EVERMESH

MIST ELIMINATOR

SELECTION OF MIST ELIMINATORS

GAS-LIQUID contactors form a large segment of equipment used in the chemical process industry. These include packed and plate distillation and absorption towers, scrubbers, evaporators, knockout drums, etc. In all these contactors the separation of the gas and liquid phase is not complete even after allowing a substantial disengagement space. The liquid phase tends to be carried away into the gaseous phase and this liquid entrainment is a common problem in any process handling gasses and liquids.
Equipment for removal of this liquid entrainment (colloquially termed as mist) in the gas stream is referred to by several terms, viz mist eliminator, entrainment separator, demister, etc. The term mist eliminator has a wide usage and hence is used in this article to denote all such types of equipment. Mist eliminators are therefore widely used to:
a)Reduce loss of valuable product to improve product purity (process gas cleaning).
b)Prevent air pollution (exhaust gas cleaning).
c)Prevent downstream corrosion and eliminate contamination (of downstream catalyst).

No gas-liquid contactor operation generates a uniform size particle and in general a droplet size distribution is generated. Depending on how they originate, these droplets can be classified as shown in Fig.1. As one reads across the table, one should realize that there are no sharp distinctions between the various zones. However, a classification scheme, though arbitrary, does emerge from Fig.1.
A spray consists of particles larger than 30 microns which is generated from low energy input contacting devices such as distillation towers, hydraulic (low pressure) nozzles and evaporators.
Mists are created from such systems as high energy pneumatic (two fluids) spray nozzles, absorption towers etc. consisting of droplets in the 3-30 microns range.
Fogs, smokes and fumes are droplets smaller than 3 microns formed due to rapid condensation or by creation (by reaction) of liquid within the gas phase.

FIG.1

Entrainment Type	Sprays	Fogs & Mists		Fogs, Smokes & Fumes
Capture Mechanism	Intertial Impaction	Intertial Impaction, Direct Interception		Impactation Interception, Brownian Diffusion
Usual Elimination Device	Vane / centrifugal Separator	Mesh	or	Fibrebed
Particle Size(Micron)	100 30	10	1	-1

FORMATION

Mist can be formed due to:
A. Improper contact resulting into a mechanical breaking operation. These include:
- i) Inconsistent voidage in a packed tower
- ii) Improper design of liquid distributor of a packed tower.

B. Process Conditions: These include:

i) When two saturated streams, at different temperatures, on mixing yield an intermediate temperature at which the total stream is supersaturated. Mixing of two glycol recycle streams in the glycol dehydration process is a typical example.

ii) Another case under this classification involves shock cooling and subsequent condensation of liquid particles from a gas. Chemical reactions between two or more gases which form a product with a low vapour pressure also leads to mist formation. The vapour phase reaction between SO, and water producing sulphuric acid mist is an example of this type.

iii) Non-adiabatic cooling of a gas containing a condensible vapour produces a very fine mist. The condensation mist of water vapour during cooling of hot compressed gases is a typical example.

The simplest way to remove an entrained droplet would be a gravity settler or a disengagement chamber. The path of the liquid is obtained from a force balance on the particle where the weight of the particle is balanced by its momentum and the drag on the particle. If the velocity of the particle is made sufficiently low, the particle settles down easily and it can be trapped and removed from the gas stream. However, a large chamber would be required for such an operation, which would render it uneconomical. Hence, industrial mist eliminators utilize one or more of the collection mechanisms cited below:

Centrifugal force | Electrostatic attraction
Inertial impaction | Direct interception | Brownian diffusion

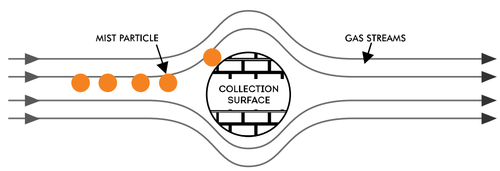
When the gravitational acceleration is replaced by a centrifugal force contribution in the force balance equation cited above, we get the basis for design of a cyclonic separator. Electrostatic precipitators develop high voltage electrical charges between parallel plates or within tubes with a central core electrode. Electrical charges present on the entrained liquid particles cause them to be attracted to an oppositely charged surface in the precipitator where they are collected and drained. Electrostatic precipitators are most effective with low liquid loading and can achieve high collection efficiencies of submicron particles.

The remaining three mechanisms shown in the Figures below are widely employed and are based on the theory of aerodynamic capture of particles as they move along a streamline with the parent gas around a solid object barrier. This barrier could be a baffle plate assembly, a packed bed of wires or fibres.

1) Inertial Impaction: In the presence of a solid body barrier, a larger or heavier particle (whose momentum varies with density and cube of its diameter) will not necessarily follow the streamline of a flowing gas. These particles are projected against this barrier due to their higher inertia and hence have to be captured by the inertial impaction mode. It is the main mechanism for removing large droplets ($>$ 10 microns) from scrubbers, evaporators and crude towers.

1. INERTIAL IMPACTION

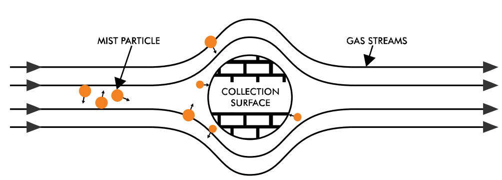
2) Direct Interception: Particles that do follow streamlines may still be collected if they travel at a distance equal to or less than their radius from the solid body barrier. This phenomenon of direct interception is often the governing mechanism in many refinery and chemical process operations.



2. DIRECT INTERCEPTION

3) Brownian Movement/ Diffusion: With decreasing particle size, particles tend to behave like gas molecules and move in a random motion called Brownian motion. The intensity of Brownian motion increases with decrease of particle size, a 0.1 micron particle exhibits five times the Brownian movement of a 1 micron particle. The capture of these particles follows collision with the collecting surface during their random motion. This mechanism is the predominant mechanism for collection of submicron particles such as fine mists from acid absorbers, chlorine cells, etc.

3. BROWNIAN MOVEMENT



Just as there are no clear demarcation areas between different entrainment types, there are no easily defined limits at which one capture mechanism ceases to be important and another takes over. All three mechanisms are effective in varying degrees, over the entire size range of particles.

EVERMESH
MESH PAD MIST ELIMINATORS

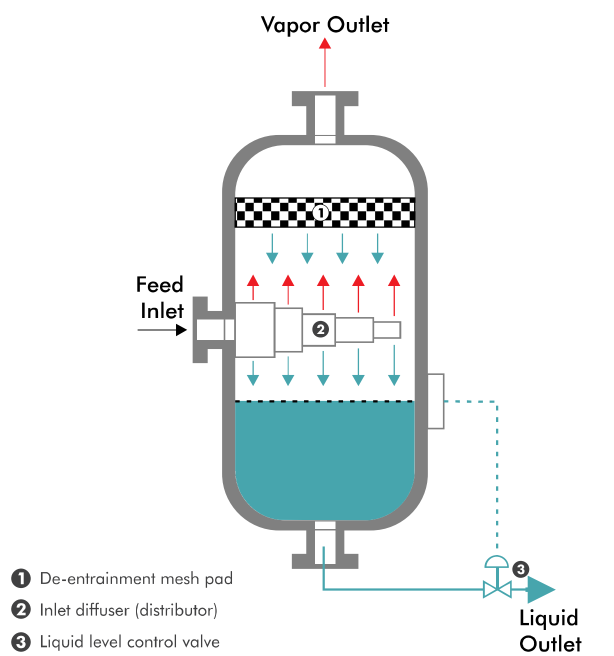
WHAT IS EVERMESH MIST ELIMINATOR?

The EVERMESH mist eliminator is a fabricated pad formed from symmetrical interlocking loops of knitted metal wire or plastic filaments. This pad, with a high free volume and large impingement area, can be installed in any existing or new process vessels to provide separation efficiencies up to 99% for particles down to five microns, with pressure drops in the vicinity of 25 mm WG. The EVERMESH mist eliminator is a static, in-line device and in the majority of cases it can be installed in the evaporators, scrubbers, pressure vessels etc., without a special housing. There is practically no maintenance required except for cleaning when used in fouling services.

Most EVERMESH mist eliminators are supplied with complete rigid support grids, which allows direct installation onto appropriate supports such as beams and rings within the vessel. Sectional installation allows ease of handling and access through vessel manways.

WORKING OF EVERMESH MIST ELIMINATOR

When vapours carrying mist pass through the EVERMESH mist eliminator, the vapours pass through the layered mesh structure of the EVERMESH mist eliminator but the liquid droplets, which have greater inertia, contact and collect on the exposed wire surface. As more droplets collect, they coalesce and grow in size until they become large enough to drain back into the system. The overhead product is a pure vapour containing practically no liquid.



DESIGN AND ENGINEERING DATA

The separating action of a separator largely depends upon the contact surface area necessary for impingement, which must be evenly distributed. Generally speaking, a higher free volume leads to a lower pressure drop. In critical cases, it may be necessary to decide whether pressure drop or efficiency should be sacrificed. However, the EVERMESH mist eliminator allows the greatest possible efficiency at the lowest possible pressure drop.

EFFICIENCY

Normally, EVERMESH mist eliminator will remove droplets down to 5 microns with an efficiency up to 99%. This efficiency will vary depending upon the particle size distribution and other operating conditions. Furnished in a wide variety of mesh styles, the EVERMESH mist eliminators offer a collection of efficiency and pressure drop combinations that can be customised exactly to specific process requirements. Special designs are now available with higher efficiencies for specific applications.

PRESSURE DROP

Pressure Drop is also a function of separator specifications and is less than 25mm WG for a majority of applications. In vacuum service, high efficiency is routinely achieved with a pressure drop of the order of 5mm WG.

EVERMESH MIST ELIMINATOR MAKES ANY GOOD PROCESS BETTER

- Improves Process Efficiency.
- Eliminates costly liquid loss.
- Solves Air Pollution Problem.
- Low cost, highly versatile and efficient method of removing liquid entrainment from gas streams.

DESIGN VELOCITY

The maximum allowable vapour velocity 'U' for most systems is calculated according to the Souder-Brown equation given below

$$U = K\sqrt{\frac{\rho_L - \rho_G}{\rho_G}}$$

U= Velocity, m/sec
K= Constant, 0.108 (in m/sec) for general applications
ρ_L = Liquid Density, kg/m3
ρ_G =Vapour density, kg/m3

It is suggested that the design velocity should be 60-75% the value of 'U' so as to allow for surges and upset conditions. However, excellent performance is obtained in most systems for velocities 30-110% of the maximum allowable vapour velocity. For high pressure and vacuum services the constant K will need to be corrected and the design will be adjusted accordingly. The overall performance of a mist eliminator is a compromise between efficiency and pressure drop. Typically, mist eliminators are specified by means of :

- Wire diameter
- Free volume
- Specific surface area
- Pad density

SELECTION AND SIZE OF AN EVERMESH MIST ELIMINATOR IS DECIDED BY

- Gas or vapour flow rate and amount of liquid entrained
- Droplet size distribution and performance requirement
- Allowable design velocity
- Physical and chemical properties of the gas and liquid phases
- Material of construction

TECHNICAL SPECIFICATIONS

STYLE	DENSITY Kg/m^3	VOIDS %	CONTACT SURFACE AREA m^2/m^3	CHARACTERISTIC
GA	80	99	160	High Vacuum
GA1	100	98.75	200	High Throughput
GB	144	98.2	280	Standard
GC1	173	97.8	360	Dense
GC	193	97.5	360	Extra Dense
GD	220	97.2	905	Heavy Dense
GE	432	97	960	Multi-Strand
GS	128	98.4	460	High Efficiency
GT	64	97	440	Dense
GP	75	93	1100	Heavy Dense

INSTALLATION DETAILS

Installation can be done in a variety of ways but gas flow is usually either vertically upwards, with the liquid draining counter-current to gas flows, or horizontal, with the liquid draining normal to the gas flow(only in exceptional cases since the lower portion of the pad may see a liquid build-up and subsequent re-entrainment).

The wire mesh pad of the EVERMESH mist eliminator is sandwiched between a top hold down grid and a bottom support grid. Special grids with a high percentage of open area have been developed for this purpose. The wire mesh pad is resilient and slightly oversized so as to provide a snug fit in the vessel. The purchaser should provide a 50 to 75 mm wide annular support ring drilled with 3 to 6mm diameter holes and welded to the vessel well. The wire mesh pad and grid assembly is then fastened securely to the grid using 2 mm diameter tie wires (or when specifically required with suitable fasteners). Immediate support beams are also recommended for all spans larger than 1800-2000mm.

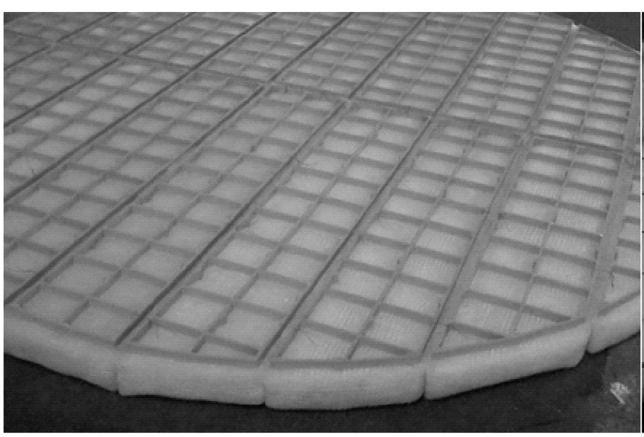
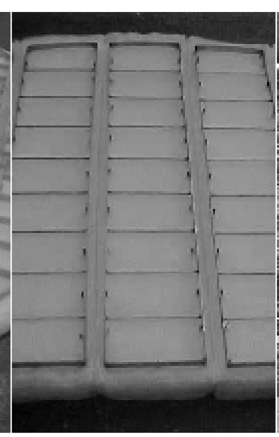
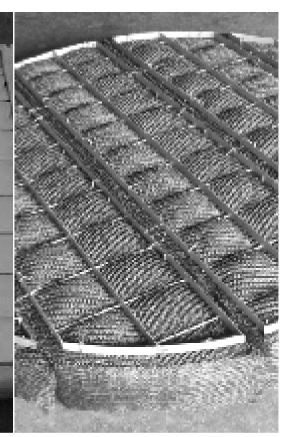
Various options are available for installation of the mesh mist elimnator depending on location of manhole / access below or above mesh mist eliminator assembly and EVERGREEN will be able to provide a variety of installation options for your specific application.

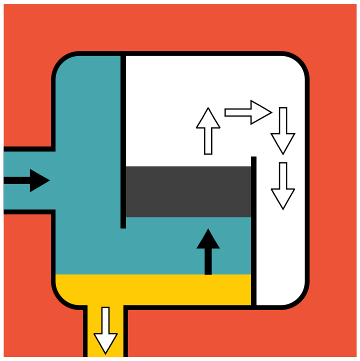
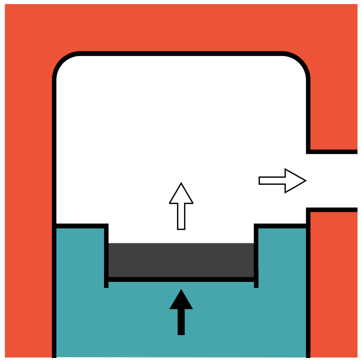
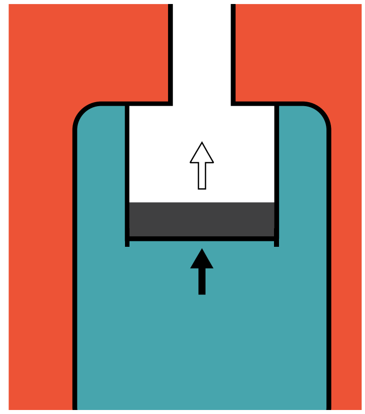
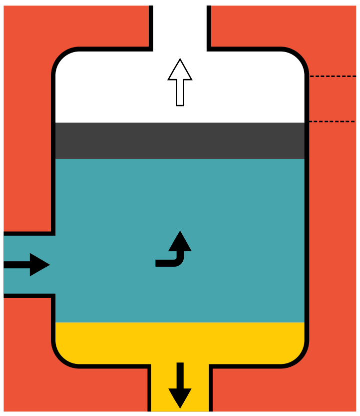
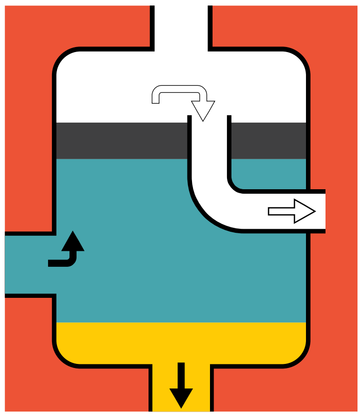
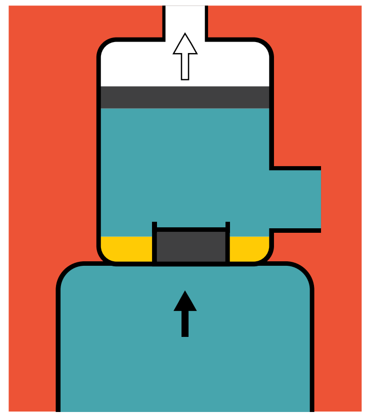
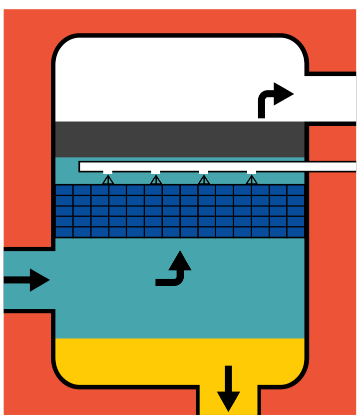
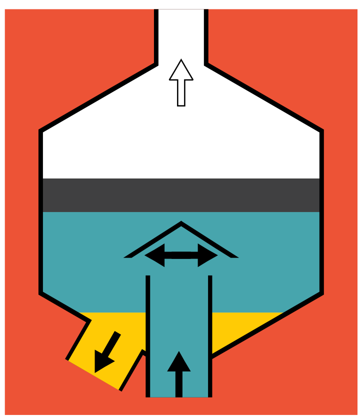
MATERIAL OF CONSTRUCTION

Selecting the right material for mist eliminators is critical not only for corrosion resistance, but also for wetting characteristics. For example, the use of specially selected plastic fabrics coupled with stainless steel has proven extremely effective in the separation of fine hydrocarbon mists entrained in high pressure natural gas systems.

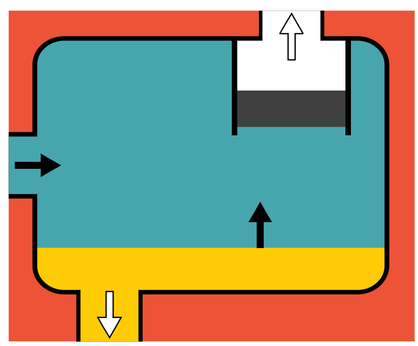
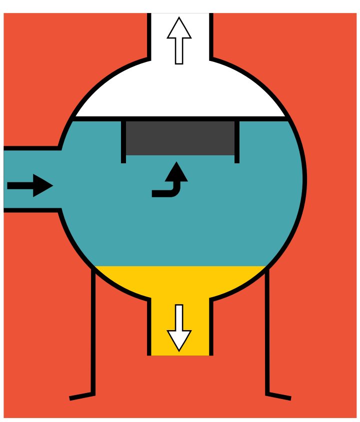
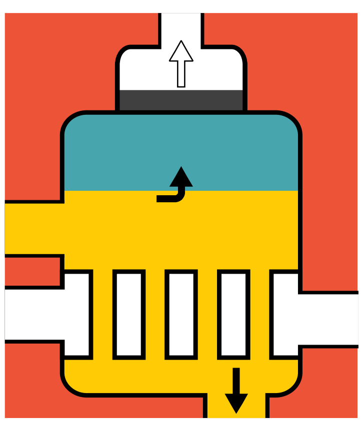
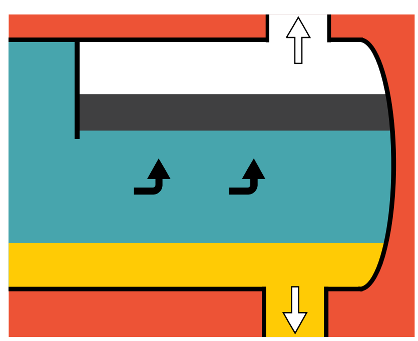
MATERIALS OF CONSTRUCTION

MATERIALS	LIQUID PRODUCT SEPARATED
Carbon Steel	for dry non-corrosive hydrocarbons
Nickel	caustic soda, food products
Monel	caustic soda & other alkalis, dilute acids
304 Stainless	water solutions, nitric acid, reduced crude petroleum fractions, etc.
316 Stainless	fatty acids, reduced crude containing naphthenic acids & other corrosives
430 Stainless	nitric acid, water, steam
Aluminum	nitric acid
Copper	freons, alcohol
Synthetic Fibre / Plastics	for corrosive service at moderate temperature

APPLICATION CONFIGURATIONS

NEW VERSIONS OF EVERMESH MIST ELIMINATORS

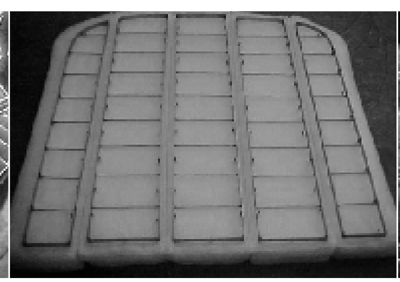
Evergreen's vast experience with mesh mist eliminators and the industries' requirement of increasing gas capacities and higher performance has resulted in the development of the following:

- Various new design configurations (EVERMESH plus) which combine multiple mist eliminator types(such as mesh & vanes) to produce an optimum combination of gas/vapour throughput, liquid loading, collection efficiency and pressure drop.
- A new family of EVERMESH design/styles with composite multilayer proprietary construction (which in a few cases replace the traditional styles originally introduced in the early 1970's). These newer styles provide up to 10% to 15% lower pressure drops or 20% to 40% higher design velocities at equivalent collection efficiencies (and in some cases increased fouling resistance). These new styles are designated by the letter N coupled to the old/ conventional style, viz. the new style GBN is the improvement in the style GB.
- A co-knit design which incorporates multi-filament yarn (polyester/glass fibre/ PTFE) containing fine fibres and metal wires to provide higher collection efficiency (99% up to 2 microns). A drainage layer is incorporated in the bottom section of this design to allow for speedy evacuation of the collected liquid.

Since these designs incorporate a combination of mist eliminator configurations (for the EVERMESH Plus) or a composite multilayer proprietary structure (for the new family of EVERMESH styles), a simple table of style specifications equivalent to the old (or conventional) styles or configurations is not possible. Application areas for these new versions include high pressure steam drums, natural gas dehydration plants, multiple effect evaporators, etc.

EVERMESH MIST ELIMINATORS TYPICAL APPLICATIONS

- Distillation Equipment
- Evaporators
- Knockout Drums
- Vacuum Towers
- Gas scrubbing systems
- Steam Drums
- Gas absorption and Stripping
- Oil refineries and Petrochemical Industry
- Fertiliser production
- Olefin and methanol production



EVERGREEN TECHNOLOGIES PVT. LTD.

Evergreen Technologies Pvt. Ltd.
3D, Maker Bhavan No. 2,
18 New Marine Lines, MUMBAI 400020 (INDIA)
Tel: 91-022-61566969/22012461/22012706
Fax: 91-022-22010024
Email: info@evergreenindia.com
www.evergreenindia.com

ISO 9001-2008 CERTIFIED ORGANIZATION