Use of Mesh Pre-Coalescers to Enhance Small Droplet Capture in Multi-Stage Demisters

Refer also to TB 16-06-2020

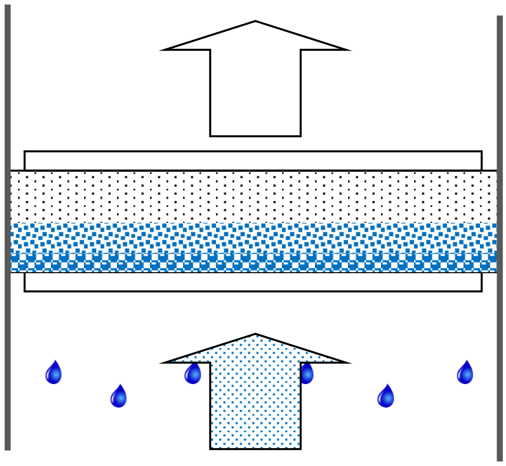


Fig. 1A: Vertical gas flow with counter-current drainage means lower K-factors and gas velocities are used for sizing and the liquid mist load is limited to avoid flooding

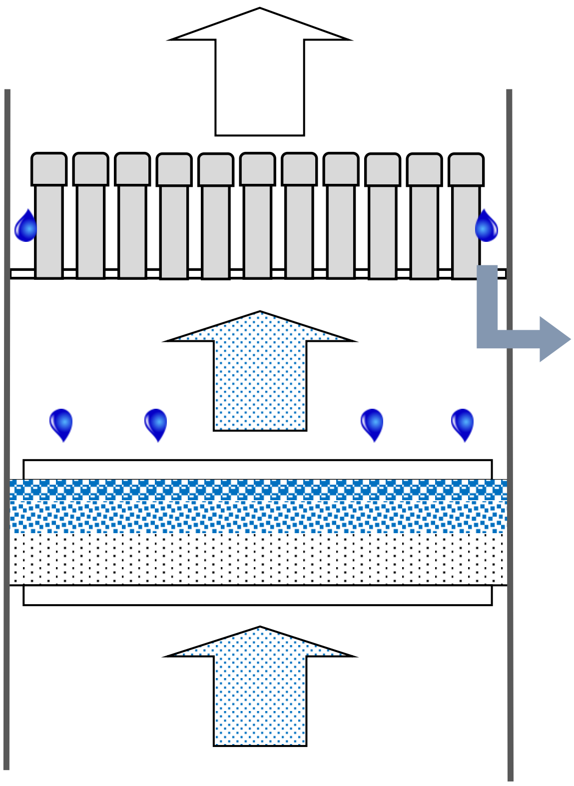


Fig. 1B: Above the flood point, the mist eliminator will not capture all liquid; it will coalesce and start to re-entrain in the gas flow as larger globules / droplets. This phenomenon means mesh pads can be used as the first stage in a multi-stage mist eliminator offering better turn-down and/or performance than a single stage:

Fig.2A: Horizontal gas flow with cross-flow drainage means design gas velocity and/or liquid loading can be higher

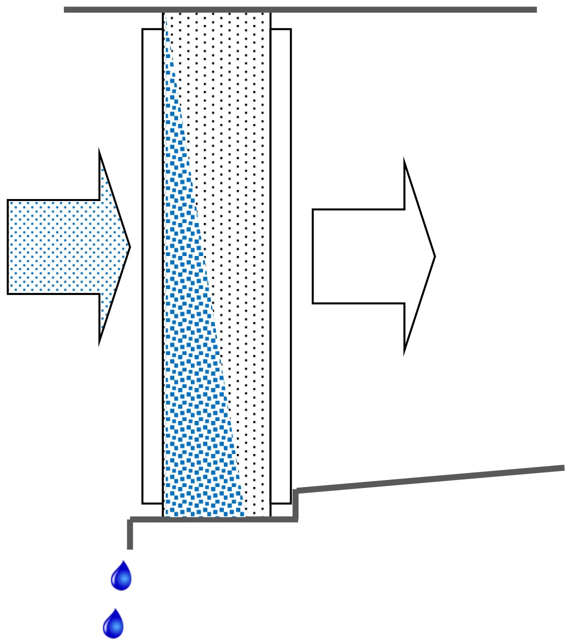
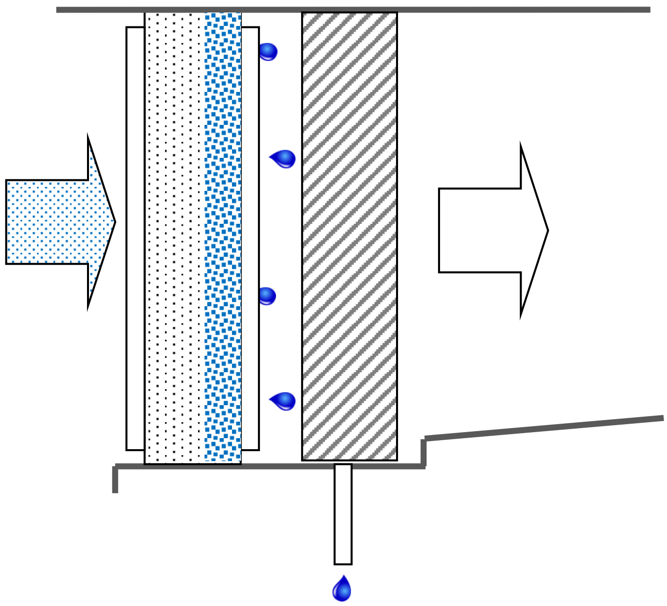


Fig.2B: Above the flood point, the mist eliminator will not capture all liquid; it will coalesce and re-entrain in the gas flow as larger globules / droplets. This phenomenon means mesh pads are often used as the first stage in a mesh+vane combi mist eliminator offering better turn-down and/or performance than a single device:



Calculating droplet capture efficiency is usually done using a number of algorithms to estimate droplet impingement on the device surfaces (e.g. wires or vanes). Generally, the higher the droplet velocity (or momentum) the more likely it is to impinge on the surface. Thus, in theory, to capture smaller droplets higher velocities should be used. A program such as ME-Calc+ can be used to plot droplet capture efficiency at various droplet sizes and flow rates to allow the designer to optimise a solution.

But what happens if a high efficiency removal solution is not possible at an acceptable diameter considering the full range of flows and fluid properties using a single demister?

The limiting velocity on single mist eliminator device design will be the flooding velocity, where captured liquid can no longer be drained as quickly as it enters, but instead starts to carry through to the gas outlet side, resulting in a steady reduction in removal efficiency.

However, as illustrated in Figs 1B and 2B above, this phenomenon may be used to advantage if we install a 2nd stage mist eliminator that has a higher gas flow capacity than the 1st stage. Here, we are using the 1st stage to capture the smallest droplets (e.g. with a wire mesh) and coalesce them into larger droplets which carry through to the 2nd stage device which captures larger droplets at increased velocity (e.g. vane pack or cyclones).

Modelling multi-stage demisters

Let's take an example of natural gas at 150 MMSCFD, 600 psig (41 barg) with 0.65 SG light condensate removal. Customer is seeking 99.9% removal at 8 microns in a 52" drum.

High efficiency circular mesh pad sizing gives 72" diameter (1800mm) with 99.9% droplet capture at 10 microns. A cross-flow vane pack fits into a 52" (1300mm) drum, but offers 99.9% capture at 12.2 microns.

But if we increase the mesh K factor to match the vane pack sizing, the mesh will theoretically capture 99.9% of droplets at 6.5 microns or larger that pass through, coalescing them into larger droplets that are caught by the downstream vane pack, meeting the customer spec.

What if the customer is been seeking this performance at 6 microns? A quick check shows the mesh meeting 99.84% at 6 microns however, the vane pack also has some removal capability at 6 microns (24.43%) so if we multiply the two efficiencies we get (1-0.9984) x (1-0.2443) = 0.00121 or 99.88% overall removal, effectively meeting the 99.9% at 6 micron request.

A side note, at turndown flows the theoretical capture efficiency decreases but the actual quantity of small droplets in the gas drops exponentially and so the absolute carryover attributable to fine mist (USG/MMSCF) drops dramatically - thus turndown guarantees are unlikely to be limited in practice to theoretical capture calculations.

Refer also to TB 21-08-2018 for flow v efficiency.