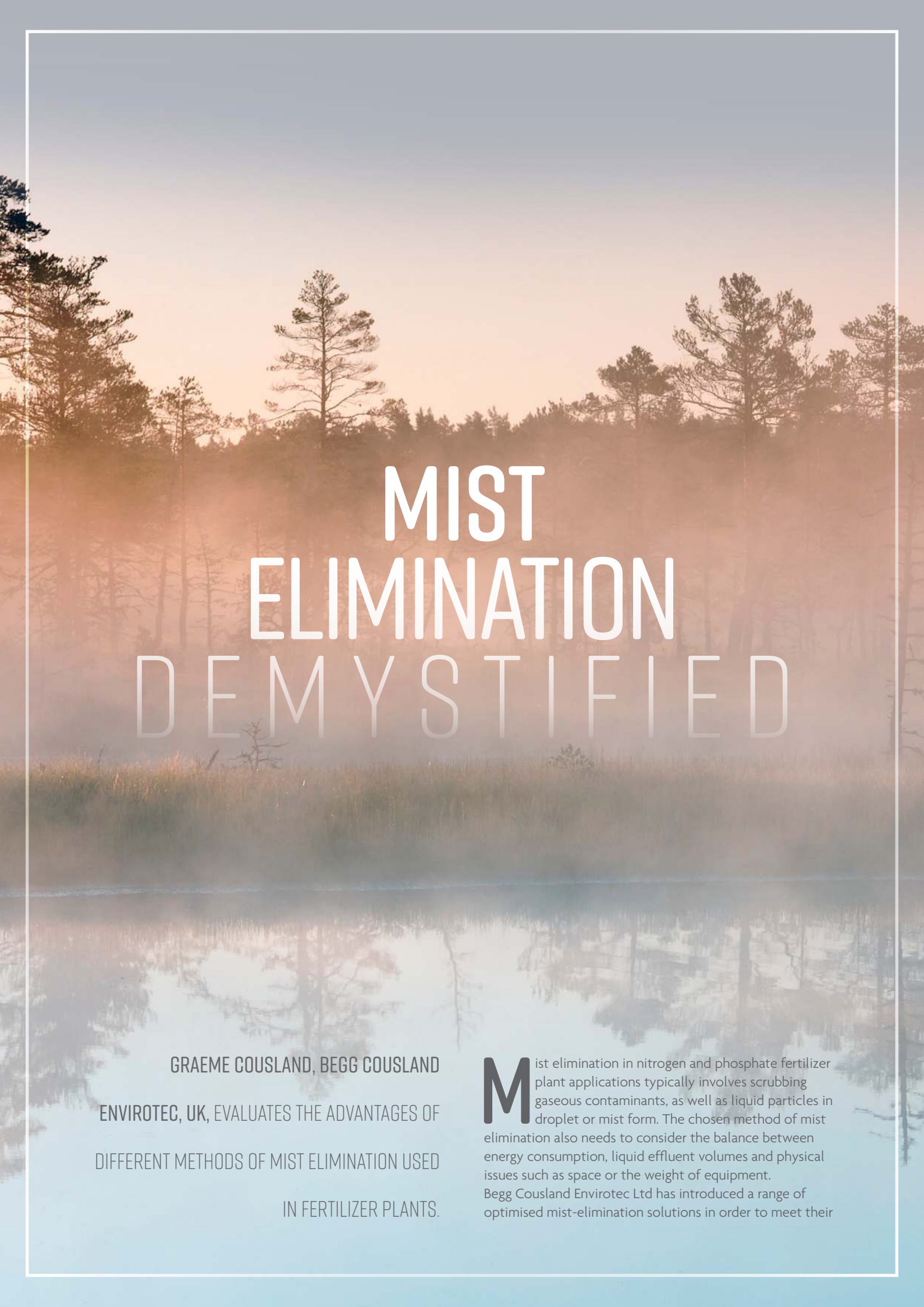

MIST ELIMINATION DEMYSTIFIED

GRAEME COUSLAND, BEGG COUSLAND ENVIROTEC, UK, EVALUATES THE ADVANTAGES OF DIFFERENT METHODS OF MIST ELIMINATION USED IN FERTILIZER PLANTS.

Mist elimination in nitrogen and phosphate fertilizer plant applications typically involves scrubbing gaseous contaminants, as well as liquid particles in droplet or mist form. The chosen method of mist elimination also needs to consider the balance between energy consumption, liquid effluent volumes and physical issues such as space or the weight of equipment.
Begg Cousland Envirotec Ltd has introduced a range of optimised mist-elimination solutions in order to meet their

Figure 1. AN prilling tower candle filter system vessel.

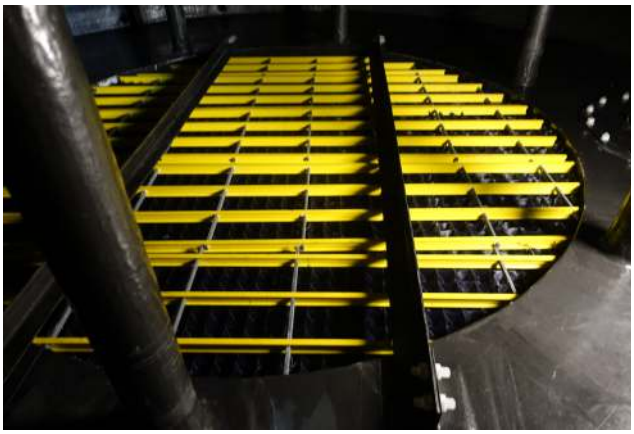

Figure 2. Irrigated BlueFil® meshpad in vertical vessel.

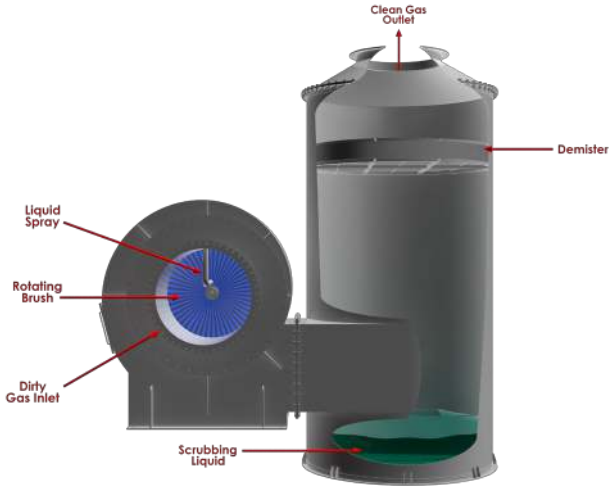

Figure 3. Schematic of a BF series 'Becoflex' scrubber.

client's emission requirements. This article discusses a selection of these mist elimination applications.

Fibre bed candle filters

Fibre bed candle filters are the most efficient type of mist eliminator for removing small and sub-micron sized particles and fumes. If these particles are not removed, they can cause a visible emission plume, which makes it even more important to achieve high efficiencies using Brownian diffusion fibres. The company's 'Becofil®' TGW15 and B14 or B14W glass fibre beds emit less than 10 mg/Nm^3 of ammonium nitrate (also exceeding the PM2.5 limits) from prilling towers. When the fibres are installed with a first stage irrigated meshpad, ammonia emissions can be reduced to less than 5 mg/Nm^3. Usually the system is installed at ground-level due to size of the filter vessel and discharge fan.

The lifespan of fibre bed candle filters typically exceeds six years, rising to 10 years if the fibres are installed on an ammonium nitrate prill tower. In instances where the filters have been installed on NPK prill towers and there has been a high level of fluorine gas present, Becofil® C14 carbon-fibre beds have achieved the same high-efficiency level as the Brownian diffusion glass fibres.

Urea and ammonium nitrate processing creates evaporator emissions that are best treated at source, unless the process technology sends the contaminated gas to another scrubber or filter system in the plant. The vapours entrain urea or NH_4NO_3 to the atmosphere unless filtered. Becofil T80.35 P.T.F.E. fibre beds can be supplied in panel form or in cylindrical element form.

Meshpad filters and demisters

These filters are often used when there is limited space available, for instance when a system can only be installed on top of a prilling tower or where insoluble solids will block fibre-bed equipment. The efficiency will depend on the fan-suction available and space/weight limitations, but the recovery of valuable products (urea/AN/CAN/NPK) can give payback and reduce emissions. These designs are also made with an irrigation section, spraying a mesh (a knitted metal wire meshpad or structured thermoplastic meshpad) instead of a packing to achieve a more intense gas-liquid contact, removing ammonia, and preventing blockages. A second stage will be installed as a 'dry' demisting pad stage, to prevent droplet spitting.

As mentioned previouly, gas scrubbing in series with mist elimination is the norm in nitrogen fertilizer production and attempting to reduce ammonia emissions. A unique combination of these is offered by the Becoflex rotary-brush scrubber, which de-dusts, scrubs and filters in an energy-efficient package system. The original development was engineered by ICI in the UK and was applied to de-dusting duties such as PTA silo vent gas.

The system uses a special (PP Fibre) brush inside a fan volute instead of an impeller. The fan motor drives the brush axle at high speed, which creates up to 110 mm H_2O of suction. The gas, which is drawn into the volute, is co-currently irrigated as it meets the spinning brush fibres, and the dynamic contact between the liquid and gas due to the fast fibre rotation not only works to remove ammonia but

it also removes solids (soluble and insoluble). The solids are spun off by centrifugal action along with the liquid, and are discharged down into the bottom of a downstream vessel, while the cleaned gas flows away upwards. This continuously self-cleaning solids removal stage then allows for a mist eliminator to be used downstream, without the risk of blockage. The suction generated by the rotating brush usually means there is no need to have a supplementary fan in the line.

Compared to a Venturi scrubber (an alternative solids removal option), the 'Becoflex' uses only $^1/_6$ of the scrubbing liquid required by a Venturi, the spray is at a low pressure, and the system has no overall pressure loss. The Venturi will have a high-motive liquid pressure (4.5 – 5 bar g), increasing energy consumption. The Venturi also removes 100% of 22 μm, while Becoflex has 100% efficiency at 3 μm.

When applied to fugitive emissions in phosphate fertilizer plants, such as phosphate rock, transport wagon unloading or cleaning, the brush scrubber acts as a stand-alone package system for capturing the P_2O_5 mist and P_4 solids, making the working environment safe for the workforce. The mist elimination stage is a meshpad, removing entrained droplets of water from the brush section.

Granulated and/or dried nitrogen fertilizer products have been successfully handled by the brush scrubbers, meeting < 5 mg/Nm^3 exit permit levels of NH_3 and NH_4NO_3. Multiple volute and brush units can be combined in parallel to handle large gas volumes and discharge into a single vessel. Currently the largest such installation treats over 200 000 m^3/hr (AN), and the smallest only 2200 m^3/hr (AN & AS).

When dealing with prilled or granulated CAN or urea with large gas volumes that then involve a large filter system at ground level, the system requires one or more scrubbing stages and a final mist elimination stage, due to the sticky nature of the fumes and the tendency to block any filter or packing media as internals. Knitted meshpads are often too dense for these duties, meaning they have a significant pressure-loss and a high risk of fouling. The energy requirement is then considered as unattractive. The use of Benvitec Environment's BlueFil structured thermoplastic filament meshes (sometimes referred to as 'phase separation' meshes) has provided a solution to problems of achieving simultaneously high efficiency, low pressure loss, low blockage risk and minimum maintenance.

In China the mesh has been a success in granulated urea filtration and scrubbing, meeting the tighter exit limits now imposed there (< 30 mg/Nm^3). Using a horizontal flow scrubbing system, with two or three stages in series, the footprint of these systems is reduced by having an upper and a lower level gas flow in parallel. Continuously wetted first stages remove the soluble urea particles and abate the NH_3. Each of the large, 3 m high meshpad panels are fitted with support grids to make them easy to install, fix in position and maintain. The energy consumption saving has been considerable – approximately 50% greater than that of the alternative system a client considered.

Phosphoric acid mist comes out of the reactor and acid extraction stages along with fluosilisic acid and these are removed by a series of sprayed mesh stages with a final demisting stage before the exit to atmosphere. There are many benefits of BlueFil meshes, for example:

Figure 4. BF series 'Becoflex' scrubber beside transfer wagon.

Figure 5. A Benvitec mist eliminator cassette with MX095 BlueFil.

Figure 6. Vertical BlueFil mesh for a horizontal flow vessel.

- The general rigidity of each layer – permitting high pressure washing without damage to the filaments and meshes.
- The increased thickness of both the mesh and the filaments compared to other media – optimising pressure loss and resistance to blockage.
- The widest range of mesh sizes – allowing even the most stringent emission limit to be achieved without excessive material usage.

Phosphate fertilizer plants have other mist elimination challenges combining P_2O_5 acid filtration with gas scrubbing in very dirty conditions, for example in MAP/DAP granulation and drying sections.

Where footprint is a problem these fume scrubbers can be designed with a vertical vessel and horizontal scrubbing and demister stages. Mostly they are made as 'cross-flow' horizontal systems permitting the packing stage and demister stage media to be installed and removed via roof doors in individual cassettes. It is critical that the media installed inside these cassettes is properly sealed against the sides and top and bottom, to prevent gas by-pass. It is an ongoing problem to get better efficiency from these systems, while not increasing maintenance and pressure loss as a result. However, in a major DAP producer's FSA scrubber, where the frequency of washing of the traditional media has led to by-pass issues, the mesh has been successfully trialled and proved much more resistant to deposition and blockage. WF