Achieving lower Particle Matter (PM) emissions and Hazardous Air Pollution (HAP) standards in a one - step Filtration Process

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CLEAR EDGE™ Filtration
A Filtration Group Company

Who is Clear Edge?

A global market & technology leader in industrial process filtration

- Over a 100 years of history as a leading filtration player
- The Company designs, develops and manufactures a broad portfolio of filtration products for a wide variety of industries (e.g. mining and minerals, chemical processing, waste water treatment, food & beverage processing)
- Clear Edge has leading market positions across the globe (#1 in the US, Europe and Australia), particularly for woven filter belt, filter cloth & hot gas filtration products.
- Global footprint with 1000 employees, 11 production sites and 3 R&D/technical centers in 9 countries.
- Technology leader driven by unique R&D capabilities.
- Clear Edge employs many scientists and application engineers, owns 150 patents and spends 3% of sales on R&D/ year
- Part of the Filtration Group, a US private company with over $700MM in turnover

Content

- Benefits of high temp/hot gas filtration
- Cerafil™ – what is it, features, benefits, duty
- Catalytic filtration technology
- Filter plant configuration & lay out
- Application
- Case studies
- Equipment train
- Conclusions

Benefits of high temperature/hot gas filtration

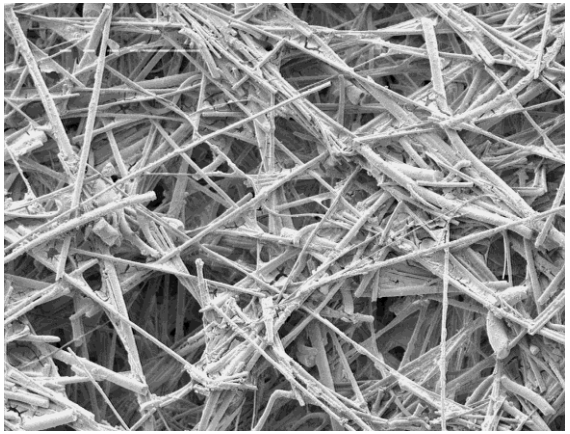
- Move away from temperature limitations of fabric bags
- Reduced requirement for dilution = smaller plant
- Avoid acid and water dew-points = minimise plant corrosion
- Effective acid gas scrubbing
- Maintain gas temperature for optimal DeNOx, SOx, Rox, Dioxin, VOC, (heavy) metals capture, etc.
- Potential for heat recovery from clean gas
- Increased stack buoyancy

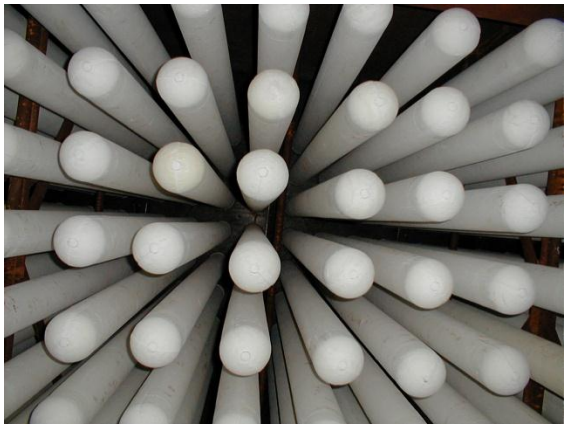
Cerafil™ - filters characteristics

- Rigid candles which are employed like fabric bags in filter plants
- Capable of operating at elevated temperature
- Applied to “hot” processes where clean off gas is required
- On the market since the late 1980’s
- Over 250 references worldwide

Cerafil™ - filter properties

- Ceramic or mineral fibre composition
- Rigid
- Highly porous structure
- One piece construction
- Self supporting





Cerafil™ - filter benefits

- **High efficiency**
  - Less than 2 mg/m^3 emissions (0.001 grains/dscf)
  - Handles sub-micron particles
- **High temperature capability**
  - Temperature resistant up to 900^{o}C (1,650°F)
- **Corrosion resistant**
  - Almost chemically inert
- **Works well in conjunction with a dry scrubbing agent**
- **Range of products and sizes**
  - Alumina-silicate, mineral fibre and catalytic products
  - Up to 3m (10ft) long by 150mm (6”) diameter

Cerafil™ - filter duties

- **Air pollution control (APC)**
- **Product recovery**
- **Product collection**

Driven by:

- Tighten Environmental legislation
  - PM and HAPs

Where can it be used;

- A new filter plant installation
- A bag filter retrofit
- A ElectroStatic Precipitator (ESP) retrofit

Cerafil™ products available

- **Cerafil XS – developed in the 1990s**
  - Market leading ceramic element
  - 200+ successful references spanning 15 years

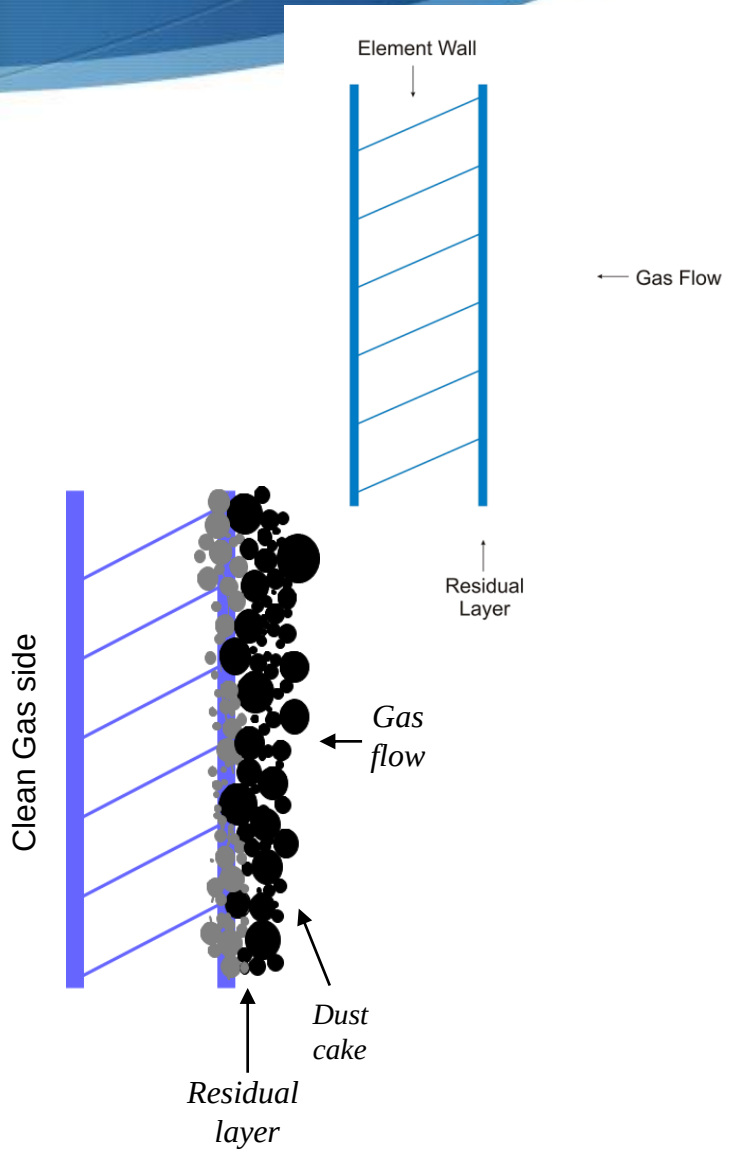
- **Cerafil GR (Green) – developed in early 2000s**
  - Manufactured from bio-soluble fibres
  - Excellent strength + performance

- **Cerafil TopKat (TK) - developed mid 2000s**
  - Combined particulate, dioxin and NOx control
  - The new solution for stringent emissions legislation

Filtration mechanism

- High filtration efficiency
- Negligible depth penetration
- Can handle variable conditions
- Potential for long life

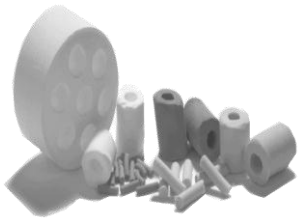
Efficiency testing to VDI 3926			
Cleaning cycles		30	2334
dP trigger	Pa	1000	1000
Residual dP	Pa	570	770
Inlet gas conc.	gm/Nm^3	5	5
Clean gas conc.	mg/Nm^3	0.37	0.26



Catalytic filter technology
Cerafil TopKat™

CERAFIL TopKat

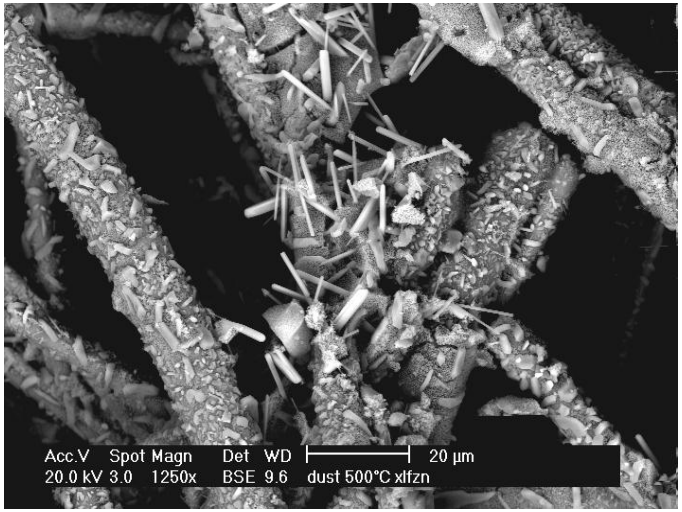
Combination of two well established and effective technologies



Cerafil XS

SCR

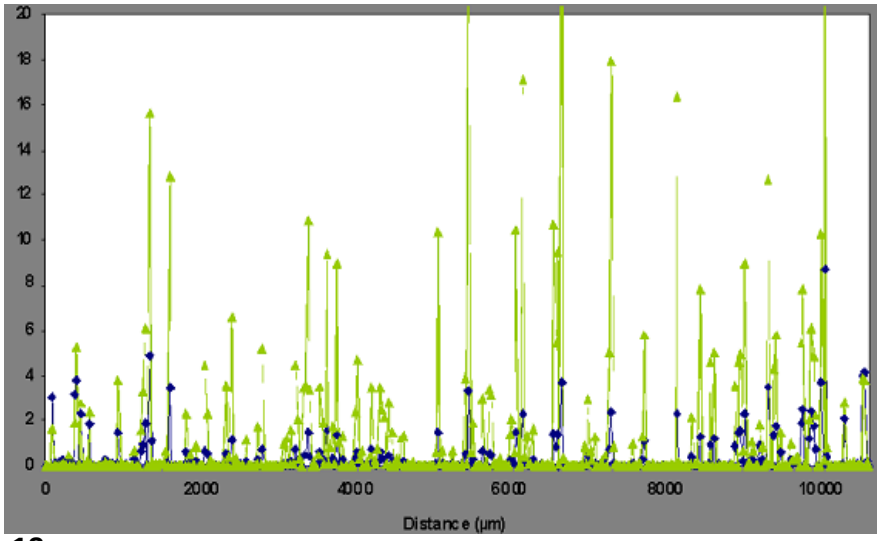
Catalyst distribution



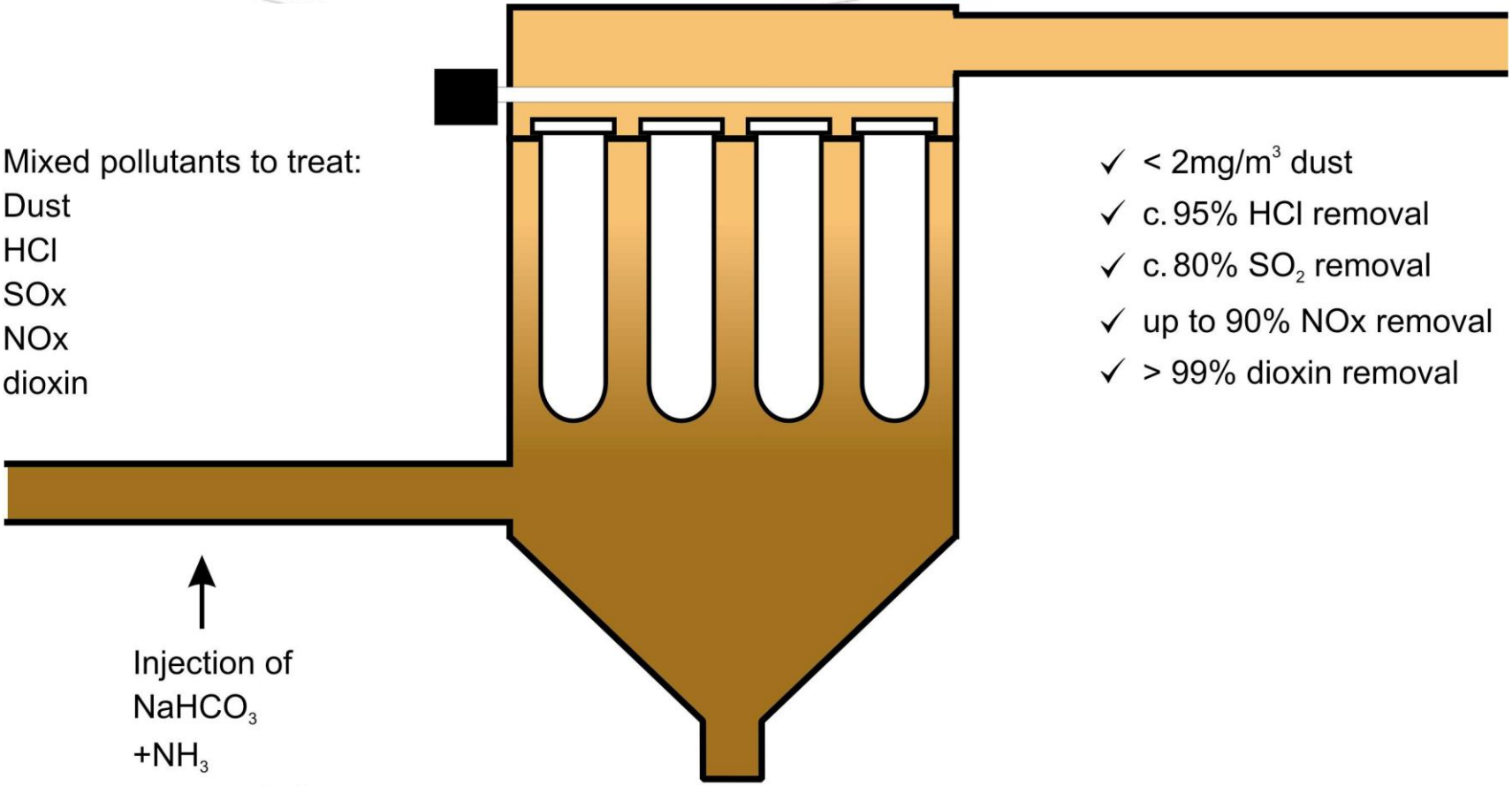
Nano sized catalyst particles promote access to active surfaces

Catalyst distributed throughout element wall

Residence time and efficiency maximised

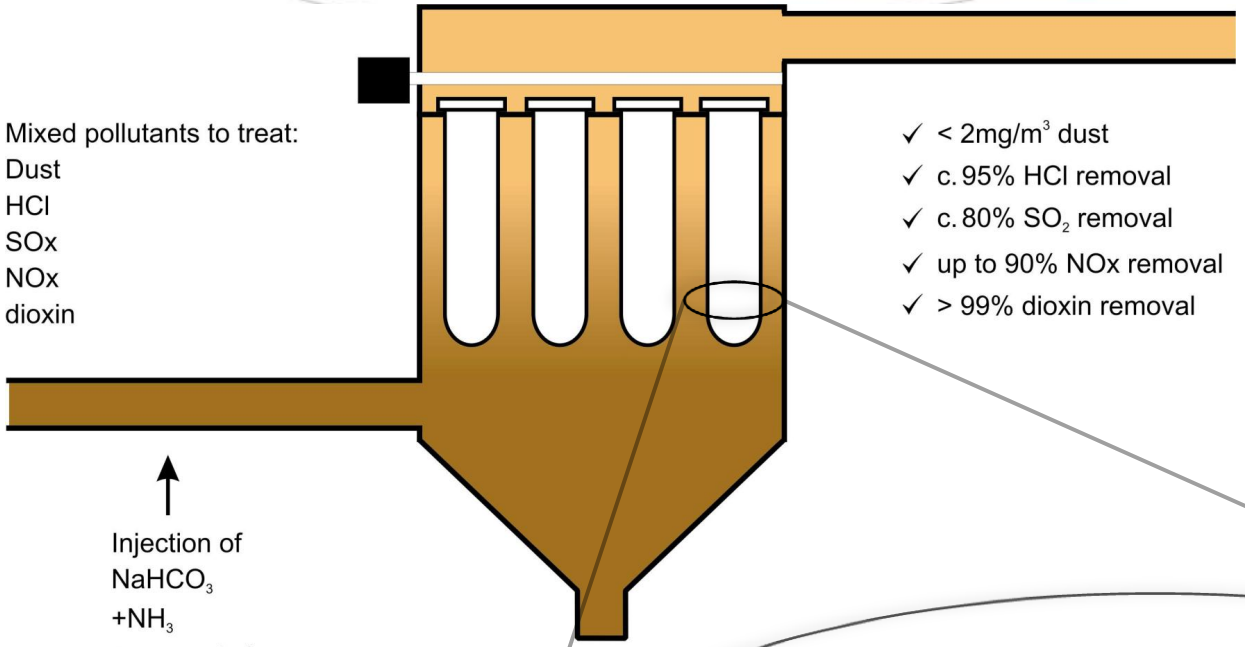


Catalytic element performance



- ✓ < 2mg/m^3 dust
- ✓ c. 95% HCl removal
- ✓ c. 80% SO_2 removal
- ✓ up to 90% NOx removal
- ✓ > 99% dioxin removal

Catalytic element performance



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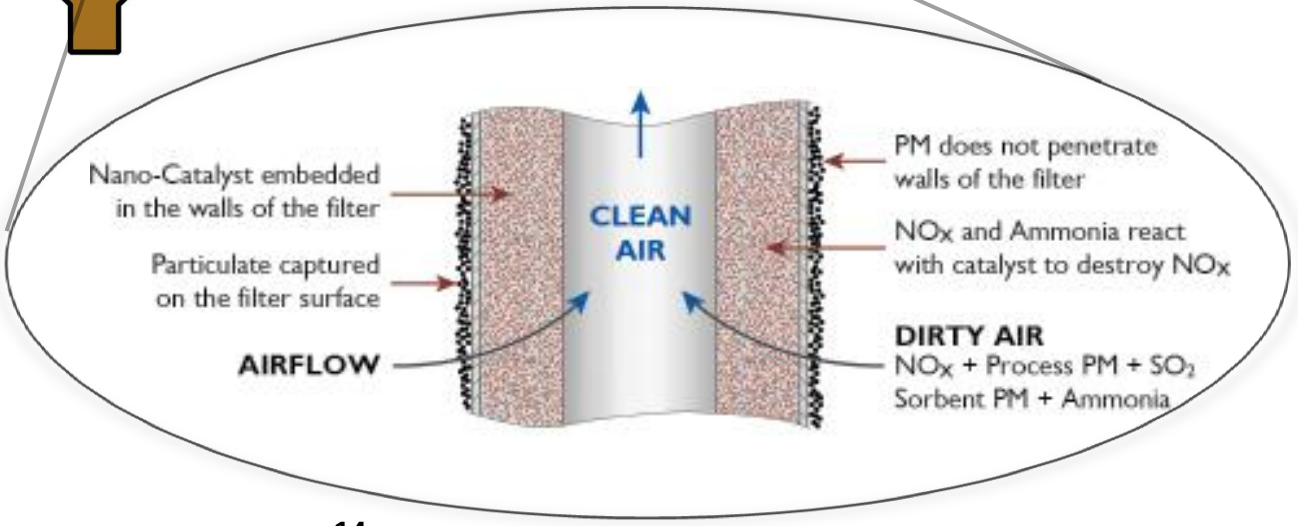
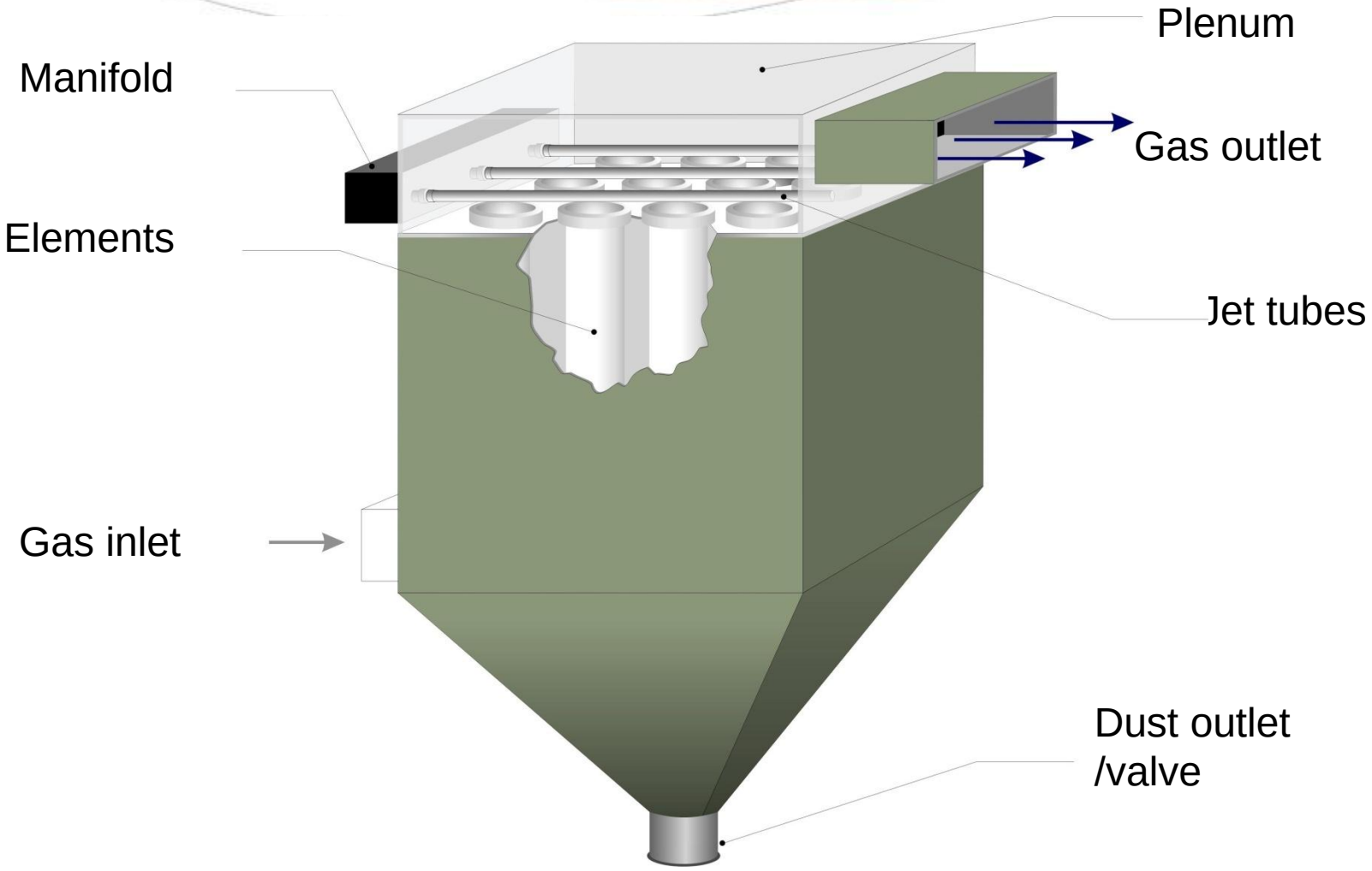
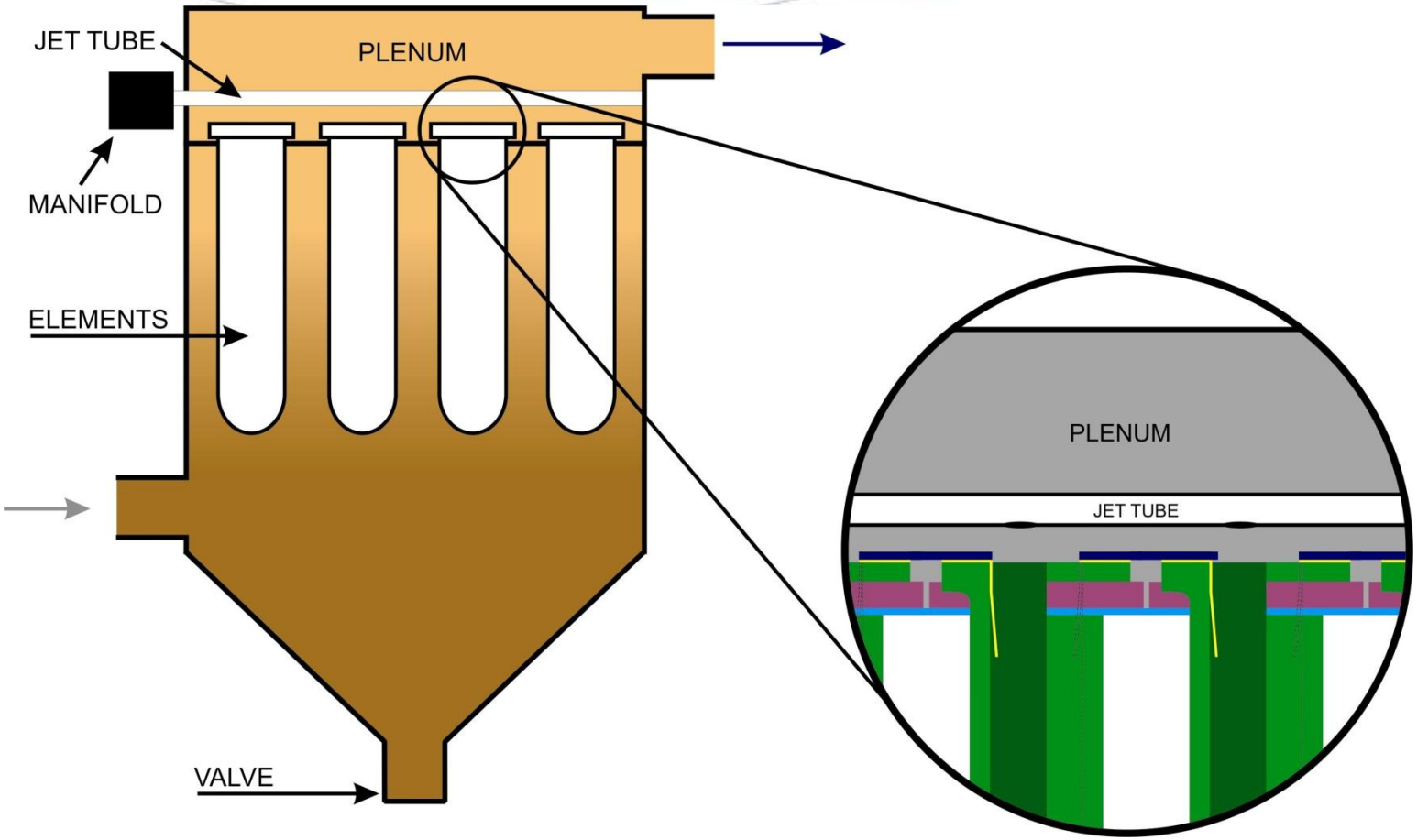


Filter plant configuration



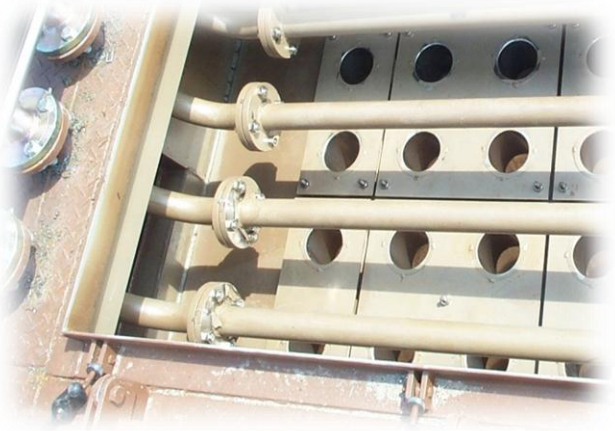
Filter plant - tube sheet layout



Element clamping & cleaning

Tube sheet, seals and filter elements

Top views of reverse pulse system



Applications, such as

- Cement production
- Chemicals manufacture
- Diesel Engines
- Gasification processes
- Glass furnaces
- Metal smelting
- Mineral processing
- Sewage sludge incineration
- Waste incineration
- Power plants & Boilers

Clinical waste incineration, UK

Key facts

- Installed 2006
- 270 TK 1000 filter elements
- Average Temp 340°F (170°C)
- Dioxin removal efficiency 99.2%
- Dust removal efficiency 99.9%

Pilot plant trial and scaled up after one year

Case study - Platinum smelting, South Africa

Key facts

- Installed 1998
- 10,368 GR 1250 filter elements
- Average Temp 482°F (250°C)
- Filter Area 25,683ft² (2,385m²)
- Pressure Drop 8.8” (225mm) WG

Still in operation and working successfully

Case Study – Waste Incinerator - Japan

Key facts

- Installed 2002
- 324 XS 3000 filter elements
- Mixed feed waste - burns plastic, wood, plasterboard, paper
- Average Temp 374°F (190°C)
- Gas Flow 19,122acfm (32,410 Am^3/h)
- Pressure Drop 8.8” (225mm) WG
- PM <2.5mg/Nm^3

Still in operation and working successfully

Case Study – Waste Incinerator - Japan

Key facts

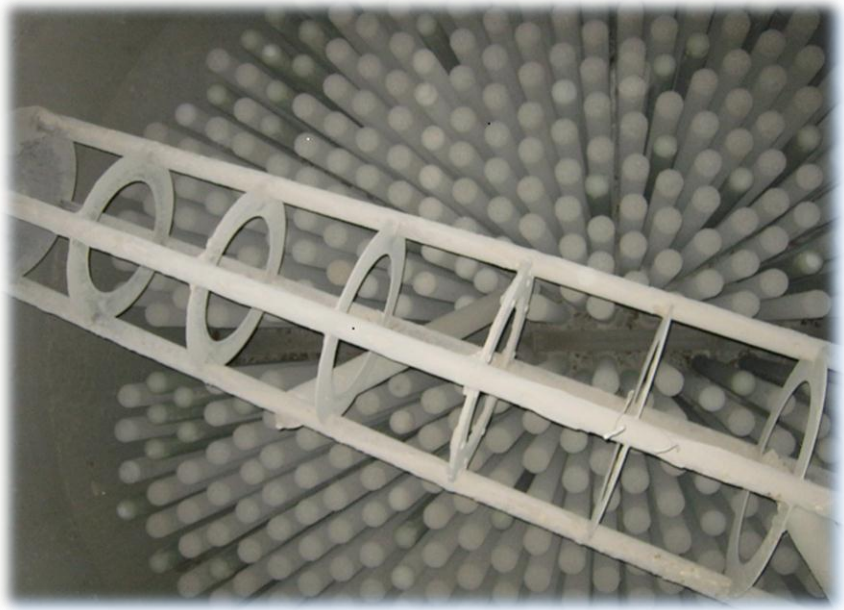
- Installed 2002
- 524 XS 3000 filter elements
- Average Temp 446°F (230°C)
- 2007 started clinical waste incineration
- 2008 – introduced 524 TK -3000
- Dioxin emissions <0.026ng-TEG/g achieved

Replaced elements - during switch over to TopKat in 2008

Case Study – Alumina – Australia

Key facts

- Installed 2005
- 2520 GR 3000 filter elements
- Duty – product & process recovery
- Average Temp 410°F (210°C)
- Filter area 37,975ft² (3,525m²)
- PM < 2 mg/Nm³
- Gas Flow 79,650 acfm (135,000 Am³/h)



Average life of filter elements 5-6 yrs.

Case study - Asphalt reclamation, The Netherlands

Key facts

- Installed 2006
- 2640 XS 3000 filter elements
- Average Temp 572°F (300°C)
- Filter Area 39,784ft² (3696m²)
- Gas Flow 174,640 acfm (296,000 Am3/h)
- Face velocity 0.022m/s

First replacement of filter elements 2013/14

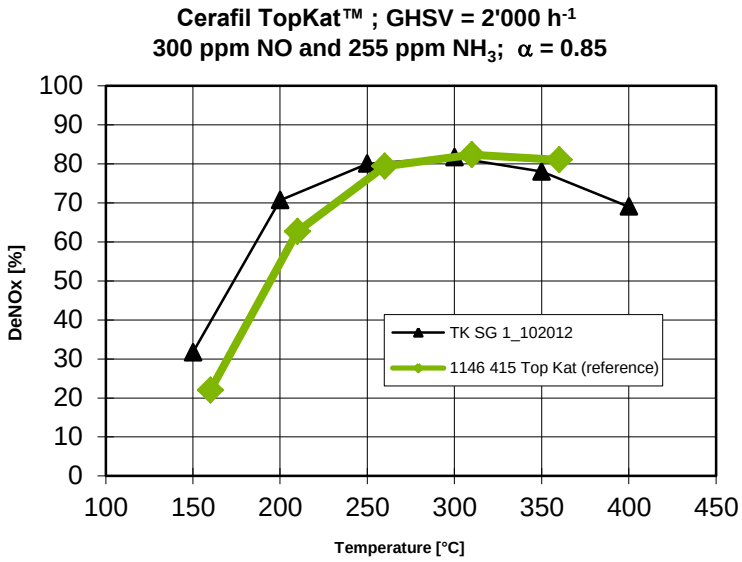
Case study - Glass Furnace, Spain

Key facts

- Installed 2009
- 1900TK 3000 elements
- Average Temp 662°F (350°C)
- Gas Flow 77,290 acfm (131,000 Am3/h)
- Face velocity 0.014m/s

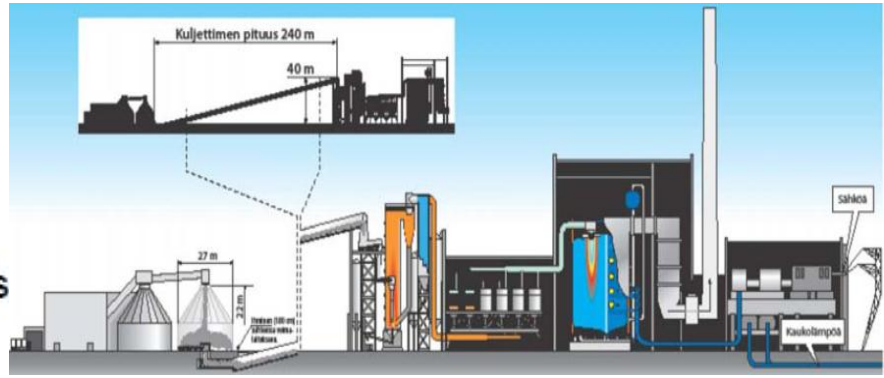
After 3.5 yrs. of operation PM, HAP control still performing at 95% level

No replacement of elements to date



Case Study - Waste to Energy (WtE), Power Plant 2010

- 4.000 XS x 2,250mm long
- Newly developed advanced Waste to Energy (WtE) technology at the Lahti Energia, Kymijärvi II plant in Finland.
- First in the world to be fueled by clean gas produced from Solid Recovered Fuel (SRF).
- SRF fuel is fed into the gasification reactor where it is surrounded by a hot sand fluidised bed at circa 900^{0}C. The bed material and unreacted fuel is recycled back to the gasifier via a recycling cyclone.
- The gas is then cooled to approximately 450^{0}C where the impurities in the fuel turn into solid state ash suspended in the gas stream.
- SRF feed rate - 360 cm^3/h (250,000 t/pa)
- Boiler steam temp - 540^0 C & pressure - 121 bars

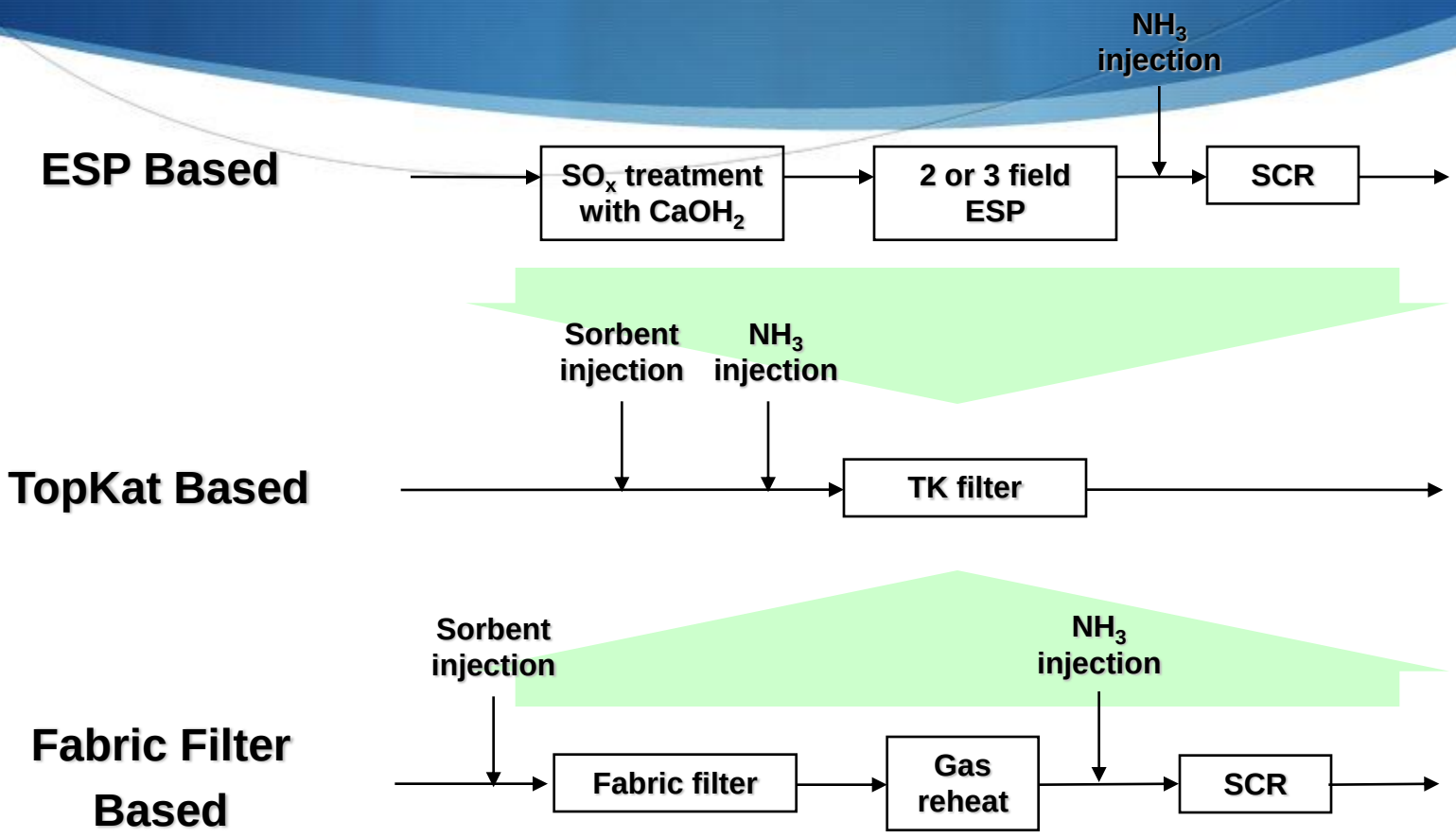


Case study - Ceramics Kilns & Glass Furnaces , USA

Key facts

- Installations 2011 & 2012
- 2500 TK 3000 elements (+/-500 depending on plant size)
- Average Temp 685°F (363°C)
- Gas Flow 150,000 - 200,000 acfm
- PM < 5 mg/Nm3 at outlet
- SO_2, up to 90% removal (if project requires)
- NOx, up to 90% destruction (if project requires)

Equipment train options for particulate, SOx & NOx



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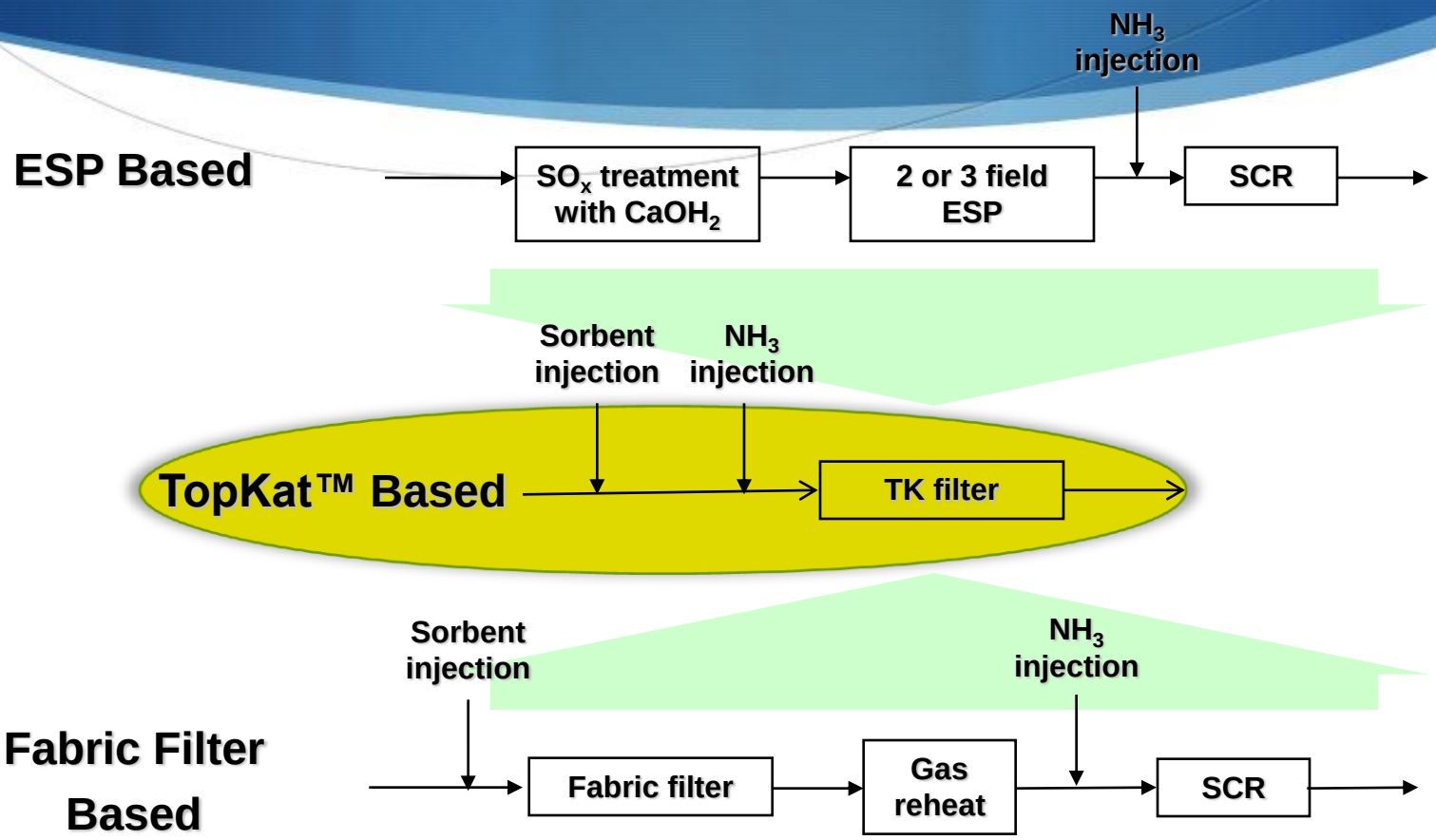
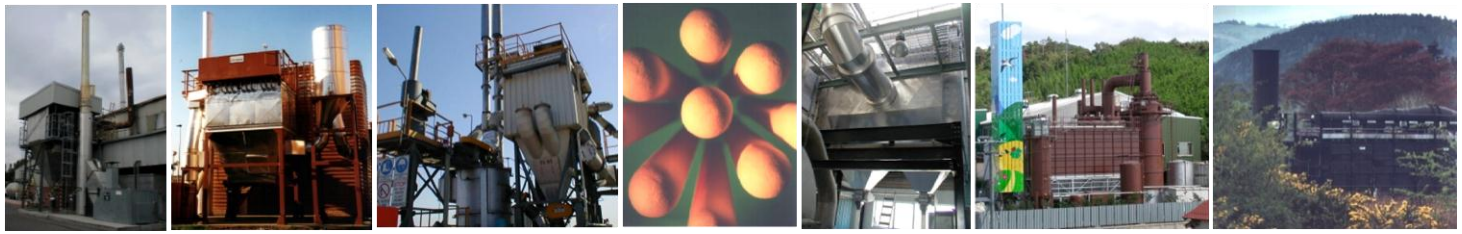


Conclusions

- Lower PM, HAPs control in a one-step process
- Reduced total costs of ownership
- Lower Capex, Opex & Energy cost
- Future proof technology
  - Compliance with legislation limits
- Scalable technology to suit your process needs



Thank you

Further details from

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Further reading – Filtration News article – August 2013

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WINNER