General considerations in removing entrained liquids from gas streams

Using mist eliminators for removing mists, sprays and fogs from process streams will...

- *raise process efficiency*
- *reduce valuable product loss*
- *increase throughput capacity*
- *improve side draw and overhead purity*
- *prevent downstream corrosion*
- *remove pollutants*

Why entrainment occurs

In any process equipment where gas and liquid come into contact, the gas will always entrain some liquid. It is always detrimental. Entrainment is generated by two basic mechanisms: mechanical and condensation as shown in Figure 1.

Droplets in mists generated by mechanical means are almost always over 5-10µ in diameter. For example, hydraulic spray nozzles generate mists of droplet diameter greater than 250µ while pneumatic nozzles form mists with droplet diameters over 15µ. Gas bubbles breaking on a boiling or bubbling liquid surface will form droplets from 1500µ down to just 5µ in diameter, so careful consideration to performance requirements must be given to equipment such as evaporators, tray columns and steam boilers.

Although entrainment swept off the surface of random packing or the surface of heat exchanger tubes consists mainly of relatively large, easily removed droplets >25µ, some types of condensation entrainment are smaller and not so easy to collect. Extremely fine entrainment, <15µ for instance, is often generated when a liquid condenses from a saturated vapor, as in a compressor where lubricating oil is locally heated and vaporized, and then quickly condenses, causing very fine smoke-like entrainment ~7µ. Condensation, having a smoke-like appearance, can also occur when two gases such as SO_2 and water react to form a liquid product, sulfuric acid. These latter types of entrainment require high efficiency separation equipment.

Physical properties of the liquid also have significant effects on droplet size. Consider in most cases, the higher the viscosity, the larger the droplet size – and the lower the surface tension, the smaller the droplets.

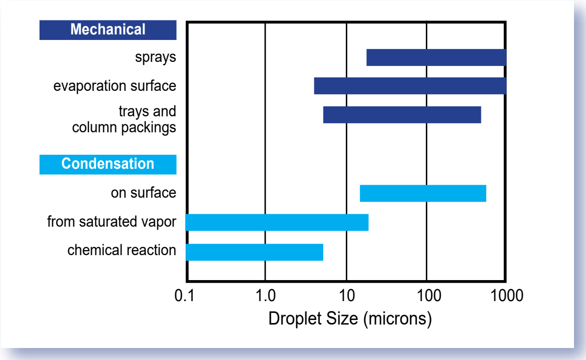

Figure 1
Typical droplet size distribution ranges for entrainment caused by various mechanisms.

Mechanisms of entrainment removal

Mist capture generally can occur by three mechanisms as shown in Figure 2. Note that there are no sharply defined limits where one mechanism takes over from another. Since momentum of a droplet varies directly with liquid density and the cube of diameter, heavier or larger droplets tend to resist following the streamline of a flowing gas and will strike targets placed in their line of travel. This is inertial impaction, the mechanism responsible for removing most droplets ≥5µ. Smaller droplets that do follow streamlines may collide with solid objects if their distance of approach is less than their radius. This is direct interception. It is often the governing mechanism for droplets in the 1-5µ range.

With sub-micron mists, Brownian capture becomes the dominant collection mechanism. This depends on Brownian motion − the continuous random motion of droplets in elastic collision with gas molecules. The smaller the particles, the greater the efficiency of Brownian capture.

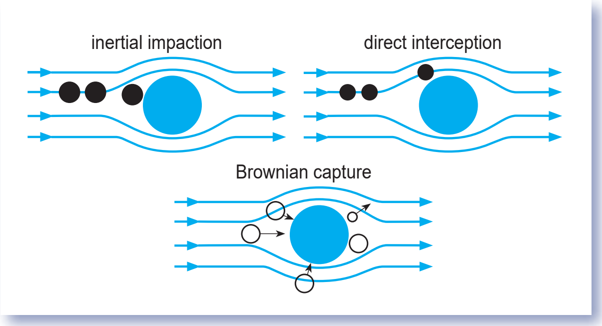

Figure 2
Three basic mechanisms of mist capture.

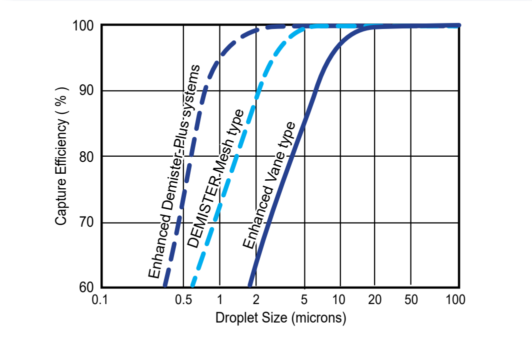

Figure 3
Efficiency of droplet capture vs. droplet diameter is shown for three different types of mist eliminators. This performance is based on typical design conditions for the various entrainment separators and will vary based on actual process data.

Types of mist eliminators

Almost all mist elimination equipment falls into four classes: knitted wire mesh styles, corrugated vane type blade assemblies, cyclonic tube boxes and fibrous bed panels or cylinders.

When to use a mist eliminator

- **Reduce loss of valuable product –** mist eliminators can stop liquid losses in absorbers, evaporators and distillation columns, markedly cut glycol, amine or catalyst consumption.
- **Increase throughput capacity –** anywhere gases and liquids come into contact in process equipment, significant velocity increases will be made possible by installing a mist eliminator.
- **Improve product purity –** mist eliminators can prevent contamination of side draws and overheads in refinery atmospheric and vacuum towers, and other distillation columns.
- **Eliminate contamination –** mist eliminators can prevent poisoning expensive downstream catalysts - provide boiler feed water quality condensate from evaporator overheads
- **Stop downstream corrosion –** mist eliminators can protect ductwork and heat exchangers – prevent solids build-up on fan, turbine and compressor blades, eliminating serious maintenance problems.
- **Prevent air pollution –** mist eliminators help reduce emissions from acid plants to environmentally acceptable levels – prevent ammonia and sulfite plumes – stop stack entrainment from settling in nearby parking lots.
- **Reduce water pollution –** mist eliminators installed upstream of evaporator barometric condensers can prevent entrainment of polluting substances in the water effluent.

The practical starting point for mist eliminator selection is always the wire mesh pad type (Figure 4). Experience with more than 250,000 mist elimination installations over the past 45 years, EIT has found that in most cases the knitted wire mesh DEMISTER Mist Eliminators provide required separation efficiency at lowest installed cost.

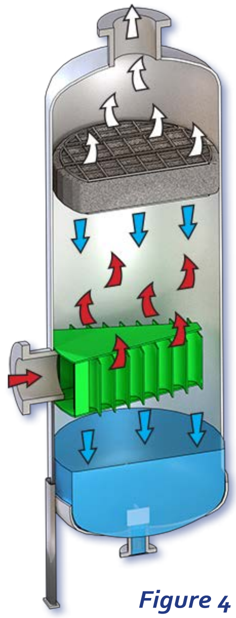

Figure 4

If the mist contains high liquid loadings, high levels of solid particulates, or is highly viscous or sticky, then Enhanced™ Vane Mist Eliminators may offer a better solution.

When submicron droplets are present at low velocities, fibrous beds with ultra-high surface area are the proper selection.

At high pressures, >35 bar (500 psi), where there is a need to capture fine entrainment at high velocities, Enhanced Cyclonic™ Mist Eliminators are best.

When the most difficult or challenging applications exceed single devices, then a system of mist eliminators or Enhanced Demister-Plus™ Mist Eliminators, which incorporate the latest in separation technology, will provide an excellent solutions.

More detailed information and calculations are presented in the series of EIT Mist Elimination technical bulletins to help clarify selection. Your final design should be made only after reviewing your application with experienced EIT process engineers. The proven expertise and practical know-how that EIT has built up over the years will help optimize the design for your particular application. We invite you to take full advantage of this assistance and send in a completed process data sheet.

EIT Mist Elimination Technical Bulletins

Wire Mesh DEMISTER

Enhanced Vane

Enhanced Demister-Plus

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