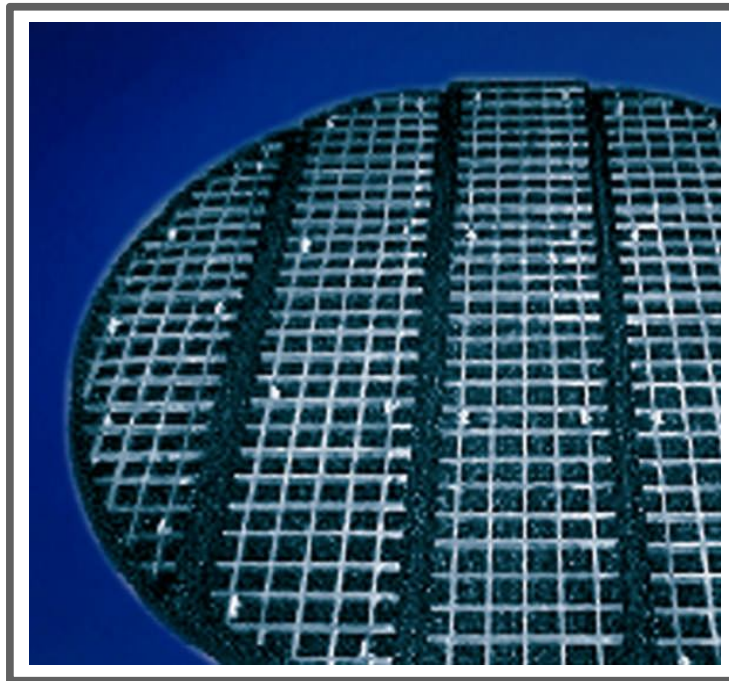# Raschig USA XMIST Wire Mesh Mist Eliminators Product Bulletin 300
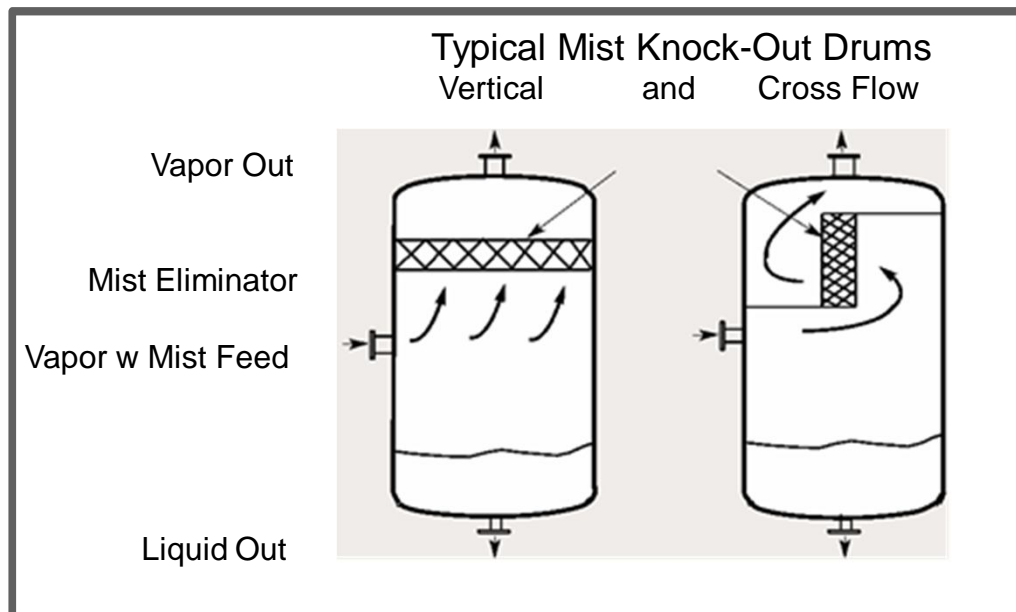
Raschig XMIST Wire Mesh Mist Eliminators
(Formerly Jaeger XMIST)

Features

- Wire Mesh Mist Eliminators are engineered to provide the optimum performance for mist elimination or entrainment separation.

- High Efficiency

- Low Pressure Drop

Benefits

- Advanced mechanical design and careful selection of materials provide maximum performance lifetime.

- As a consequence of maximizing performance lifetime, life-cycle cost (total cost) is minimized.

- Superior technical support minimizes risk in process design and plant operations.

- When-needed delivery prevents unnecessary plant downtime.

- Industry leadership in quality assures customer satisfaction

Typical Mist Knock-Out Drums
Vertical   and   Cross Flow

Vapor Out

Mist Eliminator

Vapor w Mist Feed

Liquid Out

RASCHIG

Raschig USA Inc. ®

INTRODUCTION

Raschig USA XMIST mist eliminators provide highly efficient performance and economy, resulting from superior engineering, manufacturing, and technical support. Various models are manufactured to span the range of conditions encountered in any process. If the process can accommodate a moderate pressure drop and if there is little possibility of fouling by solids, then a very high surface area mist eliminator can be used. If, on the other hand, pressure drop or fouling is a significant consideration, then an intermediate surface area mist eliminator is appropriate. For extreme liquid loading or for serious solids contamination, a low surface area vane type (chevron, parallel plate) mist eliminator is needed (see Product Bulletin 302).

CONSTRUCTION OF MIST ELIMINATORS

Raschig USA XMIST mist eliminators consist of two components: the knitted wire matrix, referred to as "mesh"; and the framework, referred to as "grids". Grids may be constructed from materials different from the mesh. For example, low-carbon alloy steel (e.g. type304) may be recommended for the grids (which undergo welding). For the mesh, however, ordinary alloy steel (e.g. type 304) is appropriate. Polypropylene mist eliminators may have polypropylene grids or fiberglass reinforced plastic grids.

Mist eliminators typically have six inches of mesh thickness with one-inch thick grids, making an overall thickness of eight inches (20mm). Decades of experience have shown that a six inch mesh thickness provides optimum performance for vertical up-flow operation in hydrocarbon processes. By customer specification, Raschig USA XMIST mist eliminators can also be supplied with four-inch or eight-inch mesh thickness. For air-water systems, experience has shown that four inch thickness polypropylene units provide excellent entrainment control.

Raschig XMIST mist eliminators are fabricated according to stringent specifications to ensure longest possible service life.

MATERIALS OF CONSTRUCTION

Materials of construction are a key consideration for maximizing the service life of the mist eliminator. For a typical wire size of 0.011 inch (280 microns), even a low corrosion rate will quickly deteriorate the mesh.

Raschig USA XMIST mist eliminators are custom manufactured using materials specified by the client. Typical stainless steel, polypropylene and PVDF items are maintained in inventory. Other alloy steels are available by special order; other polymeric materials are also available. Extremely high surface area units using co-knits of stainless steel with either multifilament glass fiber or multifilament PTFE fiber (and others) are available by special order. Raschig engineers are available to provide technical input for material selection by the client.

RASCHIG

Raschig USA Inc. ®

MODEL NUMBERS

Raschig USA XMIST mist eliminators have model numbers based on their mesh density, specific surface area and materials of construction. The ME1 prefix indicates that it is a wire mesh mist eliminator. Parallel plate (vane-type) mist eliminators are designated ME2. A unit popular in air strippers, ME1-04-085-PP/FRP has a mesh bulk density of 4 pounds/ft^3, and a specific surface area of 85 ft^2/ft^3. It is constructed using polypropylene mesh with fiberglass reinforced plastic grids. It's comparable in performance to the ME1-09-085-304/304L stainless steel pad.

Table 1 – Raschig USA XMIST Mist Eliminator Properties

Model	Bulk Mesh Density	Surface Area	Wire Size	Critical Droplet Diameter
	lb$_m$/ft^3 (kg/m^3)	ft^2/ft^3 (m^2/m^3)	Inch (micron)	Micron or micrometer
Stainless Steel				
ME1-05-45	5 (80)	45 (150)	0.011 (280)	10
ME1-09-085	9 (144)	85 (283)	0.011 (280)	6
ME1-12-115	12 (192)	115 (383)	0.011 (280)	5
ME1-09-158	9 (144)	158 (526)	0.006 (152)	4
Polymer Mesh				
ME1-04-085	4 (64)	85 (283)	0.030 x 0.090 (762 x 2286)	6
ME1-04-285	4 (64)	285 (949)	0.012 (305)	2.6

PERFORMANCE

Mist eliminator performance is evaluated on the basis of efficiency, pressure drop, and corrosion resistance. Efficiency is a well-characterized property of a mist eliminator. It is primarily a function of droplet size, wire size, surface area of the mesh, pad thickness and physical properties of the system. Because the efficiency versus droplet size curve is so sharp (see Figures 1 and 2), a good variable to characterize performance is the 'critical' droplet size. Raschig XMIST mist eliminator performance characteristics include a critical droplet size, defined as the diameter at which 99% capture occurs. Droplets larger than the critical diameter will be captured at a rate greater than 99%, droplets smaller than the critical diameter will have a capture efficiency less than 99%. As a 'rule-of-thumb' droplets smaller than one-third the critical diameter will pass through the mist eliminator unimpeded. In terms of an overall removal efficiency the volume of uncaptured liquid may be negligible (or at least tolerable for the process). Table 1 shows the critical droplet diameter for the most popular styles of Raschig USA XMIST mist eliminators .
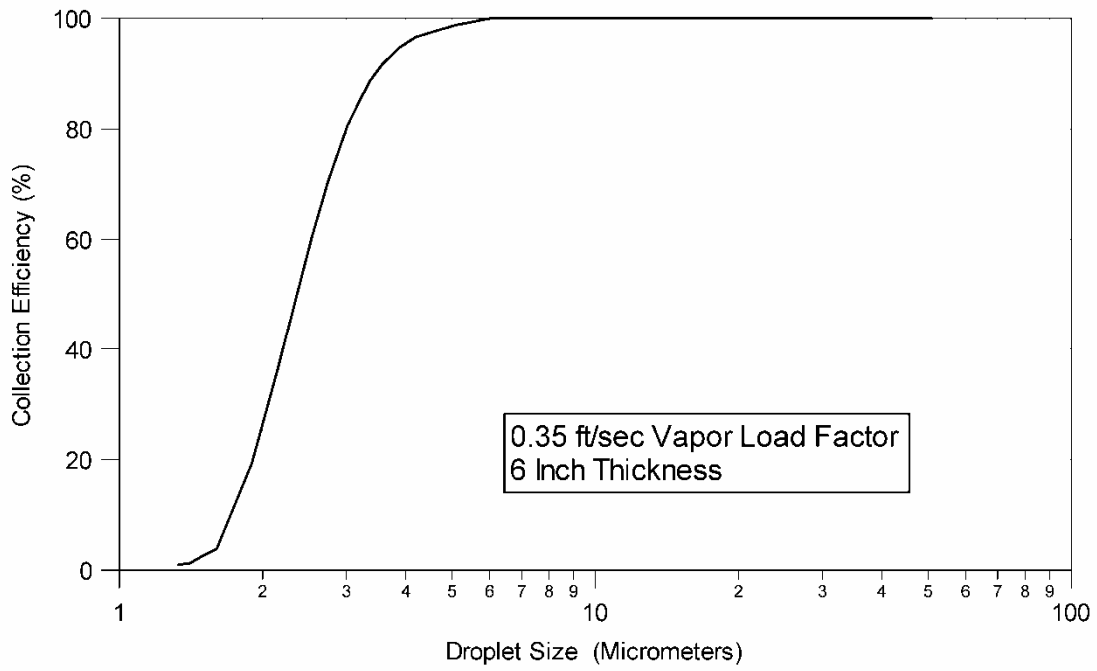
RASCHIG

Raschig USA Inc. ®

EFFICIENCY vs DROPLET SIZE

0.35 ft/sec Vapor Load Factor
6 Inch Thickness

Figure 1: ME1-09-085 / ME1-04-085

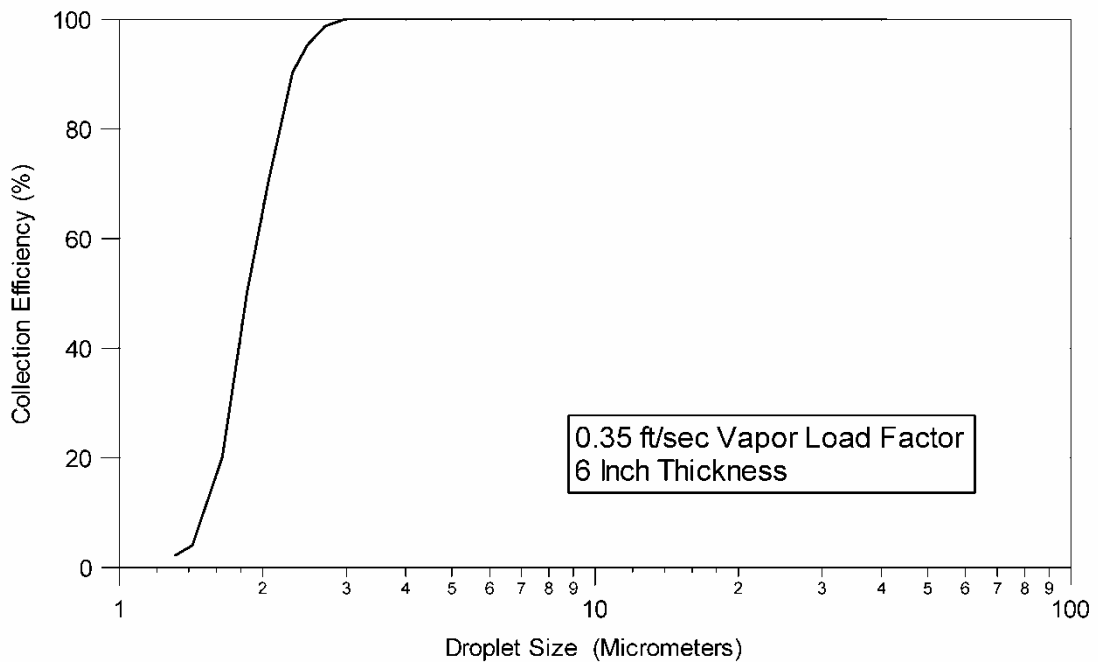0.35 ft/sec Vapor Load Factor
6 Inch Thickness

Figure 2: ME1-04-285

The most common type of mist eliminator is constructed using 0.011 inch diameter stainless steel wire to create a mesh bulk density of 9 pounds/cubic foot (Raschig USA XMIST ME1-09-085). Depending on design, Raschig USA wire mesh mist eliminators have critical droplet diameters between 2 and 20 microns. Parallel plate (vane) units have critical droplet diameters between 20 and 50 microns. Multifilament co-knit units can achieve critical droplet diameters in the submicron range. However these units are prone to fouling.

FOULING

The same mechanism that causes mist eliminators to be effective at capturing liquid droplets also causes them to be effective at capturing solids. Any particle above a critical size, liquid or solid, will intercept a filament of the mist eliminator. Because of surface tension, the droplet or particle will be "captured". Liquids will coalesce and drain downward by gravity. Solid particles, however, generally are trapped on the wet filament. Therefore, fouling becomes the main reason why mist eliminators must be replaced periodically.

Fouling becomes a problem whenever an upstream operation inadequately removes solid particulates. Fouling can also become a problem if an upstream operation requires a high degree of recycle. Whenever fouling is anticipated, the mist eliminator should have differential pressure monitoring.

A spray wash system is sometimes used to counteract fouling. The spray should be directed at the upstream edge of the mist eliminator so as to avoid an artificial overload in liquid holdup. If heavy solids loading is anticipated, a parallel plate (vane type) unit is appropriate (see Product Bulletin 302).

PRESSURE DROP

In general high pressure-drop across a mist eliminator correlates with high efficiency. However there is not necessarily a cause and effect. There is, however, cause and effect for high surface area correlating with high efficiency. Pressure-drop for Raschig USA XMIST mist eliminators varies from less than 1 inch H_2O for low bulk density units up to 10 inches H_2O for extreme efficiency multifilament co-knitted units. In most instances the pressure-drop of a mist eliminator is not a design constraint (see Figures 3 and 4).

MIST GENERATION

'Mist' is a term that refers to droplets less than 10 microns in diameter. 'Spray' refers to droplets larger than 10 microns. Mechanical processes (two-phase contacting, leakage from high-pressure seals, condensation, etc.) typically produce droplets larger than 20 microns. Extremely high shear rates (such as in centrifugal compressors or in machining) however may produce droplets one micron and smaller (submicron). Furthermore chemical processes such as gas phase reactions are also possibly capable of producing submicron droplets.
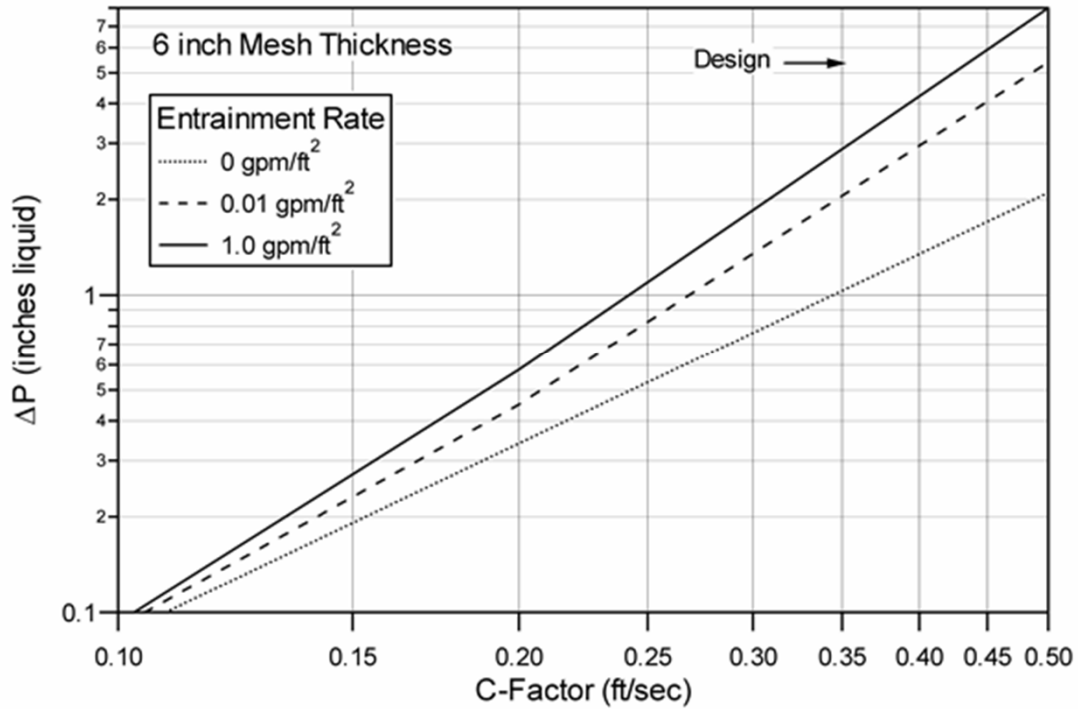
PRESSURE DROP vs VAPOR LOADING

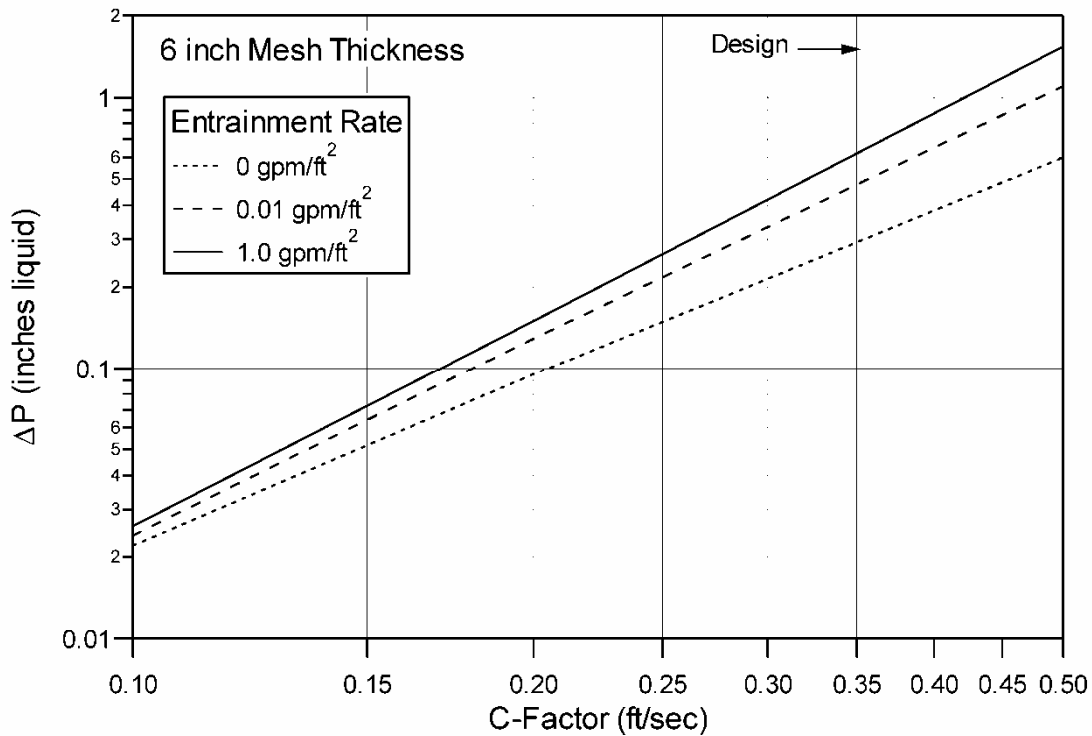**Figure 4: ME1-09-085 / ME1-04-085**

Figure 5: ME1-04-285
(C Factor is defined in the text.)

Droplet size is not uniform. There is a distribution in droplet size about an average or mean. Collisions between droplets causes the mean droplet size to increase. For example, oil mist from high-speed machining has a particle size distribution between 0.1 and 1 micron or larger. A Raschig USA XMIST co-knit mist eliminator will remove essentially all the droplets greater than approximately 0.6 microns but the smaller droplets will pass. Another example is an air stripper column; most of the droplets produced in such a unit are larger than 20 microns. Therefore a Raschig USA XMIST ME1-04-085 mist eliminator will remove more than 99.99% of the entrained liquid (provided the correct operating ranges of vapor rate and liquid load are maintained).

PROCESS SYSTEM PHYSICAL PROPERTIES

Fluid mechanical properties of two-phase process systems operating in gravity conditions are primarily determined by density difference and by interfacial or surface tension. Process systems having viscosities less than 10 centipoise are often analyzed as 'inviscid' systems. This means that viscosity effects are ignored. For mist elimination problems viscosity effects can generally be ignored. Vapor density, liquid density and interfacial tension are the critical physical properties.

Interfacial tension represents the energy necessary to create a unit area of liquid surface. The units of interfacial tension are dynes per centimeter (ergs per square centimeter). Water/air systems have an interfacial tension (interfacial free energy) of approximately 27 dyne/cm (erg/cm^2). This is a relatively high interfacial tension for vapor liquid systems, consequently, droplet size is relatively large (spray regime). If there are surface active contaminants (such as detergents) the interfacial tension may be decreased considerably. This results in smaller droplet sizes. In hydrocarbon distillation processes interfacial tension is typically 0.1-5 dyne/cm. Fine mists however are not generally a problem except in vacuum distillation. Although interfacial tension dramatically affects droplet coalescence and liquid drainage its magnitude is not usually considered directly in the selection of mist eliminators.
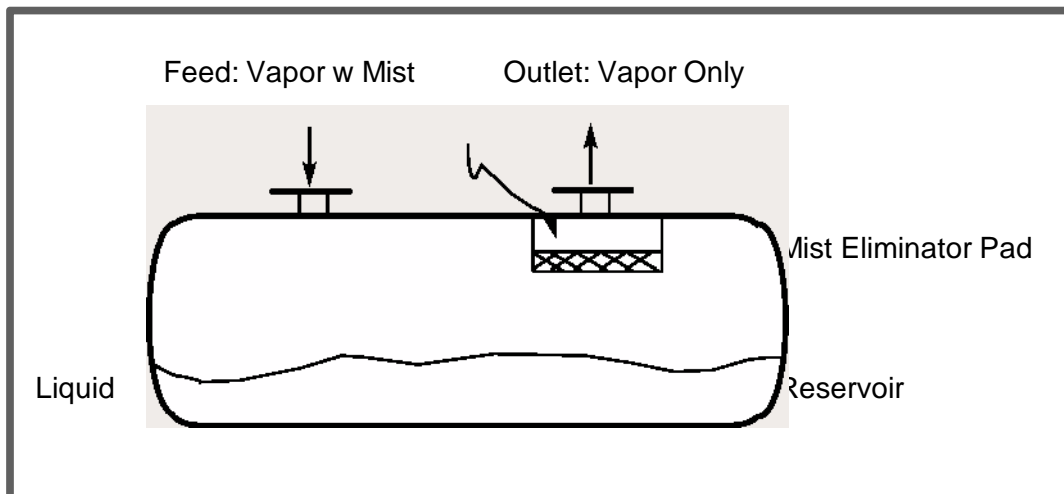
Vapor and liquid density determine inertial, gravity and buoyancy effects in two-phase systems. Consequently, system loading is expressed as a volumetric flux (flow per unit area or superficial velocity) multiplied times the square root of the vapor density and divided by the square root of the density difference between the phases. This variable is referred to variously, including "C-factor" and Souders-Brown velocity. C-factor expresses the vapor flux for a two-phase system that is independent of the system. Vapor flux in an air-water system is mechanically similar to that in a hexane liquid-vapor system as long as the C-factors are equal. C-factor is, therefore, used as the design parameter for mist eliminators.

$$\text{C-Factor} = Q/A * [(\rho_V)/(\rho_L - \rho_V)]^{1/2}$$

where

Q = Volumetric Flow Rate, ft^3/sec

A = Cross-Sectional Area for Flow, ft^2

ρ_L and ρ_V = Density of Liquid and Vapor, lbs/ft^3

INSTALLATION

Mist eliminators are manufactured in sections so that they may be installed or removed through manways. Each section is constructed oversize to ensure a compression fit and, therefore, no vapor bypass. Care must be exercised in the installation to prevent warping the grids or deforming the mesh. The sections must be secured firmly to the support ring and cross beams. Raschig USA (formerly Raschig / Jaeger Technologies, formerly Jaeger Products) application specialists should be consulted for installation recommendations. Properly selected and installed Raschig USA XMIST mist eliminators will provide excellent entrainment separation and long service life.

RASCHIG

Raschig USA Inc. ®

MIST ELIMINATOR SIZING

Mist eliminators are generally sized based on a C-factor of 0.35 ft/sec (0.11m/sec) for vertical up-flow or 0.5 ft/sec (0.15 m/sec) for horizontal flow. In horizontal flow, liquid drains faster from the pad because drag effects are at right angles (cross-current) rather than opposite to the vapor flow (counter-current). The resulting better drainage allows a higher vapor load.

For fractionation systems, such as distillation or stripping, the C-factor based on column cross-section is generally less than 0.30 ft/sec (0.11m/sec). A mist eliminator operating at these conditions is not at risk of flooding, even at liquid entrainment rates approaching 8gpm/ft^2 (0.05 m^3/sec-m^2). For entrainment rates above 1gpm/ft^2, the design C-factor should be diminished by 3%/gpm/ft^2. If entrainment is anticipated beyond 8 gpm/ft^2 (0.05 m^3/sec-m^2), a parallel plate (vane type) mist eliminator should be used (see Product Bulletin 302).

Mist eliminator efficiency decreases with decreasing vapor flux. For this reason fractionating columns operating a low C-factor of 0.13 ft/sec (0.04 m/sec) or lower) often have a mist eliminator smaller than the column diameter or else employ blanking baffles to increase vapor flux.

Superficial velocities observed in air-water tests are not appropriate for other systems. Vacuum systems can tolerate high superficial velocities because buoyancy effects and drag effects (upward forces) are small relative to gravity effects (downward force). In high pressure systems, on the other hand, superficial velocities must be lower because buoyancy effects and drag effects are large relative to gravity effects.

Minimum mist eliminator area is calculated by:
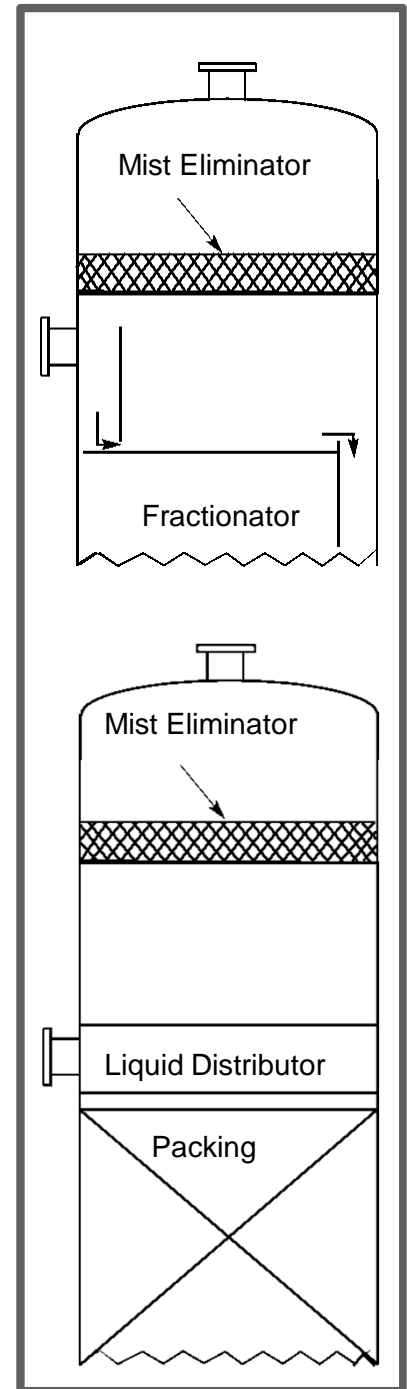
$$A_{min} = Q/0.35 * [(\rho_V)/(\rho_L - \rho_V)]^{1/2}$$

where

Q = Volumetric Flow Rate, ft^3/sec
A = Cross-Sectional Area for Flow, ft^2
ρ_L and ρ_V = Density of Liquid and Vapor, lbs/ft^3

for vertical up-flow.

RASCHIG

Raschig USA Inc.®

APPLICATION CHECKLIST

❏ Process engineering input concerning the droplet size distribution could help in selecting a mist eliminator.

❏ At process conditions producing a C-factor of 0.35 ft/sec for vertical up-flow, a wire mesh mist eliminator will be operating at 70% to 80% of flood, depending on liquid entrainment rate. A design C-factor 0f 0.35 ft/sec is therefore recommended for most situations.

❏ For horizontal flow, a design C-factor of 0.5 ft/sec may be used.

❏ Turn-down of a wire mesh mist eliminator permits adequate vertical up-flow operation between 0.12 ft/sec and 0.4 ft/sec, at entrainment rates between zero and 1 gpm/ft^2.

❏ Between 1 and 8 gpm/ft^2 wire mesh mist eliminators should be de-rated at 3%/gpm/ft^2 (i.e. use a smaller C-factor).

❏ For entrainment rates beyond 8 gpm/ft^2, parallel plate (vane or chevron) mist eliminators should be used.

❏ Re-entrainment (flooding) generally occurs at a pressure drop of 2 - 3 inches of water column for typical wire mesh mist eliminators 6 inches in thickness. This represents the approximate steady-state condition for upward forces and downward forces on the liquid attached to the wire filaments.

❏ If solids are present (dissolved or suspended) consider the application of a spray wash system in co-current flow with the vapor.

❏ Solids could also indicate the use of a parallel plate type mist eliminator.

❏ If plugging or fouling is anticipated, differential pressure measurement may be appropriate.

❏ Diligence in the anticipation of corrosion effects can have a major effect on the cost of entrainment control. Chlorides, pH and temperature are key corrosion considerations.

❏ Flow channeling (uneven vapor distribution) can cause diminished efficiency or local flooding in the mist eliminator. Consult Jaeger applications engineers for guidance concerning these problems.

❏ Raschig USA applications engineers can provide assistance to determine if blanking strips or baffles are needed.

Raschig USA Inc. ®

For more information and design assistance, please contact us at:

Raschig USA, Inc.
Formerly Raschig Jaeger Technologies
2201 E. Lamar Blvd. #240
Arlington, TX 76006
800-678-0345
817-695-5680
info@raschig-usa.com