Begg Cousland Envirotec

The Art of Troubleshooting Mist Eliminators
Begg Cousland Envirotec
Company Profile - Highlights

- Original Begg Cousland established 1854 in Scotland

Happy to stay part of the U.K.!!!!
Begg Cousland Envirotec

Company Profile - Highlights

- Original Begg Cousland established 1854 in Scotland
- Specialisation on Mist Elimination from 1965 (Demisters, then Mist Eliminators)
- Overseas Licensees operative in China (Jiangsu New Hongda) and in India (Begg Cousland Private Ltd.)
- UK Production facilities moved to in Italy in 2007 (Begg Cousland srl)
- Begg Cousland Envirotec HQ & main offices remain in Glasgow
Begg Cousland Envirotec

Range of Mist Eliminators
Since 1950s Begg Cousland have made mesh pad type Demisters using knitted wires in metal and fluoroplastic, to collect liquid droplets of 5 microns and larger.

By adding fibre yarn, as a co-knit material along with the wire, it forms Coalescer mesh, to collect smaller liquid droplets in the range of 2 to 5 microns.

Demisters and Coalescers, as a single or double stage arrangement, are mostly used in Drying Towers. In older plant designs they have been used for Absorber service also.
Typical materials we use for Sulphuric Acid plant service are:

- 316 Stainless Steel
- Alloy 20
- SX (from Outotec Edmeston)
- Saramet (from Chemetics)
- Lewmet (from Lewis Pumps)
- Hostaflon ETFE
- Glass Fibre
- Teflon Fibre
Begg Cousland Envirotec
Demisters & Co-Knit Mesh Pads
Begg Cousland Envirotec
Demisters & Co-Knit Mesh Pads

Vertical Panel Polygon Demister Panels are removable through top access doors.

No tower entry
Safety Design
# Begg Cousland Envirotec

**Demisters & Co-Knit Mesh Pads**

## Operating Guide + Performance Data

<table>
<thead>
<tr>
<th>Mesh Pad Type</th>
<th>Velocity Range m/s</th>
<th>Pressure Loss Range mm H2O</th>
<th>Particle Size Efficiencies</th>
<th>Selection Criteria</th>
</tr>
</thead>
</table>
| Wire only Demister Style H | 1.0 – 3.5 | 30 - 100 | 100% > 5µ | S Burning
| | | | | Solids Risk |
| 1 stage Coalescer / Demister | 1.0 – 3.0 | 40 - 120 | 100% > 5µ
| | | | | 99% 3 - 5µ |
| 2 stages Coalescer + Demister | 1.0 – 3.0 | 50 - 120 | 100% > 5µ
| | | | | 99.5% 2 - 5µ |
| | | | | Mist Issues
| | | | | Not high liquid load |
| | | | | Mist Issues
| | | | | High liquid load |
Since 1960s Begg Cousland have made fibre bed mist eliminators (Candle Filters), to collect liquid mist below 5 microns, even sub-micron.

The fibre beds are made of a variety of fibre diameters and lengths, selected in each case to give the desired / optimum balance of energy requirement and efficiency. Generally more efficiency means more energy or more cost.

Mist Eliminators in a Standing or Hanging arrangement, are mostly used in Absorber Towers. Standing type are sometimes used in Drying Tower service also.
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

- Standing Type Arrangements

- ‘F2’ Type Series
- ‘F3’ Type Series
- ‘F4’ Type Series
- ‘F’ Type Xtra-Flow Series

GAS FLOW FROM BELOW

GAS FLOW FROM BELOW

GAS FLOW FROM BELOW

GAS FLOW FROM BELOW THROUGH EITHER FIBRE BED
Begg Cousland Envirotec

*Mist Eliminators / Candle Filters*

- **Standing* Type Fibre Beds for DT / FAT**
  - **High Velocity Types**
    - G35K / G35 Glass Fibre and Wire Co-Knit (*also Panels*)
      - 100% Collection > 3µ
      - 75 - 80% Collection 1 - 3µ
    - G25 Glass Fibre
      - 100% Collection > 3µ
      - 90% Collection 1 - 3µ
      - 70% Collection < 1µ
    - B12 Glass Fibre
      - 100% Collection > 3µ
      - 95% Collection 1 - 3µ
      - 80% Collection < 1µ
Begg Cousland Envirotec
Mist Eliminators / Candle Filters

- Hanging Type Arrangements

- 'HT1' Type Series
  - Gas flow from below

- 'HT3' Type Series
  - Gas flow from below, drain pipe only

- 'HT4' Type Series
  - Gas flow from below, flanged drain pipe

- 'HT1' Type Xtra-Flow Series
  - Gas flow from below, through either fibre bed
Begg Cousland Envirotec

*Mist Eliminators / Candle Filters*

- Standing or Hanging Type Fibre Beds for IAT / FAT / Tail Gas Scrubber / WSA Exit

  - **Brownian Diffusion Types**
    - B14 Glass Fibre
    - B14W Glass Fibre (Rope Wound)
    - C14 Carbon Fibre (Mat Wound)
      - 100% Collection > 3µ
      - 99% Collection < 3µ

  - TGW15 Glass Fibre
  - B14W Glass Fibre (Rope Wound)
    - 100% Collection > 1µ
    - 98-99% Collection < 1µ
Standing & Hanging Type + & - Notes

- Standing Type
  + Can be installed through roof manways
  + Reduced height of brick lining in C.S. towers
  + No filling of drain pots before start-up
  + Can drain acid separately from Product Acid
  + Can be High Velocity type
  - Cannot see all flanges for leak check
  - Vibrate and damage gasket seal over time
  - Often bolted from below, where acid drips
Standing & Hanging Type + & - Notes

Hanging Type
- Can’t usually be installed through roof manways
- More height of brick lining in C.S. towers
- Need filling of drain pots before start-up
- Need header to drain acid separately from Product Acid
+ Can see all flanges for leak & emission check
+ Little vibration and good gasket seal over time
+ Bolted from above, so easy and safe
+ Can see inlet surface from below for solids check
Begg Cousland Envirotec

Standard Mist Eliminator
Troubleshooting Guidance
And Working Examples
A BLIND MAN
IN A DARK ROOM
LOOKING FOR A BLACK CAT
THAT IS NOT THERE
?
Troubleshooting Example 1

- Drying Tower upstream of blower
- Copper smelter off-gas feed
- Hostaflon ETFE wire mesh with some layers of Teflon fibre co-knit mesh
- No stick tests
- Steadily increasing pressure loss

Expected problem:
Meshpad blockage with sulphates / solids
Begg Cousland Envirotec
Demisters & Co-Knit Mesh Pads

Troubleshooting Example 1

Actual problem:
Meshpad blockage with sublimed sulphur
Begg Cousland Envirotec
*Demisters & Co-Knit Mesh Pads*

- Troubleshooting Example 1

Result:
Blower damage and downstream problems
Troubleshooting Example 1

Conclusions:

Expect the unexpected....

Get operators to monitor pressure loss changes more often and more accurately.
Troubleshooting Example 2

- Drying Tower upstream of blower
- Sulphur burning gas feed
- 316L SS wire mesh
- Bad stick tests
- No obvious increase or decrease in pressure loss

Expected problem:
Meshpad by-pass
Troubleshooting Example 2

Demister inspected and no by-pass or blockage found
Additional information:
10% increase in gas flow
Troubleshooting Example 2

Conclusion: Demister flooded at higher flow rates

Solution: 10% surface area increase and improved drainage by using a conical demister design.
Begg Cousland Envirotec

*Mist Eliminators / Candle Filters*

Troubleshooting Example 3

- Drying Tower downstream of blower
- Sulphur burner gas feed
- High Velocity Mist Eliminators installed
- ME filter media (chosen by the client) was wrapped knitted mesh and co-knit fibre mesh material, to reduce pressure loss in order to extend life and period between shutdowns
- No stick tests
- Increasing pressure loss

Expected problem:
Solids blockage
Troubleshooting Example 3

Established problem:
Significant phosphate dust deposits on outside
Troubleshooting Example 3

Established problem: Air inlet filter problems
(Phosphate dust deposits inside & outside washed off)
Troubleshooting Example 3

Conclusions:

Insufficient understanding of cause and effect

Resolve problem upstream
Troubleshooting Example 4
- Final Absorbing Tower
- Smelter off-gas feed
- High Velocity Mist Eliminators installed
- ME filter media was conventional mat-form glass fibre layers with an outer layer of knitted mesh
- Stick tests available
- Stack emission issues

Expected problem:
Mist generation in FAT beyond capability of filters
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

Troubleshooting Example 4

Additional Information:
Stack emission is both mist and spitting droplets
Troubleshooting Example 4

Additional Information:
The plant has a 50% & a 100% gas flow operation. Stack plume worse when on 50% flow.
Begg Cousland Envirotec

*Mist Eliminators / Candle Filters*

100,000m$^3$/hr comparison High Velocity vs High Efficiency

- **G25** typical velocity 2.0m/sec with \( \Delta P < 200\text{mm H}_2\text{O} \)

  \[
  \frac{100,000}{3600 \times 2.0} = \text{m}^2
  \]

  = 10 filters 610mm o/dia x 1.525m long

  **But:** Only efficient in range 60,000–100,000 m$^3$/hr & no <1µ mist

- **B14W** typical velocity 0.2m/sec with \( \Delta P < 200\text{mm H}_2\text{O} \)

  \[
  \frac{100,000}{3600 \times 0.2} = \text{m}^2
  \]

  = 30 filters 610mm o/dia x 3.66m long

  **And:** Efficient in range 30,000–100,000 m$^3$/hr & with any <1µ mist
Troubleshooting Example 4

Conclusion:

The plant has not got a good FAT filter design for handling both a 50% & a 100% gas flow operation without stack emission problems.

Improve if pressure loss allows, or upgrade.
Troubleshooting Example 5

- Intermediate Absorbing Tower
- Metallurgical plant off-gas feed
- New set of High Efficiency Brownian Diffusion Mist Eliminators installed
- Stick tests showed worse carry-over at higher flow
- Downstream drainage increase
- Pressure loss a little less than design

Expected problem:
Gas by-pass ? Flange seal leak ? High mist load - No
Identified problem:
Flange seal leaks with no gasket seal / bad bolting
Troubleshooting Example 6

- Final Absorbing Tower
- Sulphur burner gas feed
- New set of High Efficiency Brownian Diffusion Mist Eliminators installed 5 years earlier
- Stick tests show some mist, consistent with stack exit
- Pressure loss a little less than design

Expected problem:
Gas by-pass? Flange seal leak?
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

Troubleshooting Example 6
Troubleshooting Example 6

Additional information:
Old pipe-type acid distributor replaced in last shutdown with modern trough type
Troubleshooting Example 6

Conclusion:
The Mist Eliminators were not sufficiently saturated, due to the low quantity of acid (mist/spray) being entrained from the new distributor & packing.

Solutions:
Remove some top saddles?
Wetting system?
Troubleshooting Example 7

- Final Absorbing Tower
- Mixed Spent Acid Regeneration & Sulphur burning gas feed
- High Efficiency Brownian Diffusion Mist Eliminators installed
- Persistent light plume from the stack, or worse
- Stick tests did not show mist consistent with stack exit
- Pressure loss as per design

Expected problem:
SO$_3$ absorption issue?
Troubleshooting Example 7

Additional information:
The condensing mist from the stack varied according to the amount of spent acid used in the feed. The spent acid had a significant NOx impact.
Troubleshooting Example 7

Conclusion:
The condensing mist from the stack is mostly from SO$_3$ slip, which varied according to the amount of spent acid used in the feed. The Brownian Diffusion Mist Eliminators are saturated with acid, which does normally absorb a lot of free SO$_3$. However, NOx is preferentially absorbed, which means more of the free SO$_3$ went to the stack, during the periods of high spent acid feed.
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

Troubleshooting Example 7

Addendum: Nitrosyl NOHSO₄
Suggested Mist Eliminator
Shutdown Inspection Procedures
Begg Cousland Envirotec

Demisters & Co-Knit Mesh Pads

- Shutdown Procedures

From above, inspect and take photographs of top surface where anything of significance is noted, for example:

- meshpad sections not fitted properly – including meshpad seal to the wall and section-to-section
- corrosion
- deformation of meshpad layers – mechanically damaged or shrunk
- solids - including sulphate deposits
- discolourations of co-knit fibres
Begg Cousland Envirotec
*Demisters & Co-Knit Mesh Pads*

- Shutdown Procedures
Begg Cousland Envirotec
Demisters & Co-Knit Mesh Pads

- Shutdown Procedures
Begg Cousland Envirotec
Demisters & Co-Knit Mesh Pads

- Shutdown Procedures

Check the tightness of the section fixing arrangements –
hold-down bars on top, wiring from below,
hookbolts / clamps from above or below
Shutdown Procedures – All Standing Types

- From above, inspect and take photographs of filter support plate (tubesheet), using a strong torch / flashlight.

- Identify any filter flange / gasket leakage marks made by by-pass air on the top of the tubesheet or nearby vessel wall. Note other things such as sulphate sludge, drain blockage, wet areas / dry areas.

- Inspect outside of each filter from above, using a strong torch/flashlight, to identify any holes or problems such as sulphur sublimation, fibre holes, cage wire corrosion, etc..
Begg Cousland Envirotec
Mist Eliminators / Candle Filters

- Shutdown Procedures – All Standing Types
  - Inspect inside of each filter from below, using a strong torch/flashlight, to identify any holes or problems such as solids, discolouration.
  - Check tubesheet drains fitting & not corroded.
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

- Shutdown Procedures – All Standing Types
Shutdown Procedures – Hanging Types

- From above, inspect and take photographs of flanges & support plate (tubesheet) surfaces where anything of significance is noted. Identify any filter flange / gasket leakage marks made by by-pass air on the top of the tubesheet or nearby vessel wall. Note other things such as sulphate sludge, wet areas / dry areas.

- Check the tightness of bolts at top flanges

- Inspect inside of filters from above through the top hole of candle, using a strong torch/flashlight, to identify any holes or problems such as sulphur sublimation, fibre holes, cage wire corrosion, etc..
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

- Shutdown Procedures – Hanging Types
Begg Cousland Envirotec
*Mist Eliminators / Candle Filters*

- **Shutdown Procedures – Hanging Types**
  - Inspect outside of each filter from below, using a strong torch/flashlight, to identify any holes or problems such as solids, discoloration, sulphur sublimation, fibre holes, cage wire corrosion, etc..
  - Check drainpots (if used) are full of liquid and drain pipes are properly fitted and not corroded.
Begg Cousland Envirotec

The Art of Troubleshooting Mist Eliminators

Thank you for your interest and now any questions