Tri-Mer Corporation

UltraTemp High Temp Filter

for PM, PM+SO2/HCl

&

UltraCat Catalyst Filter

for NOx removal, PM+SO2/HCl

Rod Gravley
Technology Director

Kevin Moss
Business Development Director

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Tri-Mer Corporation – Company Profile

- Technology leaders in pollution control
- In-house manufacturing facility and fabrication line in central Michigan
- 15 lines of equipment to fit applications
- Turn-key project services
- Over 6,000 installed scrubber systems
- Projects from 10 cfm to 300,000 cfm
- Worldwide installations, many industries

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Tri-Mer Product Line, Wet Scrubbing, Dry Filtration, SCR

COMMEMORATING 50 YEARS OF SERVICE IN 2010

Tri-Mer® Technology

Solves Industry's Toughest Air Pollution Problems!

CCS® for Submicron Particulate PM10, PM2.5 . . .

Removes Particulate Down to 0.1 Micron with Very High Efficiency, Also Ultrafine Particulate and Condensables

- Simultaneously removes HCl, HF, HNO_3, H_2SO_4, SO_3/SO_2, Cl_2, NH_3, other soluble gases
- Low total energy use: less than 1.5" w.g. pressure drop
- Smoothly handles changes in flow volume; can be turned down over a wide range, typically 10:1 or better.
- Easily accommodates changes in particle loading and loading constituents (including TAC)

MultiPhase™ BioSystem for VOC Emissions . . .

Tri-Mer MultiPhase BioSystem™ is Superior Alternative to RTO, RCO or Conventional Biofilter

- Gas and liquid phase treatment integrated into one technology
- Treats wide spectrum of VOCs with high efficiency; handles tars, waxes, heavy VOC compounds
- Handles high particulate loadings
- Proprietary synthetic ceramic biomedia; no media bed clogging, automatically self-cleaning
- Compatible with high inlet temperatures
- Minimal waste, minimal wastewater; creates no NO_x compounds

Tri-NO_x® Multi-Chem® Scrubber Systems . . .

For Any NO/NO_2 Ratio; Guaranteed Zero NO_2 Opacity at Stack

- 40-250,000 CFM
- Non-catalytic system will not blind or poison.
- Concurrent scrubbing of SO_2, HCl, HF and other residuals
- Polypropylene, 316L stainless steel, fiberglass or high alloy metals
- Can be integrated into particulate control technology if required
- Process instrumentation fully automated
- Inlet temperatures to 1100°F

Whirl/Wet® Dust Collector . . .

For Soluble or Insoluble Particulate

- Medium-energy scrubber for 3 microns or larger
- 99% efficient over wide range of micron sizes
- Available in coated mild steel, 304L and 316L stainless steel, and all-polypropylene (unique to industry); 500-50,000 CFM
- Low water use; low maintenance

www.tri-mer.com

High Efficiency Fume Scrubbers . . .

For HCl, HF, HNO_3, Metal Finishing and Other Corrosive Applications

- Deep pack/high liquid recirculation rate units can achieve ppb level outputs
- Packed Bed Scrubbers with built-in mist elimination
- Crossflow Scrubbers: single or multiple stage

Packed Bed Tower Scrubbers . . .

For Gaseous Emissions

- NO_x, Cl_2, SO_2, also acid fumes, including H_2SO_4, HCl, HNO_3, and HF
- Can incorporate particulate control, gas quench, venturis, cartridge filters, carbon systems
- Combination systems for hot and cold gases

C/E-1 Chrome Scrubber . . .

99.5%+ Efficiency for CR_6, CR_3 Regardless of Loading

- All-mechanical system does not use chemicals or generate waste
- Capable of handling other fumes simultaneously

Fan/Separator® . . .

For H_2SO_4 and Other Corrosive Fumes

- Packaged, stand-alone system
- Ideal for steel pickling plants or battery charging operations
- Low capital and operations costs – requires less than 10% of water used by competitive systems and operates with 25% lower BHP requirement

Odor Control Scrubbers . . .

For Food Processing, Industrial and Municipal Applications

- 35-150,000 CFM
- Carbon beds available
- Zero odor at the stack

Custom-Fabricated Tanks . . .

Lengths to 100 ft.

- For pickling, plating, etching, anodizing
- Also fume hoods, consoles
- Polypropylene, PVC, PVDF, stainless steel

Fans and Ventilation . . .

Ductwork, Hoods, Fans, Blowers

- PVC
- Polypropylene
- FRP

Downdraft Grinding Table . . .

For Metal Fines, Aerospace Metals

- Work surface is FRP, polypropylene, PVC, mild steel or stainless steel.
- Grinding table has integral Whirl/Wet® dust collector which provides 99%+ collection for metal fines and dusts, and is self-cleaning.
- Several tables can be ducted to one Whirl/Wet.

Tri-Packs Tower Media . . .

- Tri-Packs is the ultimate in random dump tower packing, providing maximum surface contact between gas and scrubbing liquid by facilitating continuous droplet formation throughout the packed bed.

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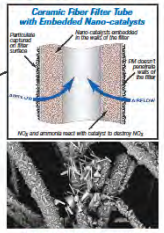
ULTRACAT
HOT GAS FILTRATION
BOILER MACT SOLUTION

UltraCat Catalyst Filters Control PM, SO_2, HCl, NO_x & Dioxins

NO_x Control at 350°F



Ceramic filter configuration typical of the 400+ filter applications worldwide.

Micrograph of nano-catalysts embedded in ceramic-coated fibers.

UltraCat Meets Boiler MACT, Glass Furnace Requirements

UltraCat catalyst filters are composed of fibrous ceramic materials mixed with nanobits of proprietary catalyst. This new generation of light weight, ductile ceramic filter is very efficient in removing NO_x and capturing particulate, including submicron PM, to extremely low levels.

Particulate Control

UltraCat filters typically capture particulate to levels less than 0.001 grains/dscf (2.0 mg/Nm³). ***For Boiler MACT compliance, levels of less than 0.004 lbs/MMBtu are guaranteed.*** The unique structure of the filters keeps the collected particles on the surface. On-line cleaning with reverse pulses of air is effective, pressure drop build up is minimal, and the embedded NO_x catalyst is protected.

NO_x and Dioxin Control

The UltraCat filter tubes have nanobits of proprietary catalyst embedded throughout the filter walls, which are about 3/4" thick *(see illustration opposite)*. The UltraCat can achieve excellent NO_x removal at temperatures of 350°F and higher. Operating range is approximately 350°F to 750°F. Urea/ammonia is injected upstream of the filters, reacting with NO_x at the catalyst to form harmless nitrogen gas and water vapor, which then exits the system as gases. The proprietary catalyst is highly resistant to sulfur poisoning and is protected from particulate contamination because it is embedded inside the filter walls. Typical NO_x results – up to 95% removal.

UltraCat is also very efficient at destroying dioxins, typically at 97 - 99%.

CO in the Boiler MACT

The proposed Boiler MACT regulates production of CO. If CO is managed by combustion conditions, then NO_x production increases. The best strategy for Boiler MACT compliance is to control the CO in the boiler and allow the UltraCat to remove the NO_x in the flue gas.

SO_2, HCl, Acid Gas Control

The UltraCat system can incorporate dry sorbent injection of sodium bicarbonate or lime for efficient dry scrubbing of SO_2, HCl, and other acid gases. Typical SO_2 and HCl results show 90 - 98% removal.

Mercury Control

The strategy for mercury control depends on the constituents in the flue gas and is analyzed on an individual project basis. Levels of mercury control can be achieved through trona injection, activated carbon of various formulations, and other approaches compatible with the UltraCat filter system.

UltraCat is the Low Cost Solution.

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Filter reference list

Over 400 installations primarily in Europe and Japan across many industries.

U.S. military applications plus a rapidly growing number of U.S. industrial installations since introduction to the industrial sector. Market driven by strict new regulatory laws.

Ref. No.	Application	Number of Elements	Filter Area m^2	Gas Flow Am^3/h	Average Temp. Deg. C	Face Velocity m/s	Average dP mm wg	Installed	Country	Region
									60mm O/D elements	
A	**Gasification & Pyrolysis**									
A10	Wood Gasification	1920	364.8	22326	450	0.017	n/a	May-09	UK	Europe
A20	Wood Gasification	640	121.6	7442	450	0.017	n/a	Dec-07	UK	Europe
A30	Wood Gasification	320	60.8	3721	450	0.017	n/a	n/a	UK	Europe
A40	Wood Gasification	320	60.8	3721	450	0.017	n/a	n/a	Germany	Europe
A50	Wood Gasification	160	30.4	1860	450	0.017	n/a	n/a	UK	Europe
A60	Wood Gasification	160	30.4	1860	450	0.017	200	Dec-07	Germany	Europe
A70	Wood Gasification	160	30.4	1860	450	0.017	n/a	n/a	Germany	Europe
B	**Waste Incineration**									
B30	Waste Incineranon	2247	516.8	29500	230	0.016	275	Nov-98	Poland	Europe
B50	Petrochemical Waste Incineration	1764	405.7	35059	290	0.024	n/a	May-02	Spain	Europe
B90	Liquid Waste Incineration	1152	265.0	n/a	n/a	n/a	n/a	2000	Spain	Europe
B100	Waste Plastic Degrader	1296	246.2	22162	250	0.025	n/a	1998	Belgium	Europe
B110	Sludge Incineration	972	184.7	26594	450	0.040	n/a	1994	Thailand	A/P
B115	Clinical Waste Incineration	864	164.2	14774	200	0.025		1999	Poland	Europe
B120	Munitions Waste Incineration	832	158.1	13584	200-250	0.024	n/a	1995	UK	UK
B130	Munitions Waste Incineration	832	158.1	n/a	n/a	n/a	n/a	1997	UK	UK
B135	Clinical Waste Incineration	756	211.7	12000	180	0.016	200	2009	China	China
B140	Clinical Waste Incineration	732	139.1	n/a	220	n/a	n/a	Feb-97	Malaysia	A/P
B150	Sludge Degrader	648	123.1	11081	300	0.025	n/a	1998	Belgium	Europe
B160	Waste Degrader	648	123.1	13300	220	0.030	n/a	1999	Poland	Europe
B170	Clinical Waste Degrader	540	102.6	14774	300	0.040	n/a	1997	Belgium	Europe
B180	Hazardous Waste Incineration	480	91.2	6850	250	0.021	n/a	1997	Argentina	Americas
B190	Clinical Waste Incineration	432	82.1	8865	200	0.030	n/a	1997	South Korea	A/P
B200	Clinical Waste Incineration	420	79.8	11491	170	0.040	300	1997	Spain	Europe
B210	Clinical Waste Incineration	400	76.0	n/a	n/a	n/a	n/a	1998	Portugal	Europe
B230	Clinical Waste Incineration	324	61.6	n/a	n/a	n/a	n/a	Oct-98	UK	Europe
B240	Clinical Waste Degrader	324	61.6	6650	220	0.030	n/a	1999	Poland	Europe
B260	Radioactive Waste Incineration	256	48.6	n/a	n/a	n/a	n/a	n/a	France	Europe
B270	Clinical Waste Incineration	216	41.0	4432	250	0.030	n/a	1997	France	Europe
B275	Mobile waste incineration	210	39.9	4176	400	0.030	n/a	2002	Germany	Europe
B280	Clinical Waste Degrader	144	27.4	2955	220	0.030	n/a	1998	Poland	Europe
B300	Waste Incineration	90	17.1	1847	400	0.030	n/a	1997	Germany	Europe
B310	Industrial Waste Incineration	63	12.0	n/a	200	n/a	n/a	Jul-95	Hungary	Europe
B320	Clinical Waste Incineration	63	12.0	n/a	200	n/a	n/a	Jun-95	Poland	Europe
B330	Clinical Waste Incineration	50	9.5	n/a	200	n/a	n/a	Feb-95	Poland	Europe
B340	L/L Radioactive Waste Incineration	42	8.0	n/a	450	n/a	n/a	Oct-94	France	Europe
B360	Clinical Waste Incineration	30	5.7	n/a	200	n/a	n/a	Feb-94	Hungary	Europe
B400	Radioactive Waste Incineration	7	1.3	n/a	n/a	n/a	n/a	n/a	France	Europe
C	**Non Ferrous Industry**									
C10	Platinum Recovery	10368	2384.6	n/a	n/a	n/a	n/a	Oct-98	South Africa	Africa
C60	Secondary Aluminium Recovery	1296	246.2	30000	225	0.032	200	Feb-92	UK	UK
C70	Aluminium Melting	1248	237.1	27316	225	0.032	200	Jul-94	UK	UK
C90	Titanium degreasing	576	132.5	9600	350	n/a	n/a	Jan-98	UK	UK
C100	Secondary Aluminium -Reverb	576	109.4	18240	140	0.046	260	Apr-94	UK	UK
C140	Metal Recovery from Circuit Boards	364	69.2	n/a	n/a	n/a	n/a	1999	UK	UK
C150	Metal Processing	324	61.6	5540	350	0.025	n/a	1997	Germany	Europe
C170	Secondary Aluminium Smelting	256	48.6	5100	100	0.029	330	Jun-04	UK	UK

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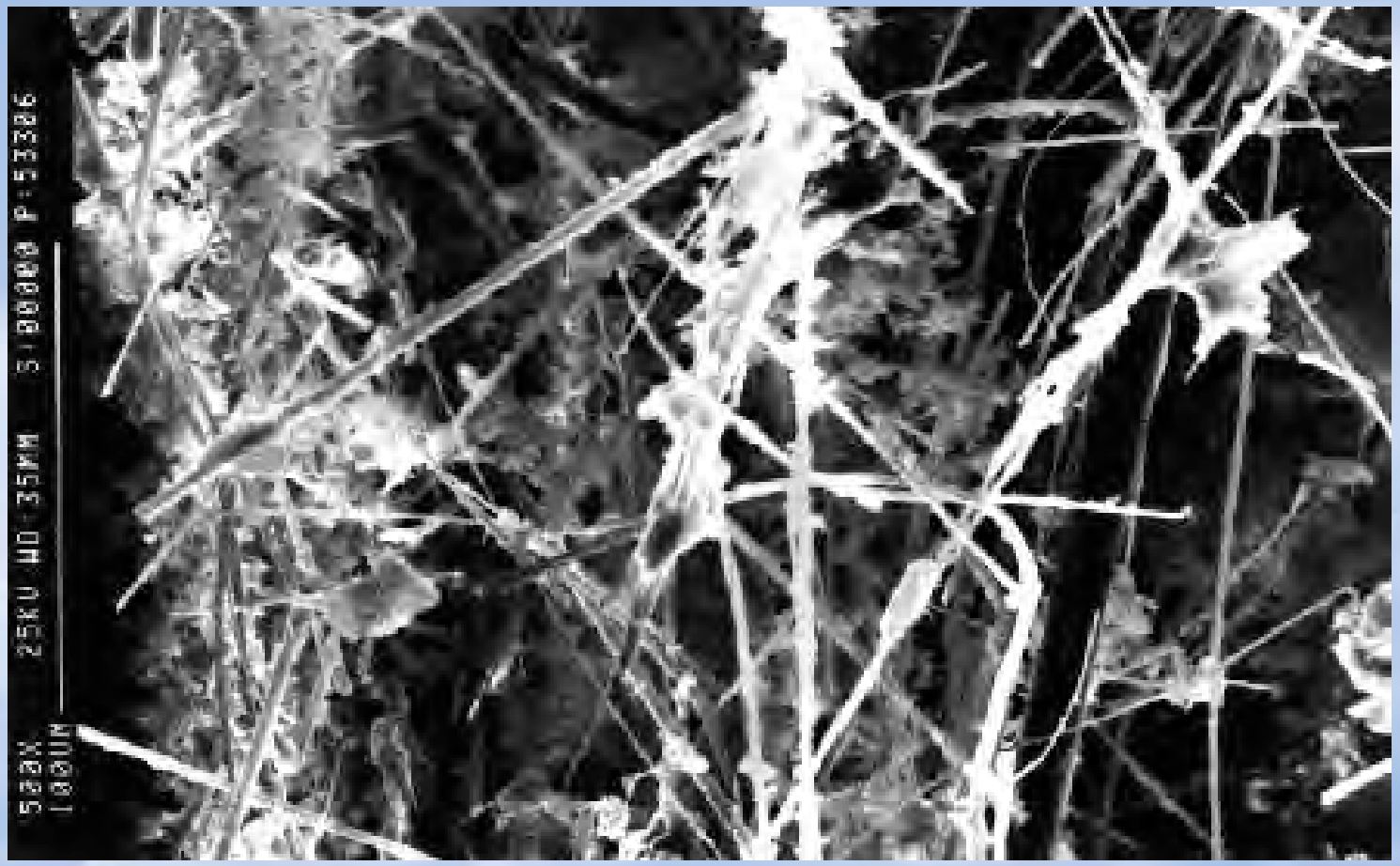
Micrograph of low-density ceramic fiber



Available and utilized in Europe since 1989.

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Types of ceramic filter technology

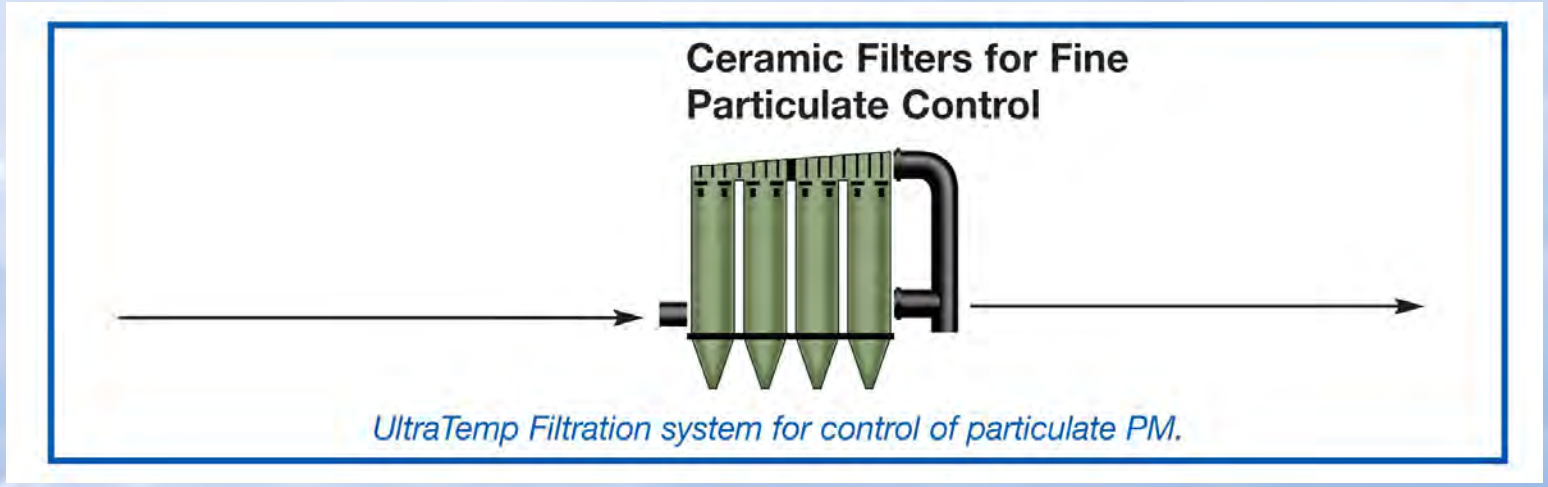
The new generation of ceramic filter is not the old style “candle” filter

CHARACTERISTICS OF HIGH- AND LOW-DENSITY CERAMIC-FILTER ELEMENTS		
	High Density	Low Density
Structure	Granular	Fibrous
Density	High	Low
Filter Drag	High	Low
Porosity, % (Inverse of resistance to flow)	0.3 - 0.4	0.8 - 0.9
Tensile strength	High	Low
Fracture mechanism	Brittle	Ductile
Thermal shock resistance	Low	High
Cost	High	Low

Source: Reported in Chemical Engineering magazine Jan 2009

UltraTemp filter for particulate control

- Operating temperature to 1650 F (900 C)
- Typical removal to below 2 mg/Nm^3 (0.001 grains/dscf)
- State-of-the-art for fine particulate control in industry
- High inlet loading capacity up to 10,000+ mg/Nm3 (5 grains/dscf)



UltraTemp Filtration system for control of particulate PM.

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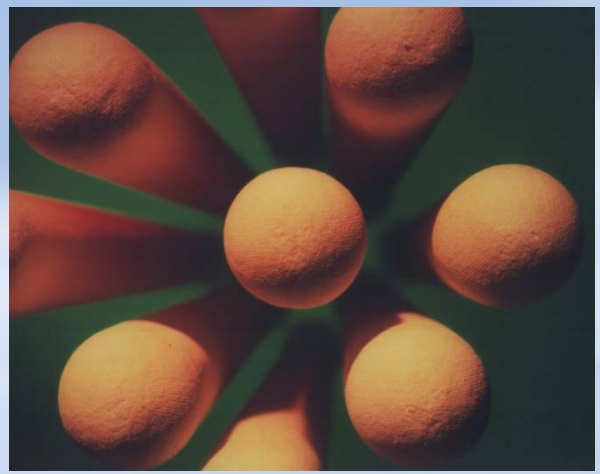
UltraTemp Filter system module, ceramic tube filters



Tubes are 3 meters (10 ft) long, 150 mm (6 in) in diameter. This length utilized since 1997.

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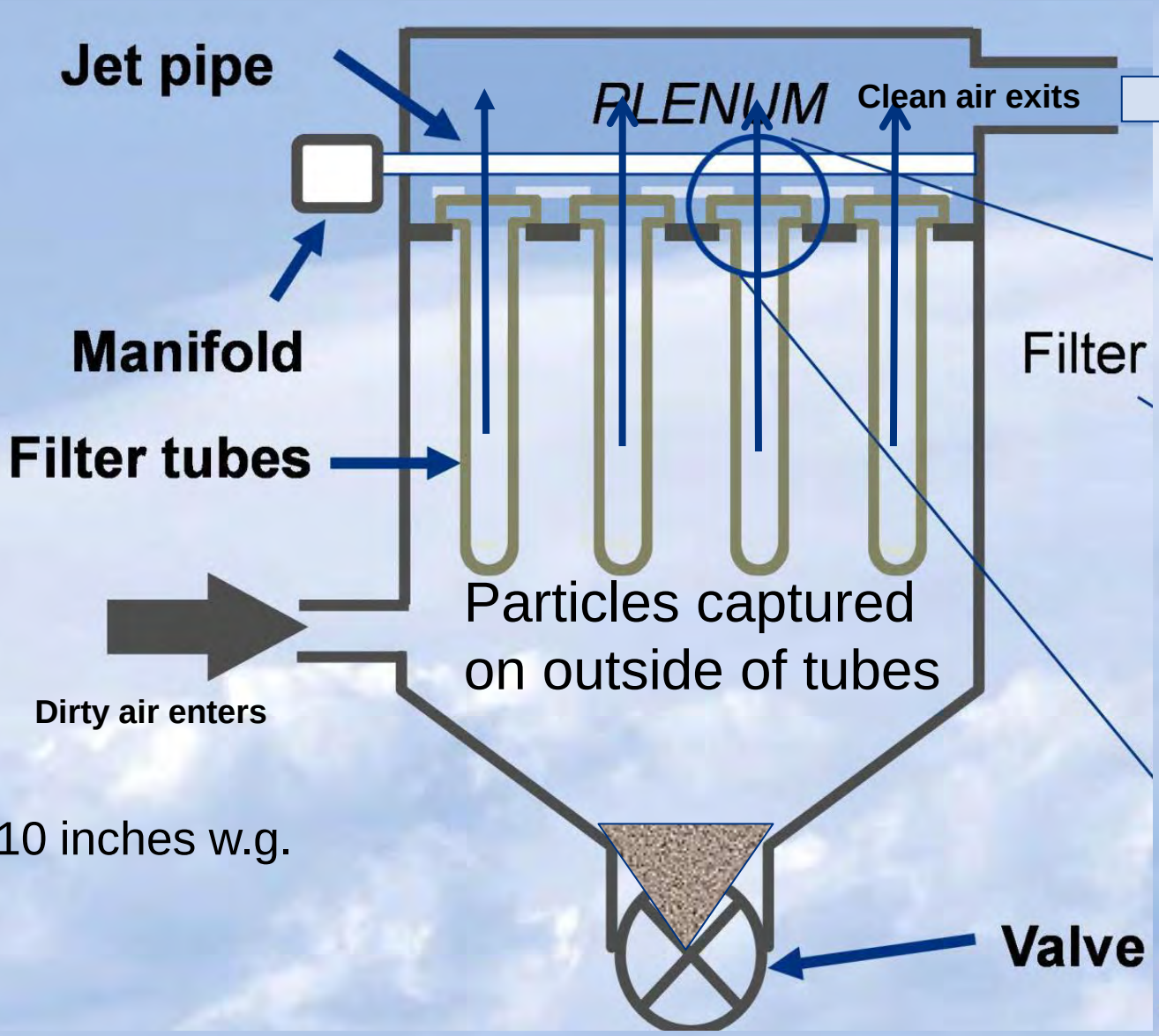
Operation of filters in housing



Pressure drop: 6-10 inches w.g.

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Examples of ceramic filter tube longevity

- Aluminium powder: 5 years
- Waste pyrolysis: 5 years
- Wood waste incineration: 6 years+
- Meat waste incineration: 4 years+
- Lab waste incineration: 15 years
- Asphalt reclamation: 4 years+
- Fluid bed metal cleaning: 5 years+
- Catalyst elements on waste application: 5 years+
- Zirconia production: 6 years+
- Munitions incineration by U.S. Army: 10 years
- Bauxite liquor burner: 10 years

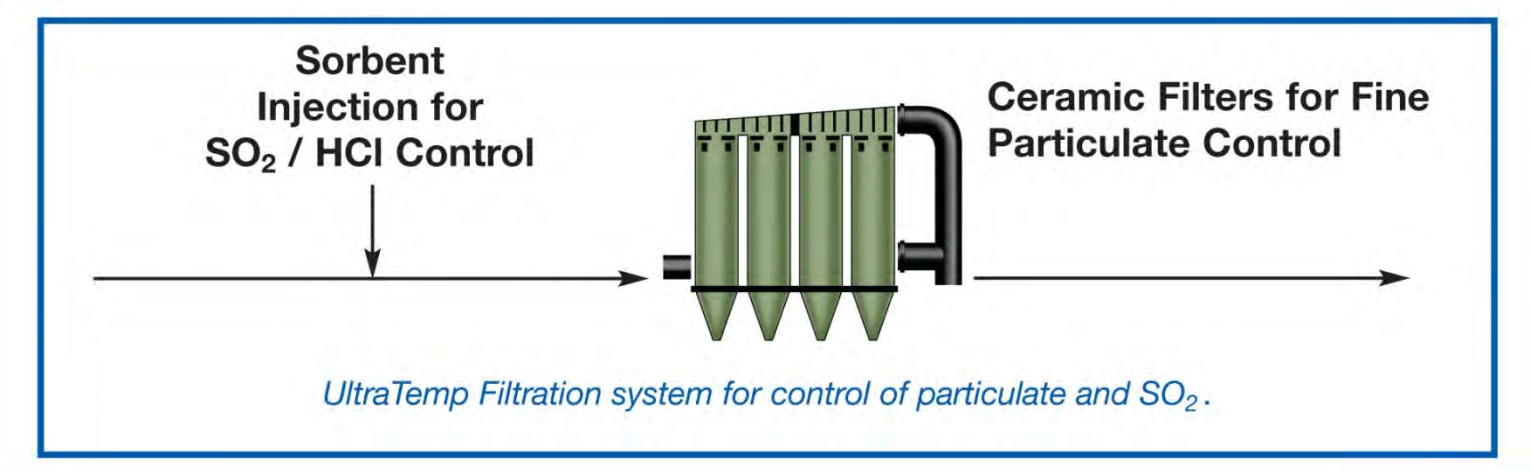
Typical filter results for particulate

EFFICIENCY OF FIBROUS CERAMIC FILTER ELEMENTS IN VARIOUS APPLICATIONS						
PROCESS	PARTICLE SIZE	INLET PM LOADING		OUTLET PM LOADING		INFERRED EFFICIENCY
	d_{50}[1], µm	mg/Nm^3	gr/dscf	mg/Nm^3	gr/dscf	%
Aluminum powder production	<50	550	0.24	<1	<0.0004	99.99
Nickel refining	<10	11,800	5.16	<1	<0.0004	>99.8
Smokeless fuel production	4.8	1000	0.44	1.5	0.0007	99.9
Zirconia production	1.2	8000	3.5	0.8	0.0003	99.85
Secondary aluminum	<1.0	870	0.38	0.5	0.0002	>99.99

Source: Reported in Chemical Engineering magazine Jan 2009

SO_2, HCl, acid gases – dry powdered sorbent injection

- Operating temperatures 350 F – 1200 F
- Typically 90% or better. Some applications reach 97%
- Both calcium (lime) and sodium-based sorbents used
- Sodium based is preferred due to advantageous chemistry
  - Sodium bicarbonate (baking soda powder) to 800F
  - Trona (a naturally occurring soda compound) to 1200F



UltraTemp Filtration system for control of particulate and SO_2.

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What about NOx removal?

Wouldn't it be great to be able to control

NOx in the same system?

First, a quick review of

Selective Catalytic Reduction (SCR)

$2NO_x$ (nitrogen oxides *gas*) + $2NH_3$ (ammonia *liquid*) + $1/2O_2$ (oxygen *gas*)

REACTING on the surface of the proper CATALYST

→ $2N_2$ (nitrogen *gas*)+ $3H_2O$ (water vapor *gas*)

Harmless basic constituents of our atmosphere

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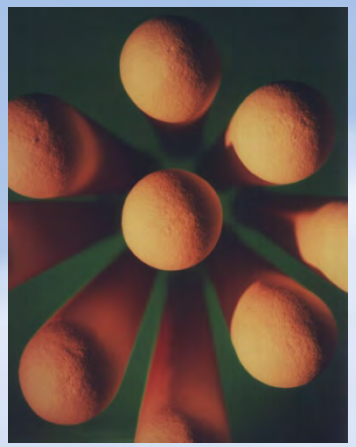
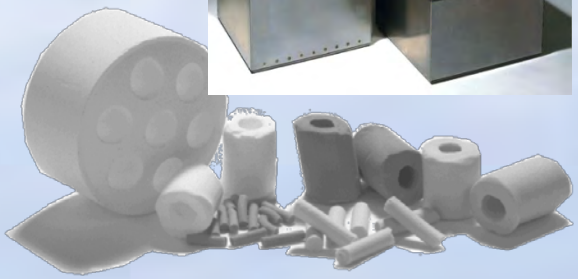
Catalytic filter technology for NO_x

The combination of two well established and effective technologies



Standard filter tube + SCR catalyst



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Award for Innovation

The catalyst-embedded filter received the prestigious ABB Environmental Award 2005 at the annual award ceremony of the Institute of Chemical Engineers in London.

Micrograph of Embedded SCR Nano-catalysts

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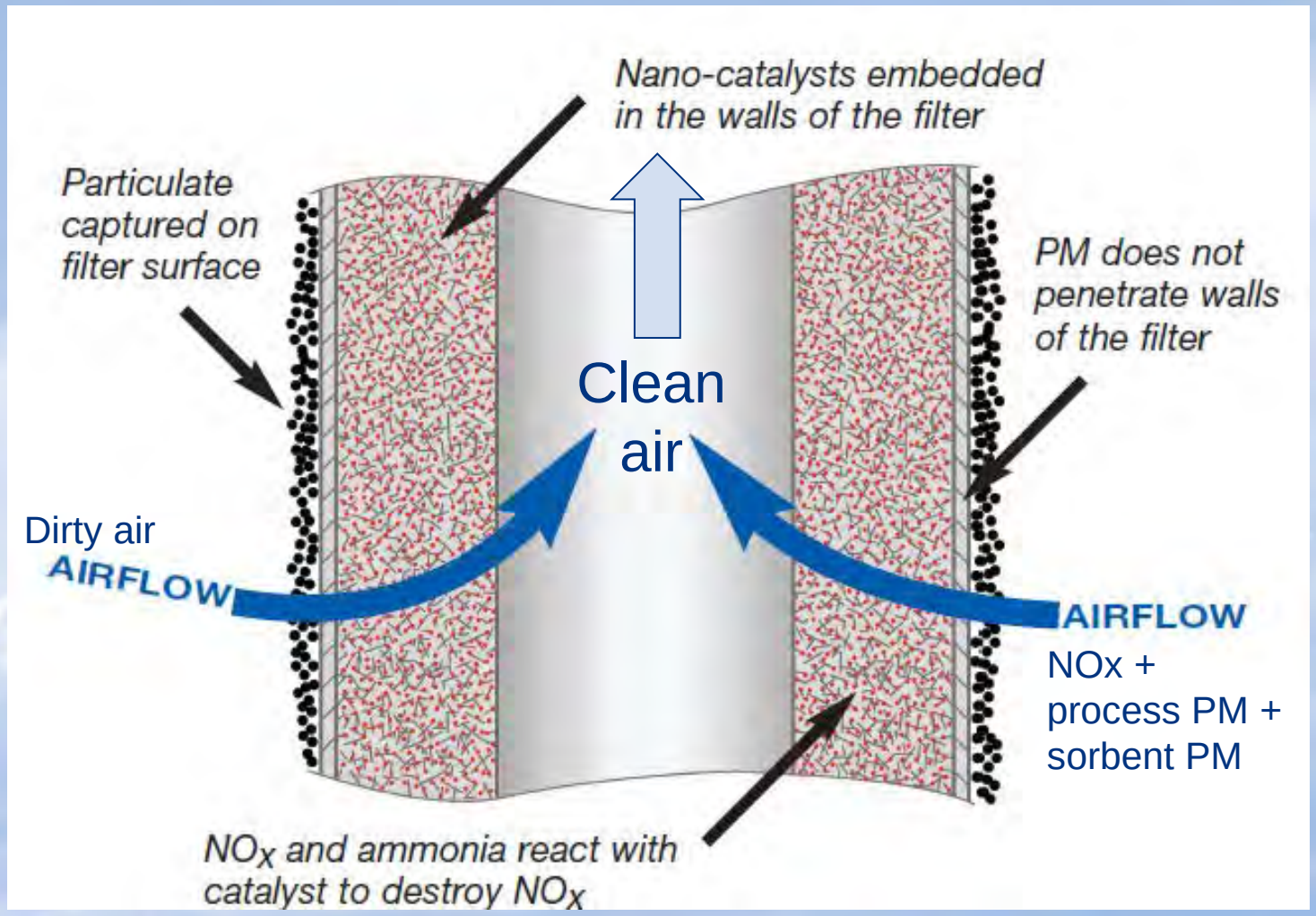
Nano-catalysts embedded in UltraCat filter walls for NOx control



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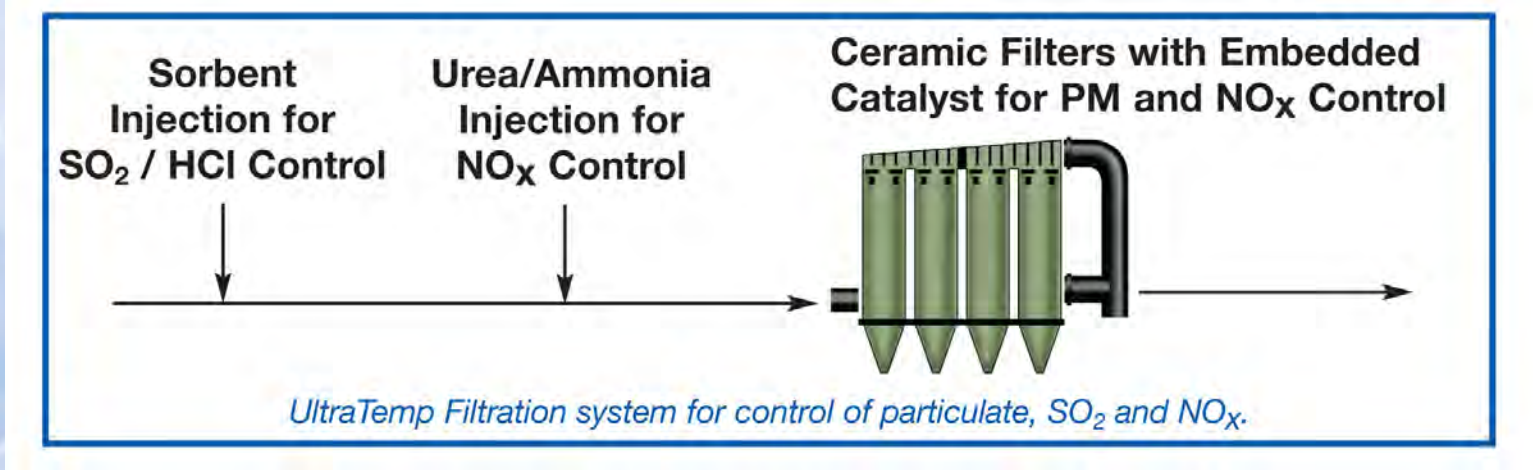
NO_x removal – low temp nanocatalyst & ammonia injection

- UltraCat Catalyst Filters preceded by upstream ammonia injection
  - Selective Catalytic Reduction (SCR) with proprietary catalyst
  - Catalyst formulation much less sensitive to SO2→SO3, HCl

- UltraCat Catalyst Filter performance: up to 95% removal of NO_x
  - Lower operating temperature limit of 350 F
  - Upper operating temperature limit of 700 F



UltraTemp Filtration system for control of particulate, SO_2 and NO_X.

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Additional Key Points for UltraCat Catalyst Filters

- Surface filtration of ceramic filter prevents poisoning of catalyst by PM. Sorbent injection lowers SO2 load.
- Catalyst does not affect filtration performance.
- Increase in pressure drop by catalyst is negligible.
- No reaction between ceramic and catalyst.
- Catalyst does not require regeneration and lifetime is expected to be 5+ years.
- Catalyst-embedded filters available since 2005.
- Recent scientific evaluation by European catalyst manufacturer on glass applications (PM+SO2+NOx removal) concluded there was no sign of catalyst deterioration after five years of service.

Results for PM, SO_2, NO_x reported at GPC Oct. 2009

Two large glass plants operating for approx. 3 years, both companies have ordered another system, two additional systems being installed, many under review.

TYPICAL GLASS FURNACE RESULTS FOR PM, SO_2 , NO_x CONTROL				
POLLUTANTS	UNITS	FILTER INLET	FILTER OUTLET	EFFICIENCY %
PM	mg/Nm^3	1500	0.5	99.97
NOx	mg/Nm^3	1000	150	85.00
SO2	mg/Nm^3	850	25	97.10
HCl	mg/Nm^3	600	5	99.20

Source: Glass Problems Conference, Columbus OH, October 2009

Pilot test results on flat glass that incorporates SO_2 and NO_x control. NOx removal could have been increased with more ammonia injection. Note that particulate loading includes the dry sorbent to control SO_2. Commercial systems initially based on these results.

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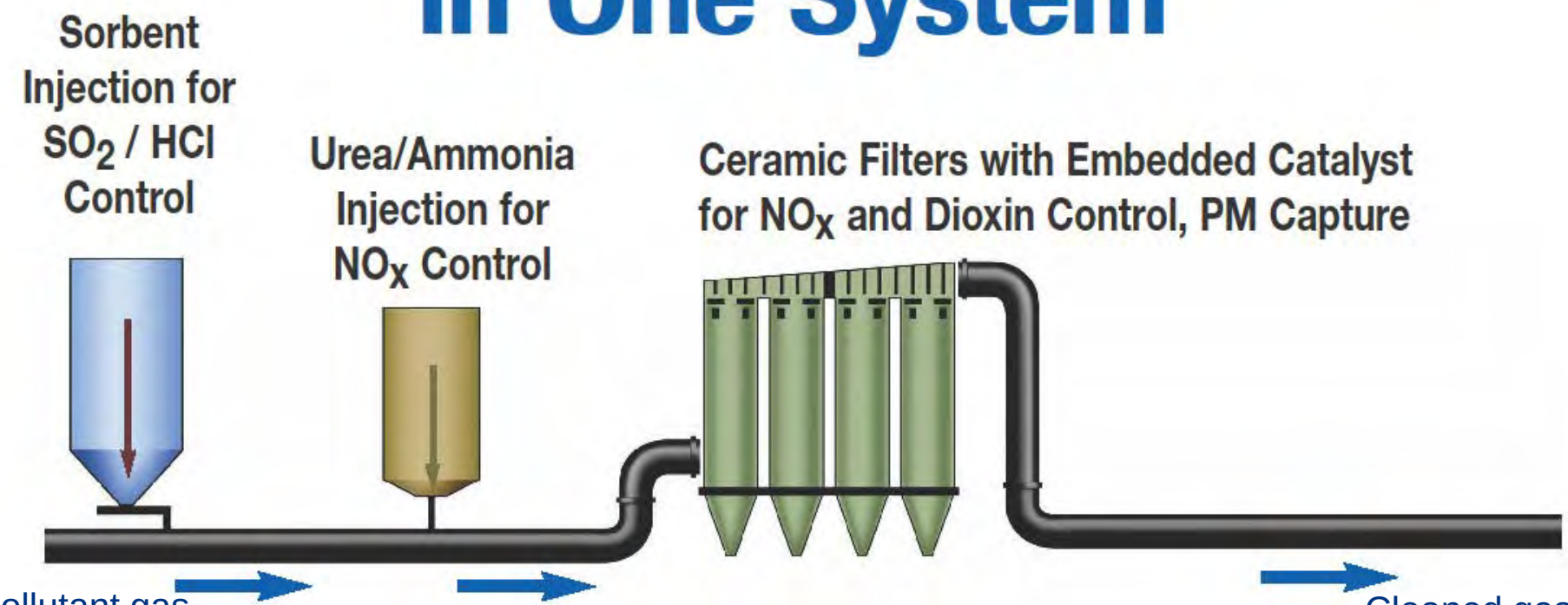
Pilot test results in various industries

TRIAL RESULTS FROM DIFFERENT INDUSTRIAL APPLICATIONS						
POLLUTANT	TEMP	INLET mg/Nm^3	OUTLET 11%O_2 Dry	REAGENT	PERFORMANCE	APPLICATION
Particulate Matter	290°C	130	<1	–	>99%	Glass Industry
	325°C	330	<1	–	>99%	Glass Industry
	185°C	725	<1.5	–	>99%	Waste from Slaughterhouse
SO_2	290°C	630	30	Sodium Bicarbonate	95%	Glass Industry
	300°C	590	18	Lime with Large Specific Area	97%	Glass Industry
	330°C	1165	480	Standard Lime	59%	Glass Industry
	320°C	1070	250	Sodium Carbonate	77%	Glass Industry
	330°C	355	8	Sodium Bicarbonate	98%	Chemical Industry
	180°C	870	<5	Sodium Bicarbonate	>99%	Waste from Slaughterhouse
HCl	330°C	650	40	Sodium Carbonate	94%	Chemical Industry
		30	<1	Sodium Bicarbonate	96%	Waste from Slaughterhouse
NO_X	280°C	1200	250	Ammonia	79%	Glass Industry
	290°C	2570	113	Ammonia	96%	Engine Fumes
	320°C	350	50	Ammonia	86%	Glass Industry
	280°C	800	<9	Ammonia	97%	Engine Fumes
	180°C	450	48	Ammonia	89%	Waste from Slaughterhouse

Source: Reported in Glass International Feb 2008

UltraCat
HOT GAS FILTRATION

Control of PM, SO_2 , NO_x in One System



Tri-Mer offers complete equipment set, engineering, and installation.

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Module, external

Technology transfer of module designs from European collaborator with dozens of installed filter systems over the last decade.

Tri-Mer is expert in steel fabrication, with steel APC equipment in place for over 40 years.

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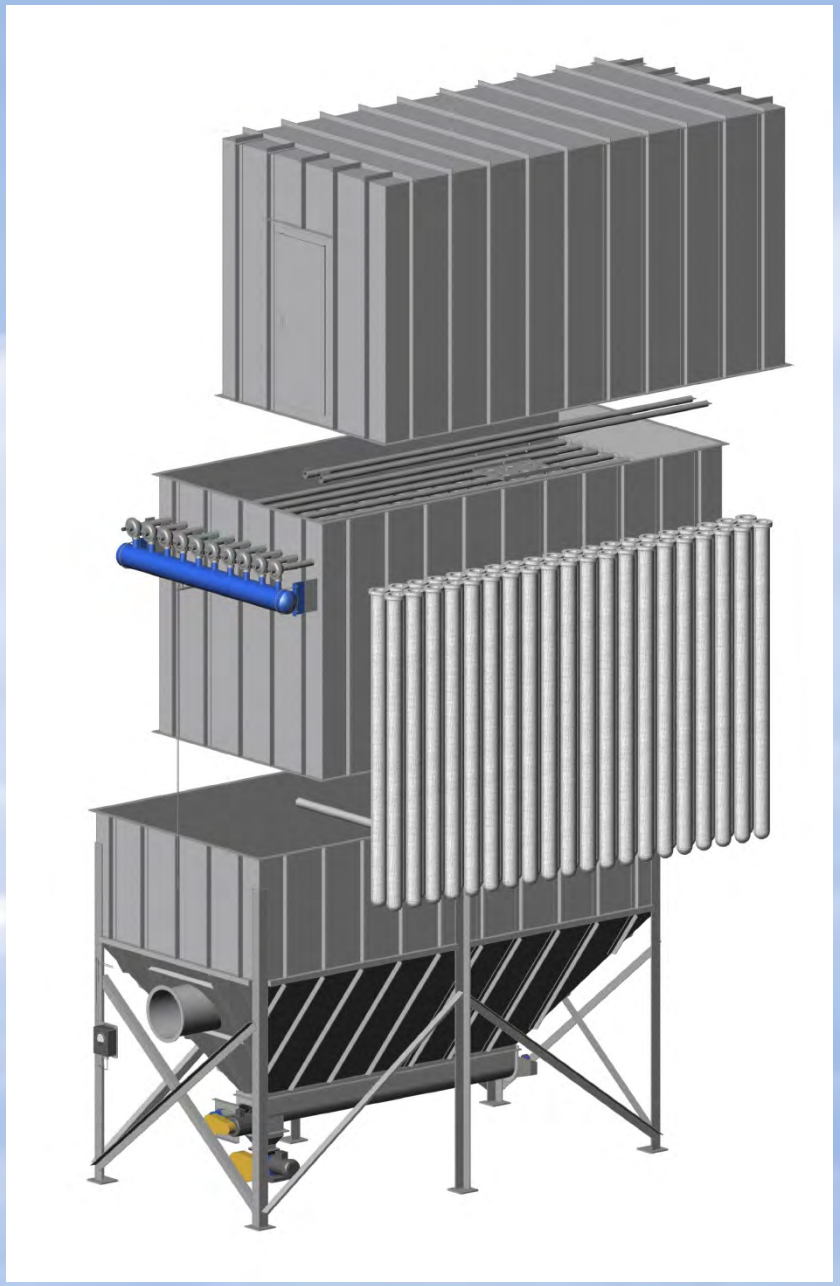
Module, shipping & install

a. Walk-in plenum module shipped in three pieces.

b. Simple installation with a crane.

c. Filter tubes installed in the field by Tri-Mer personnel.



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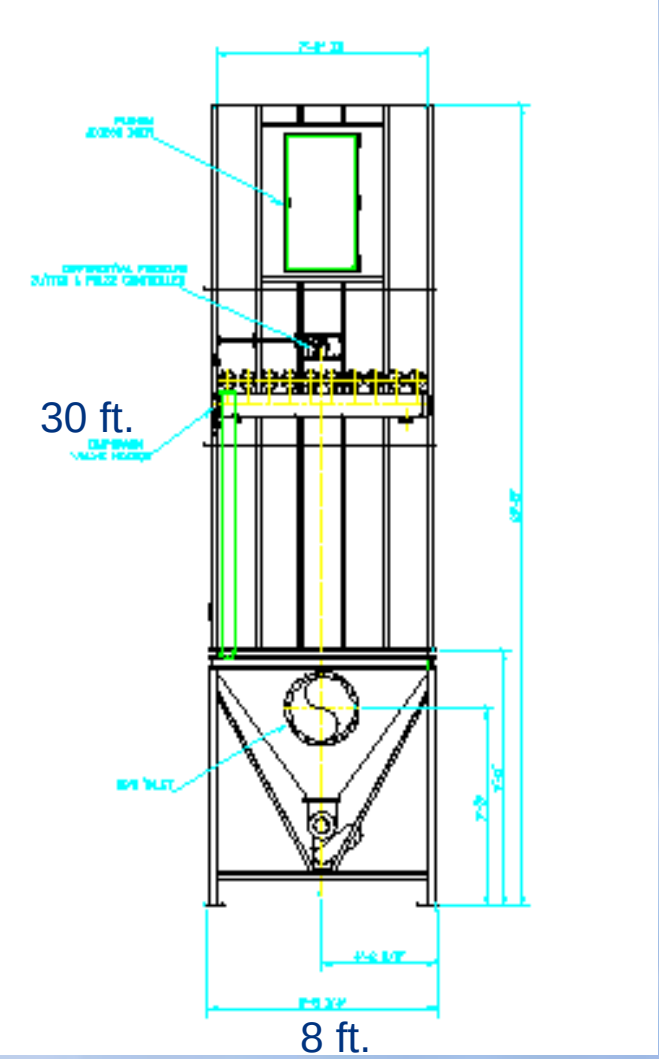
UltraTemp or UltraCat module with walk-in plenum

a) 30 ft. Walk-in Plenum provides easy filter placement, more weather-friendly enclosure.

b) All plenums insulated.

c) Outdoor/indoor placement.



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Multiple modules in parallel to match the project flow volume

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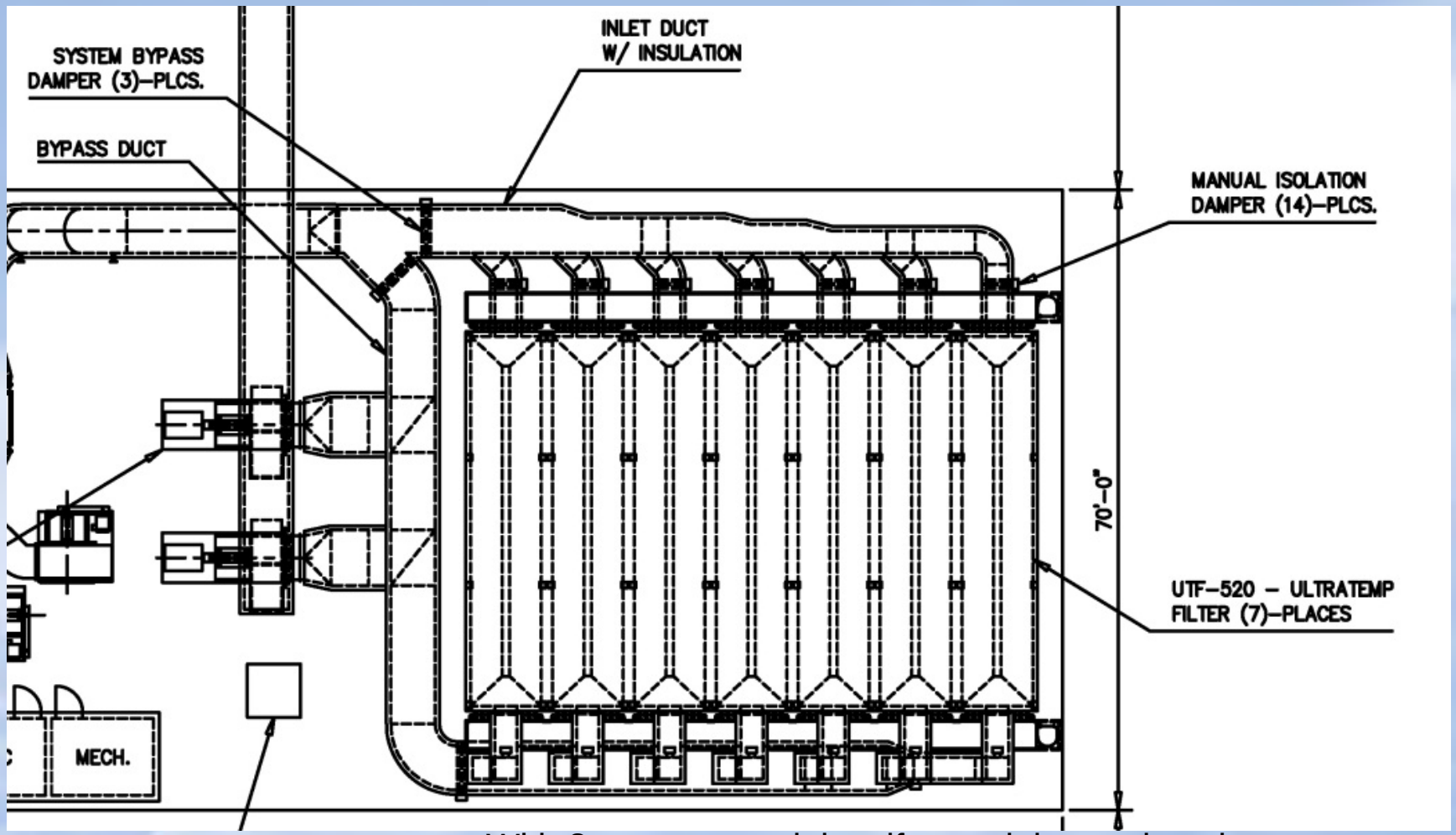
Modules in array, taking a module off-line for service



With 3 or more modules, if a module needs to be serviced, the other modules are designed to temporarily operate at higher pressure with minimal change in performance.

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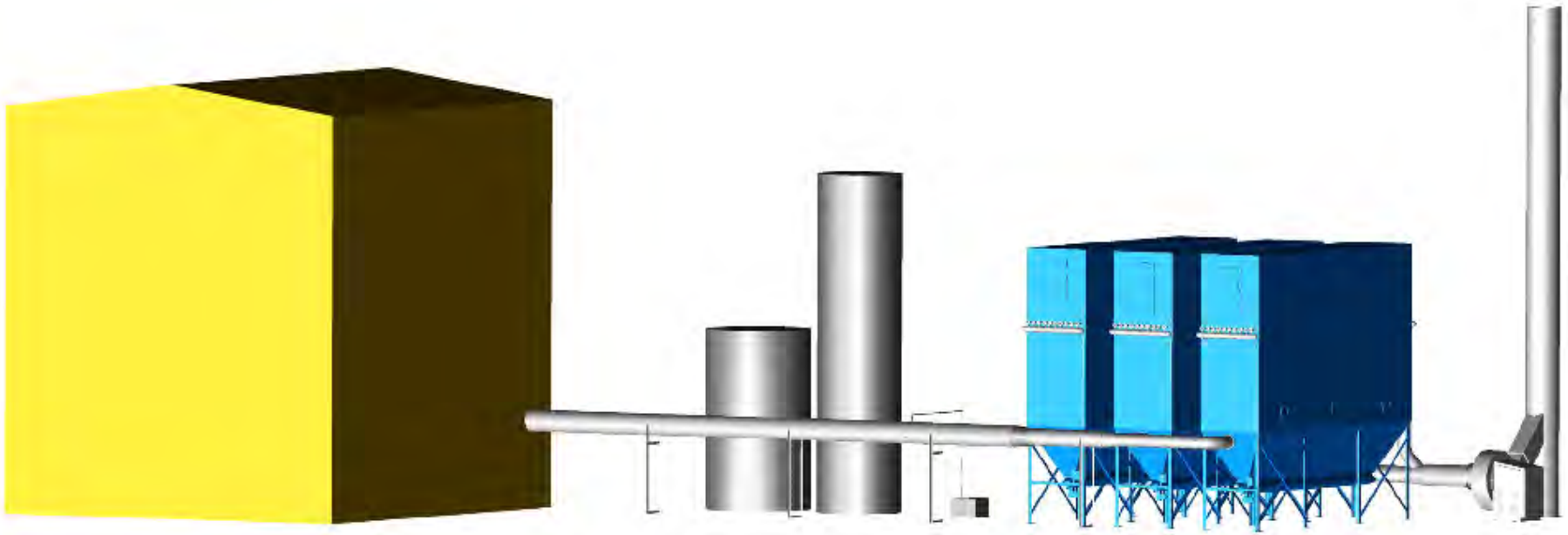
Typical arrangement for large flow volumes

"Super sack" for bicarb and "totes" for ammonia also typical



With 3 or more modules, if a module needs to be serviced, the other modules are designed to temporarily operate at higher pressure with minimal change in performance.

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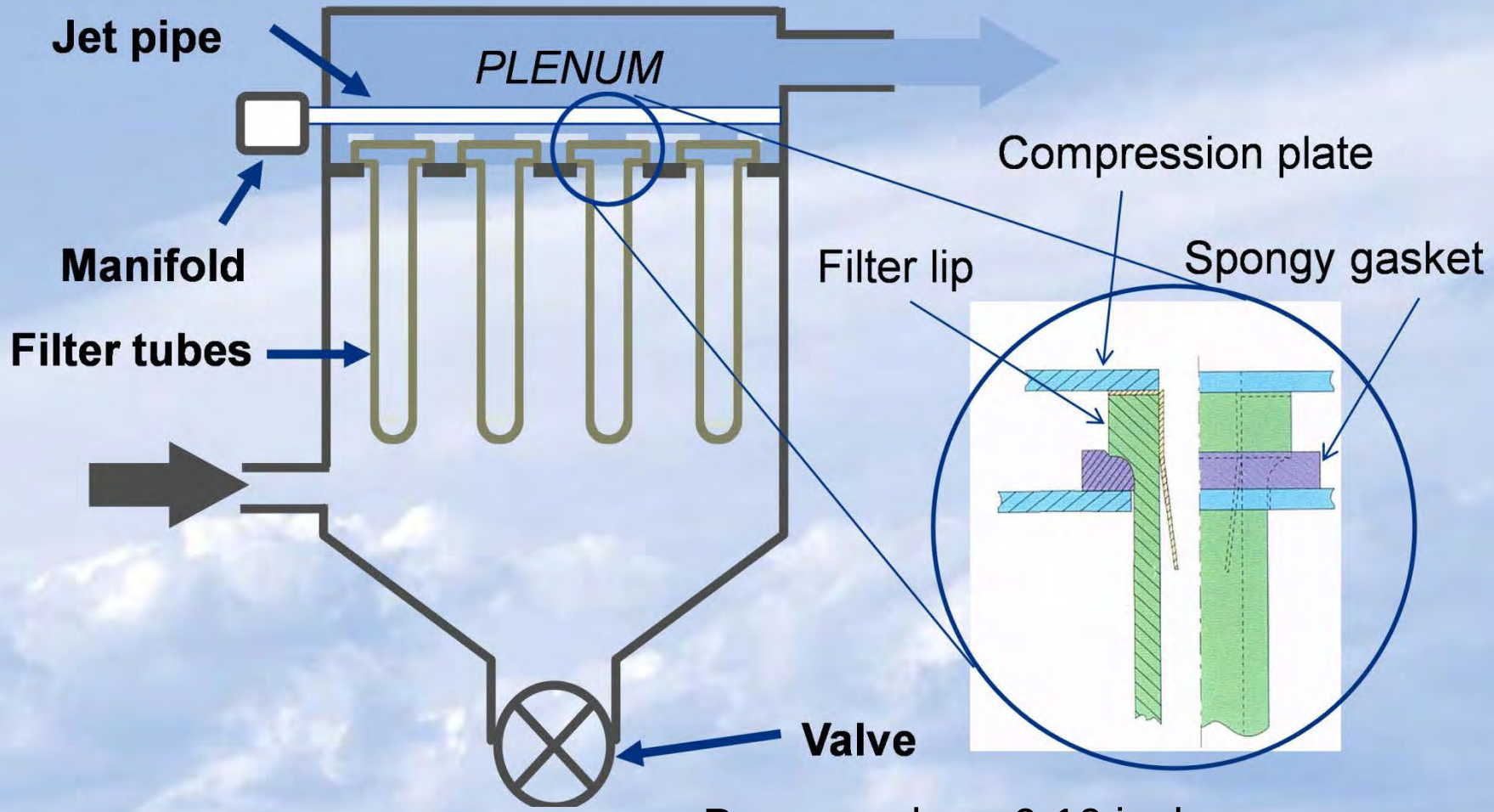
Filter tube sealing mechanism, standard pulse-jet cleaning



Pressure drop: 6-10 inches w.g.
Filters cleaned either on a timer or when dP is 1.0 in w.g.

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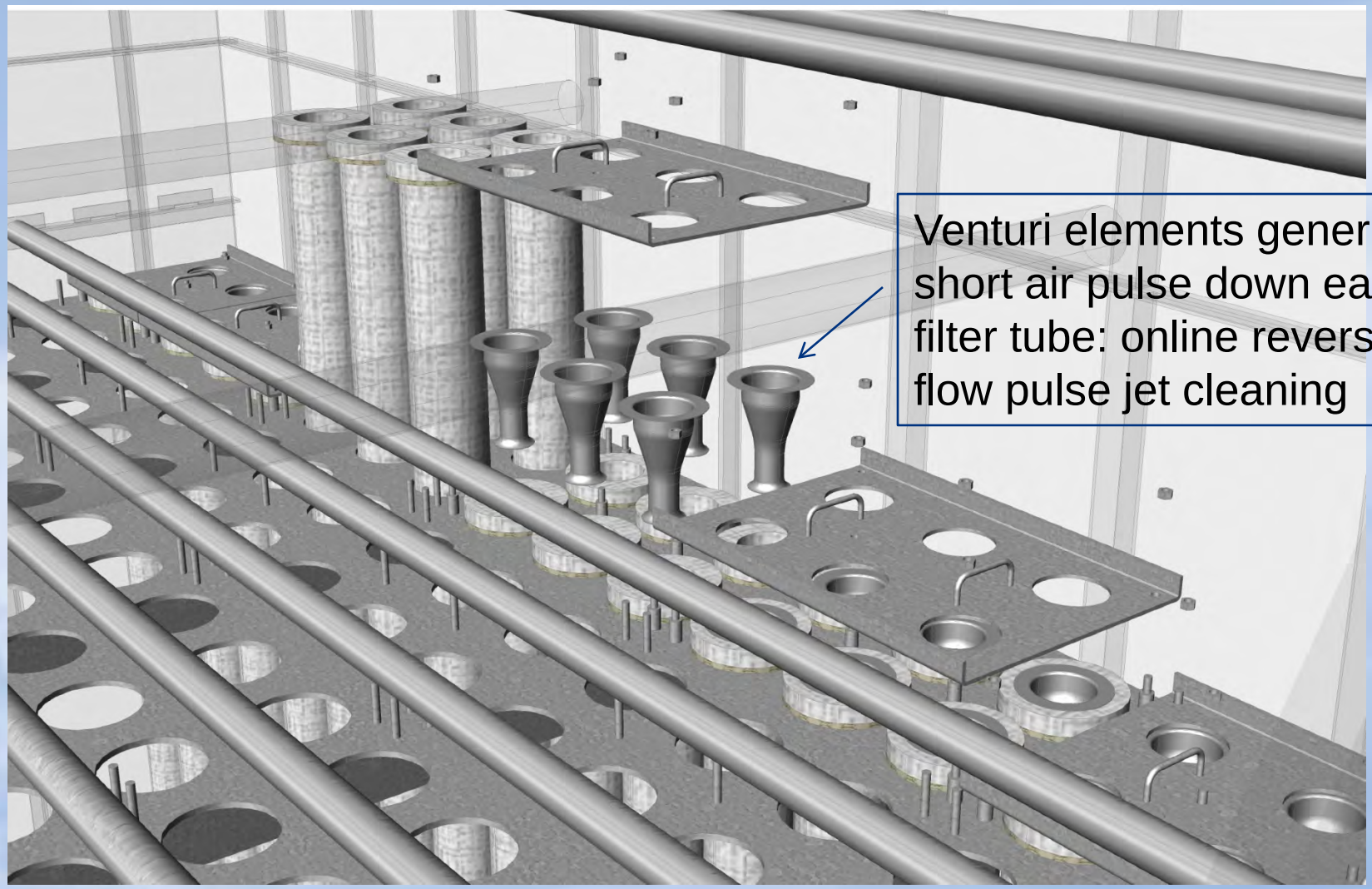
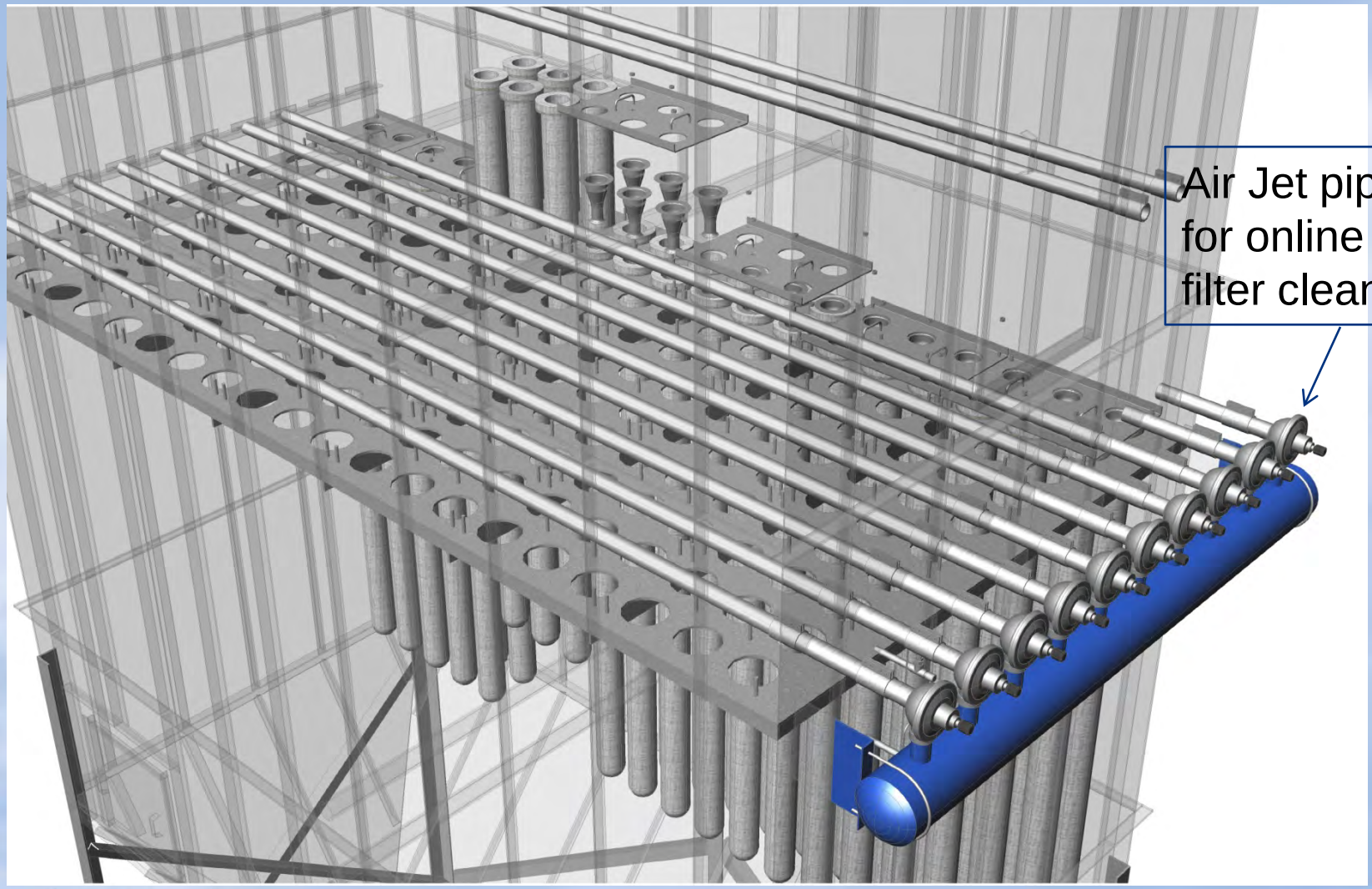
Module, internal detail. Standard pulse-jet baghouse cleaning



Module, internal



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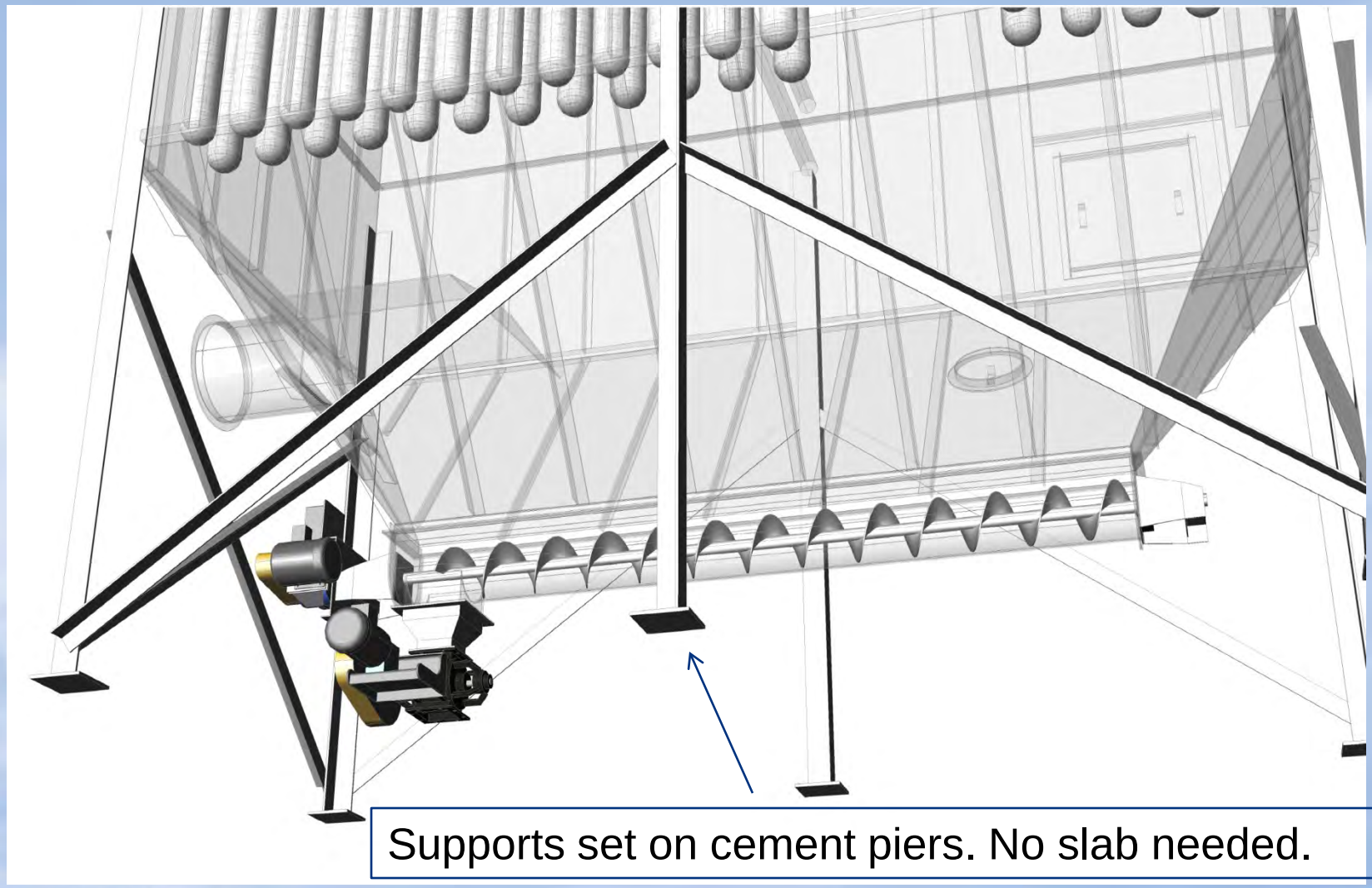
Module, underside



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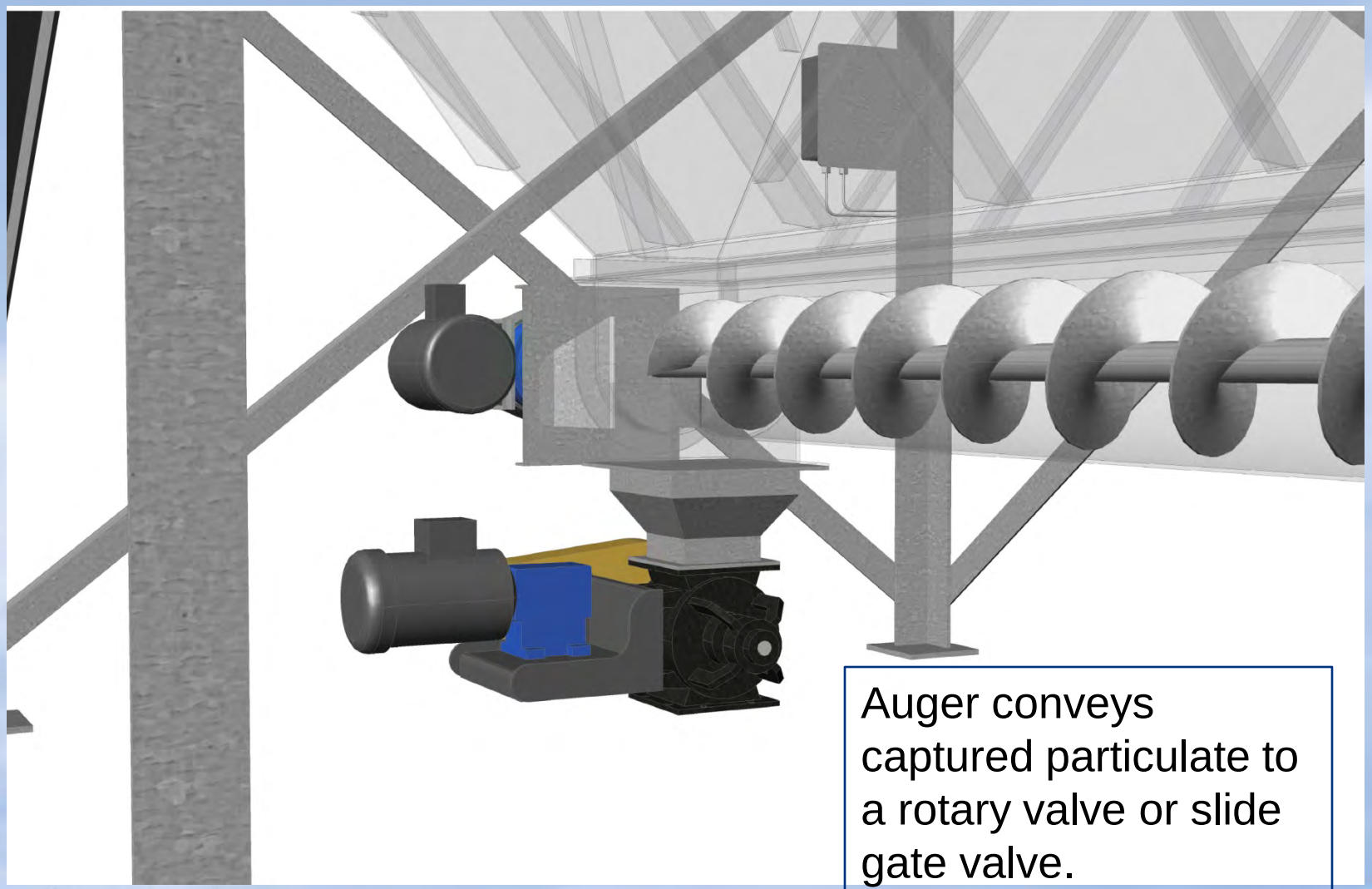
Module, underside detail



Auger conveys captured particulate to a rotary valve or slide gate valve.

Filter housing fabrication in Tri-Mer factory, Michigan

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Modules in fabrication

Module sizes vary according to flow volume required. The width stays the same but length changes.

Number of modules also varies according to application size.

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Summary: UTF, UCF advantages

- Lower initial cost because of all-in-one capability
- Lower total operating cost than a train of equipment
- Lower cost of long-term ownership
- Flexibility, simplicity of design, operation, maintenance
- Unsurpassed PM removal
- Low temp NOx removal, dioxin destruction
- SO2 & HCl removal, mercury options
- Performance guarantees
- Backed by Tri-Mer's 50 years of service and reliability