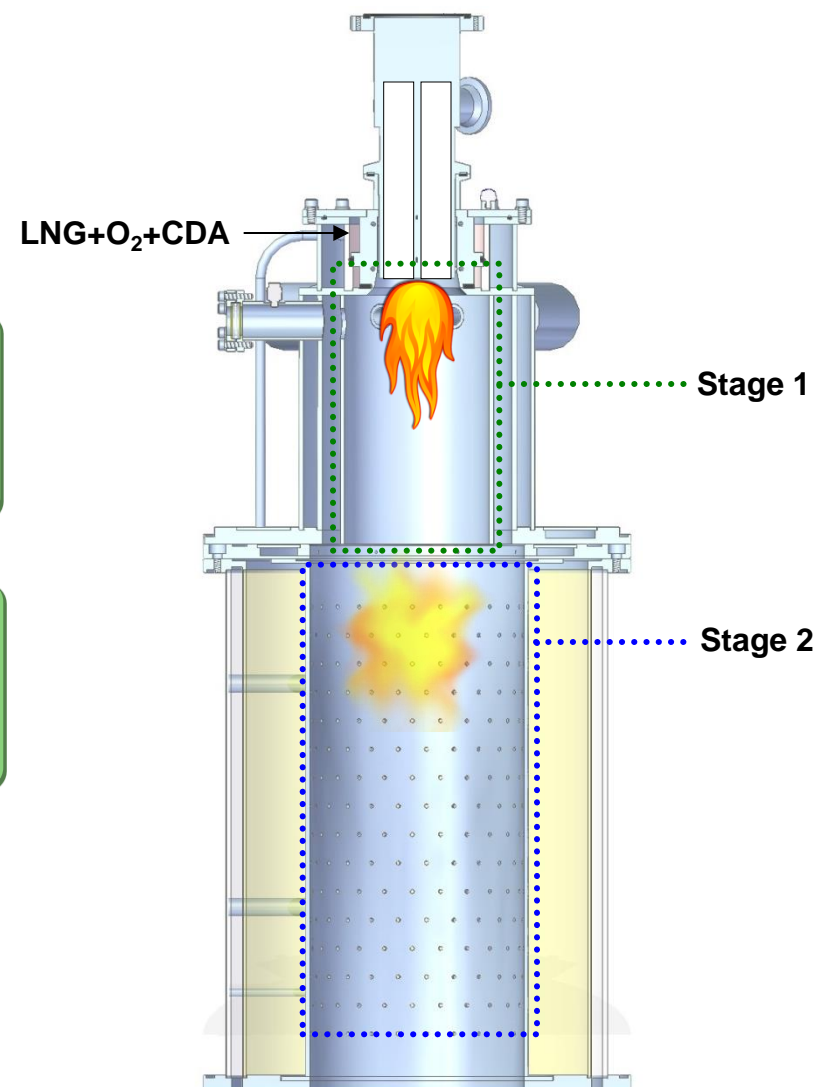
□ Dual Stage Combustion

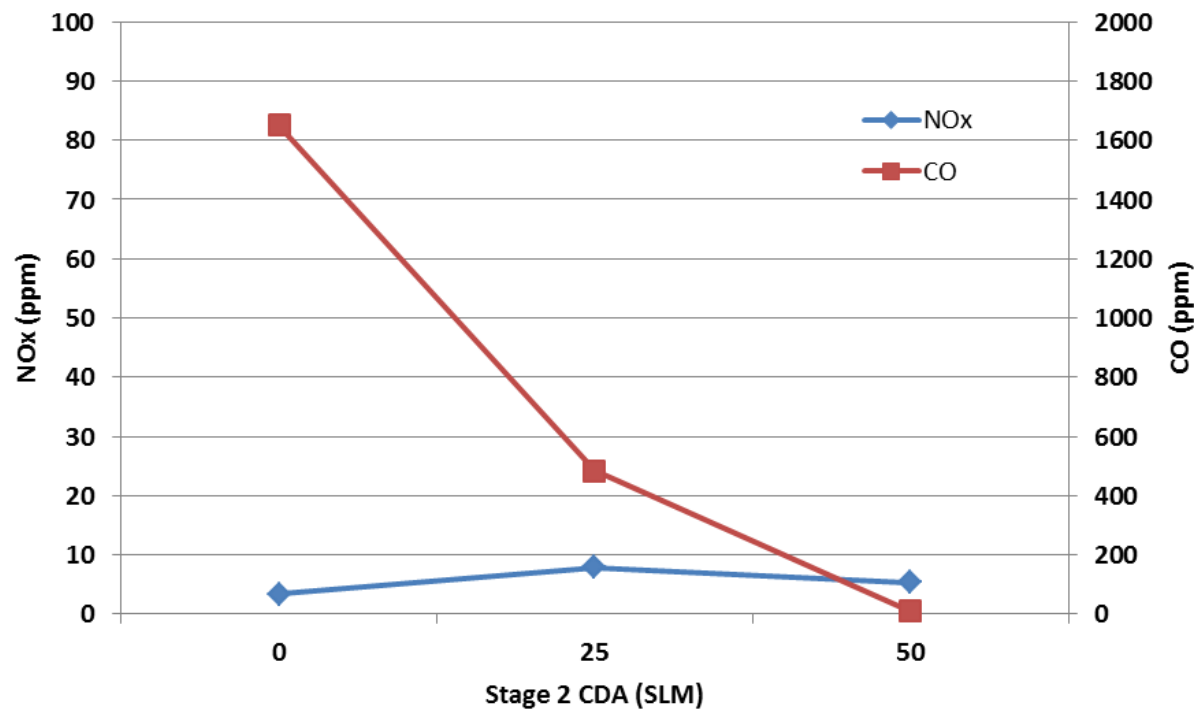
- Higher temperature operation range
- Separate control for NO_x and CO



□ Benefits

- Wide range of application
- Low NO_x emissions





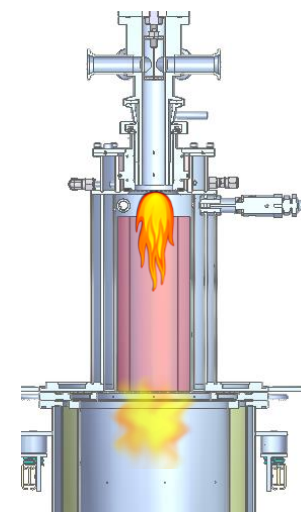
☐ Separate Control for CO

- Fuel/O2 Mix Settings : LNG 20 slm, O2 5 slm, Mix CDA 90 slm
- Stage 2 CDA for CO to CO2 conversion



❑ Multi-stage Combustion Reactor (for Dragon LE & HE)

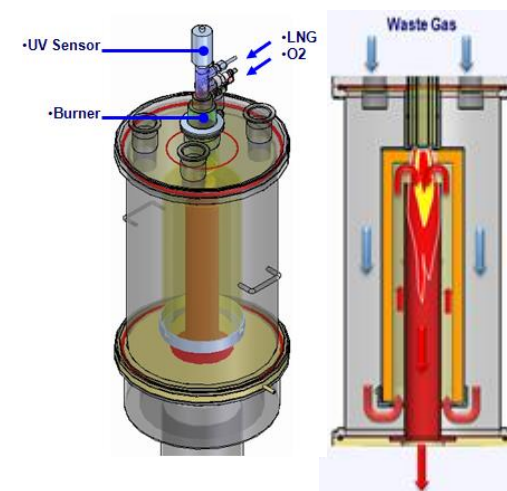
- Independent control of NO_x and CO
- >99% NF₃ DRE with <10 ppm NO_x emissions



Multi-stage Combustion Reactor

❑ Pre-heat Reactor (for Dragon HEX)

- Heat recovery for >30% energy savings
- CF₄ abatement capability

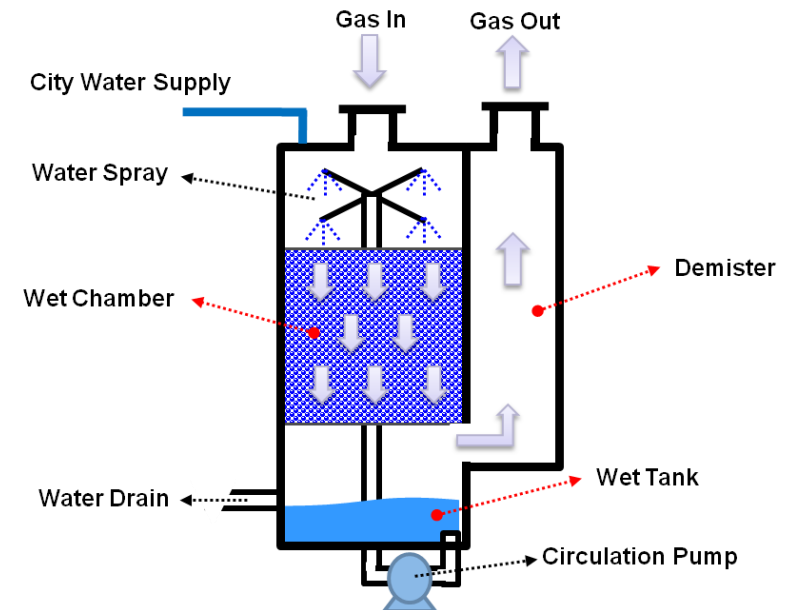


Pre-heat Reactor

Standard “Wet” Type – SWS-500

SWS-500

- ❑ HVM (high volume manufacturing) proven
 - Acid gas abatement
 - Low capital and low utility consumption
- ❑ Original “scrubber” for semiconductor industry



Larger “Wet” Type – Aqua & Aqua EP

Aqua

- ❑ HVM (high volume manufacturing) proven
 - Acid gas abatement
 - Low capital and low utility consumption
- ❑ Larger Capacity
 - 40~60 m³/min
 - EP option for fine particulate removal



Aqua



Aqua EP

Continuous Improvement Service

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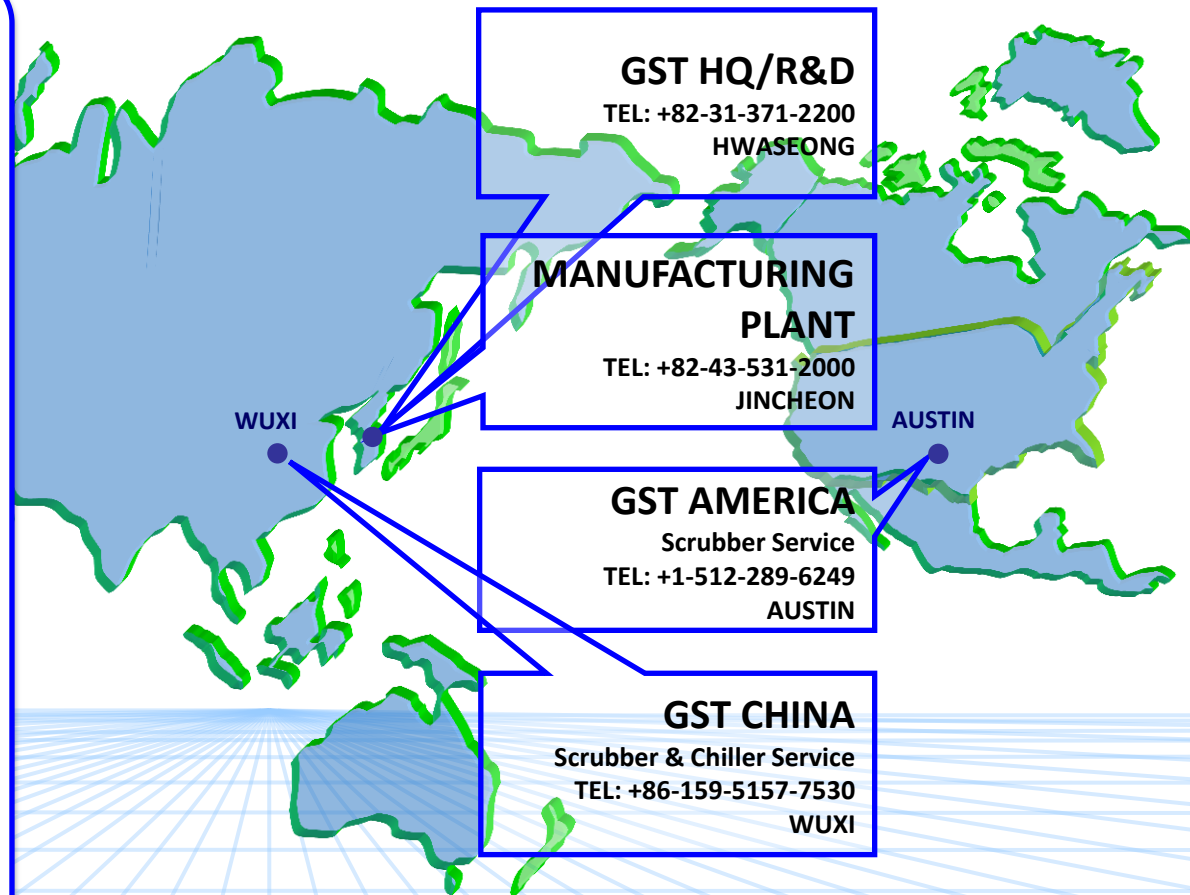
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- ❑ GST strives to provide **BEST PRACTICAL ABATEMENT** solutions
 - Full product portfolio
 - World wide reach
 - Premier semiconductor abatement company
 - GST stands behind our products and customers

- ❑ GST is pleased to offer subfab solutions for North America customers
 - Evaluations / qualifications
 - Joint development and custom engineering
 - Invitation to tour GST facilities and install base

GST GLOBAL STANDARD TECHNOLOGY

Thank you



Application Matrix - Deposition



Process	Process Gas	Typical Concerns	Option 1	Option 2	Accessories
PECVD SiH4	SiH4 / NH3 / N2O NF3	Flammable effluent mix Incompatible gases (clean and dep) F2 and GHG	Dragon - LE	ISIS-II	Hot N2 Heater jackets
PECVD TEOS	TEOS / TEB / TEPO NF3	Flammable effluent mix Incompatible gases (clean and dep) F2 and GHG	Dragon - LE	ISIS-II	Hot N2 Heater jackets
Low k CVD	TMS / mDEOS / BCHD NF3	Byproduct build-up and clogging Flammable effluent mix Incompatible gases (clean and dep) F2 and GHG	Dragon - HE	ISIS-II	Hot N2 Heater jackets
SACVD, HDPCVD	TEOS / O3 / others NF3	Byproduct build-up and clogging Flammable effluent mix Incompatible gases (clean and dep) F2 and GHG	Dragon - LE	ISIS-II	Hot N2 Heater jackets
Metal	SiH4 / WF6 NF3 or ClF3	Byproduct build-up and clogging Flammable effluent mix Incompatible & reactive gases F2 and GHG	Dragon - LE	ISIS-II	Hot N2 Heater jackets
Nitride	DCS / NH3	Byproduct build-up and clogging Flammable effluent mix	Dragon - LE	ISIS-II	Hot N2 Heater jackets

Application Matrix - Etch, Implant, etc.



Process	Process Gas	Typical Concerns	Option 1	Option 2	Accessories
Poly	SiH4 / PH3 ClF3	Highly toxic and flammable effluent Incompatible & reactive gases	Dragon - LE	ISIS-II	
Conductor Etch	Cl2 / BCl3 / HBr / SF6 / CF4 / CHF3	Byproduct build-up and clogging Toxic and corrosive effluent mix F2 and GHG	Durian	SWS-500 Dragon -HE Catalyst Aided	Hot N2 Heater jackets
Dielectric / Silicon Etch	NF3 / CF4 / SF6 / CHF3	Toxic and corrosive effluent mix F2 and GHG	Durian	SWS-500 Dragon-HEX Catalyst Aided	
Implant	AsH3 / PH3 / BF3	Highly toxic and flammable effluent	SDS-500		
Epi	DCS / PH3 / AsH3 / SiH4 / H2	Highly toxic and flammable effluent High volume of flammable gases Byproduct build-up and clogging	Dragon - LE	ISIS-II	Hot N2 Heater jackets
Wet bench	NH4OH / HCl / HF	Large exhaust volume NH4OH and HCl fume byproduct	Aqua - EP		