Begg Cousland
World Class Filtration Solutions

Mist Elimination Equipment for Sulphuric Acid Production Plants

THE BEGG COUSLAND ENVIROTEC TEAM
MIST ELIMINATION TECHNOLOGY EXPERTS

The Begg Cousland Envirotec team have over 50 years of experience in the design, manufacturing and installation of Mist Eliminators, to offer you the optimum filter solution for your needs.

Whatever the type of H_2SO_4 plant, we can offer the best filtration option from a range that includes Demisters, Coalescers, high velocity, low pressure loss or high efficiency Candle Filters for your drying tower, inter-pass absorption tower and final absorption tower. Concentric bed Xtra-Flow designs can save space, save pressure loss or add gas flow.
Full details are in our filter brochure ***Mist Elimination Equipment & Droplet Separation from Gas.***

Detailed knowledge in-house means we understand the processes and their differing requirements and how that affects filter selection, or the best selection of materials dependent on acid strength and temperature.

Let us give you the benefit of our experience, guarantees, maximum filter life and even an ability to re-pack on site.

PROCESS TECHNOLOGY

There are different sources of the SO_2 gas used for producing Sulphuric Acid

Sulphur Burning Plant (dark and bright sulphur)
Sulphur is melted and fed to a furnace where it is burned. The air entering the sulphur furnace must first be dried in a tower where H_2SO_4 solution is recirculating SO_2 gas from the furnace is converted into SO_3 through contact with Vanadium Pentoxide catalyst. The SO_3 gases are then absorbed by recirculating H_2SO_4 solution in one or two absorbing towers.

Metallurgical Plant (Non-Ferrous metal ore smelting)
Copper / Zinc / Lead / Pyrite / Pyrrhotite Ore is smelted and the exit SO_2 gas is purified in a 'gas cleaning' section, before it is fed to the Sulphuric Acid production section. The SO_2 gas is dried, then converted into SO_3 through contact with Vanadium Pentoxide catalyst. The SO_3 gases are then absorbed by recirculating H_2SO_4 solution in one or two absorbing towers.

Spent Acid Plants
Spent acid (mainly a by-product of the organic monomer manufacturing industry, e.g. caprolactam, acrylonitrile) is burned in a furnace to generate SO_2, and the gas is washed, dried, converted and adsorbed as mentioned above in *'Metallurgical Plant'*

Wet Process (decomposer process)
H_2S hydrogen sulphide is burned and the burned exit gas is fed to the converter without drying in a Drying Tower.

According to Conversion
2 types of contact plants:
- Single Contact / Single Absorption using only 1 Absorber
- Double Contact / Double Absorption using a 1st Absorber (IAT) after the 3rd pass of the converter and a 2nd Absorber (FAT) after the final pass.

DROPLET FORMATION and MIST GENERATION

Droplets are entrained by the gas from the liquid in the packing bed or as sprays from the acid distributor.
There are 3 cases relevant to mist formation:
- water related
- shock cooling based
- by-pass oleum tower related

Water Based Mist
Physical limit of drying is 3 mg/SCF of gas as H_2O) =
16 mg/SCF as H_2SO_4.
Residual water vapour will react with SO_2 in the gas phase and condense into mists as soon as the gas temperature is below the acid dew point.

Dark sulphur contains between 0.3 - 0.6% hydrocarbons. When burned, the water vapour emitted will react with SO_3 in the gas phase and condense into mists when the gas temperature is below the acid dew point.

When a Drying Tower is not equipped with filter system, or if the filter system is not operating correctly, H_2SO_4 is entrained, passes into gas phase and then condenses into mists in the Absorbing Tower.

In Metallurgical plants SO_3 is generated in the smelter. The SO_3 can react with H_2O in a weak acid gas cleaning scrubber downstream and that acid will condense into fine mists in the Absorbing Tower, if it is not continuously and efficiently pre-filtered by Wet Electrostatic Precipitators before the Sulphuric Acid section.

In the wet process, H_2S burning gives H_2O vapour which combines with SO_3 to form a high amount of fine mists.

Mist generated in an Absorbing Tower

Shock Cooling Mist
Even if no water was present, mists are formed thermodynamically in the lower part of an Absorbing Tower, as the gas enters the tower at 200°C+ and acid is recirculated at appx. 70-80°C.
The vapour pressures of H_2SO_4 H_2O and SO_3 change quickly, and H_2SO_4 mists are generated

Oleum Tower Case
An Oleum tower operates at low temperature (40°C) to promote the absorption of SO_3 into Oleum.
Oleum towers are installed on full flow or on by-pass.
Large amounts of fine mist (<1 micron) are generated on by-pass because :
- severe quench cooling occurs.
- the partial pressure at equilibrium of SO_3 vapour is much higher than normally in an I.A.T. or F.A.T.

A GUIDE TO SELECTING METAL MATERIALS OF CONSTRUCTION (i.e. Wire / Grids / Cages / Flanges)

Weak acid (< 98%) Conditions

- T° 40°C or less: 316L Stainless Steel
- T° > 40°C & Fluorine/HF: Alloy 20
  T° > 40°C & No Fluorine/HF: Alloy 20, SX or Saramet

Strong acid (>98%)

- T° 80°C or less: 316L Stainless Steel
- T° > 80°C & Fluorine/HF: Alloy 20
  T° > 80°C & No Fluorine/HF: Alloy 20, SX or Saramet
- T° > 100°C & No Fluorine/HF: SX or Saramet

A GUIDE TO SELECTING OTHER MATERIALS OF CONSTRUCTION (i.e. Plastic Wires and Fibres)

Plastic Wire Mesh :

- T° 90°C or less : Hostaflon E.T.F.E.
- T° >100°C : Hostaflon (E.T.F.E.) Preshrunk @ 150°C

Co-Knit Wiremesh Fibre :

- No Fluorine / HF : Glass or Teflon P.T.F.E.
- Fluorine / HF : Teflon P.T.F.E.

Fibre Beds :

- No Fluorine / HF : Glass Fibre
- Fluorine / HF : Carbon Fibre

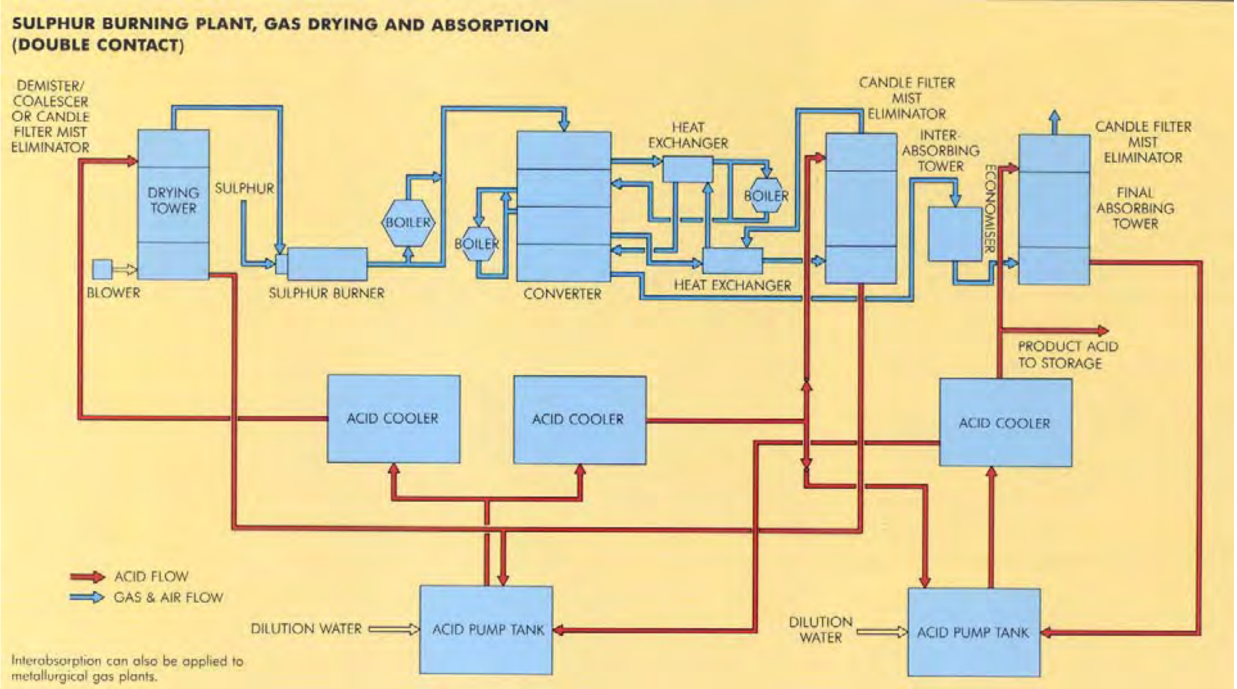
A GUIDE TO SELECTING FIBRE BED MIST ELIMINATORS
(All Fibre Types mentioned later in Applications)

BROWNIAN DIFFUSION RANGE									
Fibre Information		**Orientation Style**		**Collection Mechanisms**			**Typical Performance Data / Range**		
Fibre Type	**Fibre Material**	**Hanging Style**	**Standing Style**	**Brownian Diffusion**	**Interception**	**Impaction**	**Bed Velocity (m/sec)**	**Pressure Loss (mm H_2O)**	**Efficiency %**
TGW15	Glass Moulded	Yes	Yes	Yes	Yes	Yes	< 0.2	150 – 250	100% > 1µ >98% < 1µ
TGW16	Glass Moulded	Yes	Yes	Yes	Yes	Yes	< 0.12	250 - 300	100% > 1µ >99% < 1µ
B14W	Glass Rope	Yes	Yes	Yes	Yes	Yes	< 0.25	150 – 250	100% >1µ / 3µ 99% <1µ / 3µ
B14	Glass Moulded	Yes	Yes	Yes	Yes	Yes	< 0.25	150 – 250	100% >3µ 99% <3µ
C14	Carbon Mat	Yes	Yes	Yes	Yes	Yes	< 0.2	150 - 250	100% >3µ >99% <3µ

A C14 Carbon Fibre, Hanging Candle Filter Xtra-Flow Style

B14W Glass Rope Standing Candle Filters

HIGH VELOCITY RANGE									
Fibre Information		**Orientation Style**		**Collection Mechanisms**			**Typical Performance Data / Range**		
Fibre Type	**Fibre Material**	**Hanging Style**	**Standing Style**	**Brownian Diffusion**	**Interception**	**Impaction**	**Bed Velocity (m/sec)**	**Pressure Loss (mm H_2O)**	**Efficiency %**
B12	Glass Moulded	No	Yes	No	Yes	Yes	0.3 – 0.5	150 – 250	100% >3µ 95% 1µ - 3µ 80% <1µ
G25	Glass Moulded	No	Yes	No	Yes	Yes	0.8 – 2.5	100 - 200	100% >3µ 90% 1µ - 3µ 70% <1µ
G35	Glass Mat	No	Yes	No	Yes	Yes	1.0 – 2.5	100 – 200	100% >3µ 80% 1µ - 3µ
G35K	Glass Mat	No	Yes	No	Yes	Yes	1.0 – 2.5	100 – 180	100% >3µ 75% 1µ - 3µ
HTP	Glass Mat	No	Panels	No	Yes	Yes	0.8 – 2.5	100 - 200	See G35 or See G35K



Application 1 : Drying Tower

Air or SO_2 is dried with H_2SO_4 before being fed respectively to the sulphur furnace or converter.

Mist Formation/Nature/Load

Mechanically generated H_2SO_4 spray from the acid distributor causes droplets to be entrained. Mostly large particles above 2 microns diameter.
Due to low temperatures, no thermal generation of mist.
Load: typically 500 mg/Nm³

In metallurgical off-gas fed plants, smaller mist-sized particles can be entrained from upstream gas cleaning towers, especially during malfunction periods, and add to the inlet load to the filter.
Max. Load: 1,000 mg/Nm³

Problems to Solve

- Corrosion of downstream equipment, e.g. blower
- Negatively affect 1st catalyst mass
- Downstream filtration problems, due to decomposition of liquid particles into SO_3 and H_2O, in the furnace or converter, which will form small mist particles in the I.A.T. or F.A.T.

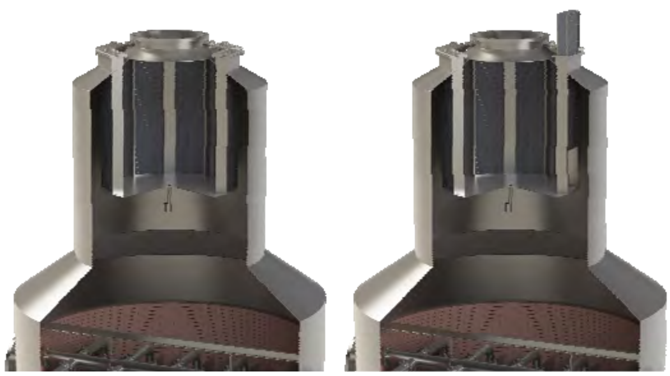
Design Solutions

For all plants –
- Single stage Demister with meshpad made in 316L SS, or Alloy 20, SX, BlueFil ETFE or Hostaflon ETFE
- Double stage Demister with meshpads made in 316L SS, or Alloy 20, SX, BlueFil ETFE or Hostaflon ETFE
- High Velocity Candle Filter, standing type F, with G25, G35 or G35K glass fibrebed in 316L SS structures.

For Metallurgical off-gas or Spent Acid fed plants –
- Combination Coalescer/Demister with some layers of Co-Knit Coalsecer mesh added to conventional Demister mesh. Co-Knit fibre in Glass or Teflon. Can be horizontal or coned at 10°.
- 2 stage system with lower co-knit Coalescer meshpad coned at 10° + upper horizontal Demister.

Inside View of Vertical Demister Panel Polygon

For safer maintenance, using only external access, we developed the Vertical Demister design, with panels sealed inside the tower top in a horseshoe polygon frame. Each panel is easily lifted in and out through doors on the tower top and needs no-one inside the tower.
It presents a more robust solution than horizontal drawer designs, and requires no additional platform area.
The time needed to change over a set of demister panels is much shorter than for conventional horizontal types, which means it can offer the chance to change blocked demisters in a short stoppage. And much more safely…



Schematics of Vertical Demister Panel System

Schematics of Most Meshpad Arrangement Options – Typically For Drying Towers

Single stage horizontal

Double stage horizontal

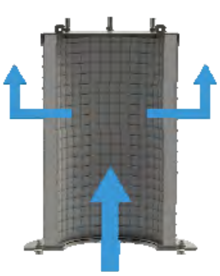
2 Size double stage horizontal

Single stage, upward coned Demister (or + co-knit layer)

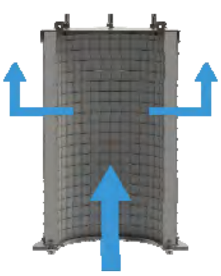
Double stage, with upward coned 1st stage Coalescer

Double stage, with downward coned 1st stage Coalescer

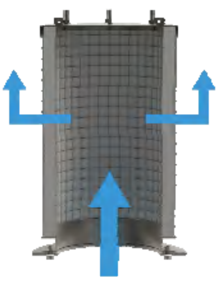
Schematics of Most Candle Filter Arrangement Options – For Drying & Absorbing Towers



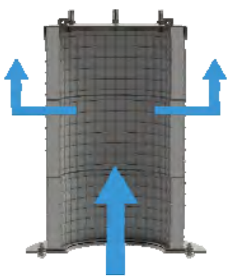
F2
Outside Bolts



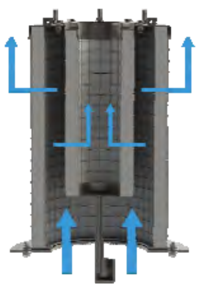
F3
Mid-Bed Bolts



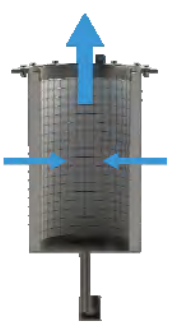
F4
Raised Stool



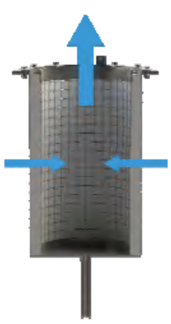
F2 STAR
Drainage Rings



F2 XTRA-FLOW
Concentric Beds

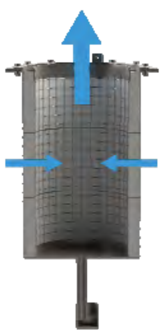


HT1
Drainpipe & Pot

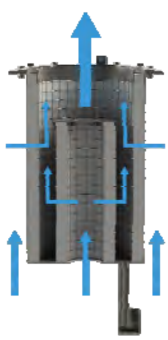


HT3
Drainpipe

HT4
Flanged Drainpipe



HT1 STAR
Drainage Rings



HT1 XTRA-FLOW
Concentric Beds

Application 2a: Intermediate Absorbing Tower – No Oleum Upstream

Mainly SO_3 gas from the 3rd catalyst pass is cooled and fed to the I.A.T. for absorption in H_2SO_4 before going through a gas/gas heat exchanger and back to the converter for the 4th catalyst pass.

Mist Formation/Nature/Load

In addition to the typical 500mg/ Nm³ load of mechanically entrained droplets from the acid distributor, there will be mist particles thermodynamically formed in the tower. Typical particle size granulometry is 40% < 1 micron, 30% 1-3 microns, 30% > 3 microns.

Bright sulphur burning :
Load: typically 1,000 – 2,000 mg/Nm³

Dark sulphur & spent acid burning, & metallurgical off-gas:
Load: typically 2,000 – 3,000 mg/Nm³

Problems to Solve

- Critical downstream gas/gas heat exchanger corrosion
- Downstream filtration problems, due to decomposition of liquid particles into SO_3 and H_2O, in the converter, which will form small mist particles in the F.A.T.

Design Solutions

- Medium Velocity Candle Filter, standing type F, with B12 series glass fibrebed in 316L SS structures.
- High Efficiency, Brownian Diffusion type Candle Filter, standing type F or hanging type HT, with TGW15, B14W or B14 series glass fibrebed in 316L SS structures.
  Option of concentric bed Xtra-Flow design.

Application 2b: Intermediate Absorbing Tower – Oleum By-pass Upstream

Some of the gas from the 3rd catalyst pass is fed to an Oleum Tower as a by-pass flow, before mixing again with the main gas flow to the I.A.T.

Mist Formation/Nature/Load

See **DROPLET FORMATION and MIST GENERATION** - ***Oleum Tower Case*** on page 2
Typical particle size granulometry is 50% < 1 micron, 40% 1-3 microns, 10% > 3 microns.

Load: typically 3,000 – 4,000 mg/Nm³

Problems to Solve

Same as Application 2a above

Design Solutions

- Very High Efficiency, Brownian Diffusion type Candle Filter, standing type F or hanging type HT, with TGW16, TGW15 or B14W series glass fibrebed in 316L SS structures. Option of concentric bed Xtra-Flow design.

View from below of a Drying Tower Demister

Application 2c: Intermediate Absorbing Tower – Heat Recovery process

The I.A.T. is a special design, with 2 stages, and hot acid is fed into the 1st stage.

Mist Formation/Nature/Load

Typical particle size granulometry is 60% < 1 micron, 35% 1-3 microns, 5% > 3 microns.

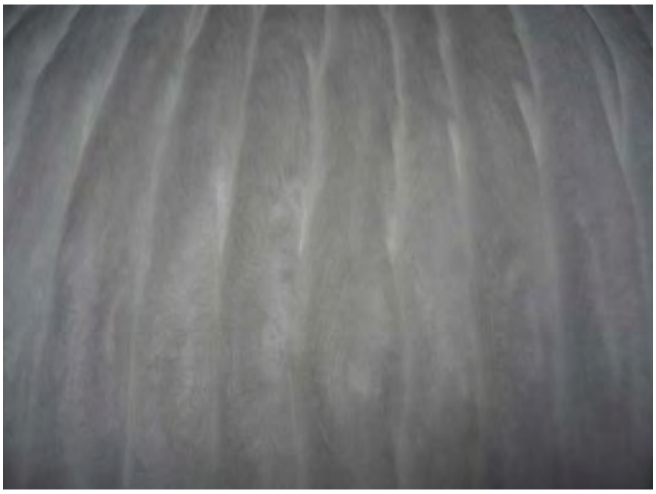
Load: typically 10,000 – 25,000 mg/Nm³

Problems to Solve

Same as Application 2a above, except the high mist load of small particle sizes requires special care on pressure loss and efficiency, and avoiding re-entrainment from the flooding condition mist eliminators.

Design Solutions

- Very High Efficiency, Brownian Diffusion type Candle Filter, standing type F or hanging type HT, with TGW16 or B14W series glass fibrebed in 316L SS structures.
  Option of concentric bed Xtra-Flow F design
  Option of the STAR design, with intermediate drainage rings, over the length of the filter, to assist quicker drainage from the fibre bed, and reducing pressure loss and risk of re-entrainment.



View of a B14W Fibrebed

View of hanging type candle filters from below

Application 3a: Final Absorbing Tower in Double Absorption Plant

SO_3 gas from the final catalyst pass is fed to the F.A.T. for absorption in H_2SO_4 before the stack exit to atmosphere.

Mist Formation/Nature/Load

There is less absorption activity in the F.A.T., so in addition to the typical 500mg/ Nm^3 load of mechanically entrained droplets from the acid distributor, there will be some mist particles thermodynamically formed in the tower. Typical particle size granulometry is 30% < 1 micron, 30% 1-3 microns, 40% > 3 microns.

Load: typically 700 – 1,500 mg/Nm^3

Problems to Solve

- Air pollution ; Emission limits may be by mass (e.g. less than 20mg/Nm^3 of H_2SO_4, or measured along with SO_3 as a combined maximum value) or they may be by stack plume opacity (20mg/Nm^3 is also the limit of visibility of H_2SO_4 mist)

Stack emission plumes like this can be eliminated

Design Solutions

- Low or Medium Velocity Candle Filter, standing type F, with B12 or G25 series glass fibrebed in 316L SS structures.
- High Efficiency, Brownian Diffusion type Candle Filter, standing type F or hanging type HT, with TGW15, B14W or B14 series glass fibrebed in 316L SS structures. Option of concentric bed Xtra-Flow design.

Application 3b: (Single) Absorption Tower

SO_3 gas from the converter is fed to the A.T. for absorption in H_2SO_4 before stack exit to atmosphere.

Mist Formation/Nature/Load

Same as Application 2a above

Problems to Solve

Same as Application 3a above

Design Solutions

Same as Application 3a above

Wet Catalysis Plant filter vessel

Application 3c: Wet Catalysis Plant Absorption Tower

SO_2 / H_2S gas from refinery operations is not dried before the converter (i.e. No D.T.)

Mist Formation/Nature/Load

Load: typically 40,000 – 100,000 mg/Nm^3

Problems to Solve

- Air pollution

Design Solutions

- Very High Efficiency, Brownian Diffusion type Candle Filter, standing type F or hanging type HT, with TGW16, B14W series glass fibrebed in Polypropylene or 904L structures. Option of concentric bed Xtra-Flow F design

Wet Catalysis Candle Filters below vessel exit

Application 4: SO_2 Tail Gas Scrubber in Single Absorption Plants

SO_2 levels exiting a single absorption H_2SO_4 plant can be between 2,000 and 3,000 ppm. Scrubbing the tail gas to acceptable SO_2 emission values can be done with seawater, caustic, lime slurry, hydrogen peroxide or ammonia.

Mist Formation/Nature/Load

In an ammonia scrubber, ammonium hydroxide is recirculated and PH is 6.2 which leads to high loads of ammonia salts as solid, soluble mist, < 1 micron in size
Load: typically 15,000 mg/Nm³

Problems to Solve

- Air pollution

Design Solutions

- Very High Efficiency, Brownian Diffusion type Candle Filter, standing type F with TGW16 or B14W series glass fibrebed in Polypropylene structures. Option of concentric bed Xtra-Flow F design.
  Pre-wet the inlet gas to solubilise the ammonia salts.

Candle Filter in a GRP + Derakane Resin Structure

Application 5: Acid Concentrator

The Acid Concentrator concentrates weak acid into commercial strength acid. Hot gas from a combustion furnace directly contacts the weak acid, and exits to atmosphere.

Mist Formation/Nature/Load

Weak acid mist
Load: typically 5,000 – 10,000 mg/Nm³

Problems to Solve

- Air pollution

Design Solutions

- High Efficiency, Brownian Diffusion type Candle Filter, standing type F or hanging type HT, with TGW15 or B14W series glass fibrebed in Polypropylene or GRP/Derakane resin structures.

Becoflex BFCF unit on Oleum tanker loading duty

Application 6: Oleum / Liquid SO_3 Tank Vent

Tank air + SO_3 is vented to atmosphere, and also when tanker loading and unloading operations are being done. SO_3 will react with the air moisture to form a white fume.

Mist Formation/Nature/Load

SO_3 is hydrolysed in the fan volute section, where the rotating brush is sprayed with water.
Average mist particle size – 2 microns
Load: typically 750 mg/Nm³

Problems to Solve

- Air pollution

Design Solution

- Becoflex BFCF package system, combining a Polypropylene BF fan casing and filter vessel with a High Efficiency, Brownian Diffusion type Candle Filter, standing type F with TGW16 or B14W series glass fibrebed in Polypropylene structure.

For further information, please contact us at

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