Fiberbeds 101

What They Are…..

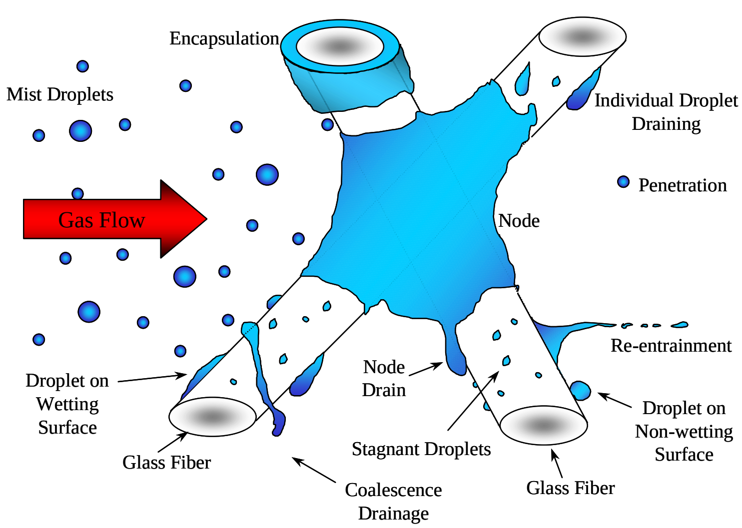
Brink mist eliminators and systems are designed to remove and collect virtually any liquid mist from any gas. Soluble solids can also be removed with Brink systems by intermittently or continuously irrigating the fiber bed with an aqueous solution. As long as collected particles can be made to drain from the fiber bed, a Brink mist eliminator will work. (Brink mist eliminators are in service collecting liquids with viscosities as high as 5000 centipoise).

Dr. Joe Brink inspecting Fiberbed Elements

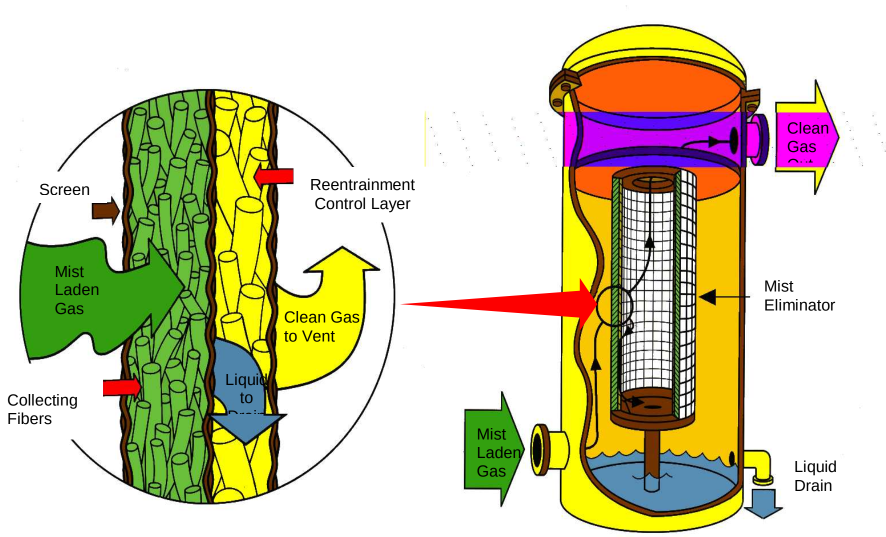
The first generation high efficiency diffusion fiberbed was developed by Dr. Joe Brink in the 1950's. A diffusion fiberbed is basically a construction of concentric wire mesh screens filled in-between with fine fiber media. The fiberbed is able to achieve high efficiencies ranging from 90 to 99.9+% depending upon choice of pack and nature of the application. In the case of strong sulfuric acid applications, chemically resistant glass fiber is used as the collecting media.

Regardless of the geometric shape or particular type or series, all Brink mist eliminators basically consist of a bed of fine fiber collecting media secured between two concentric cylindrical screens or between two parallel flat screens. Chemically resistant glass fibers, synthetic fibers and other special type fibers are used as the packing material, depending on the process environment. Structural cage parts and flanges are made of any wrought weldable metal, plastic or glass reinforced resins.

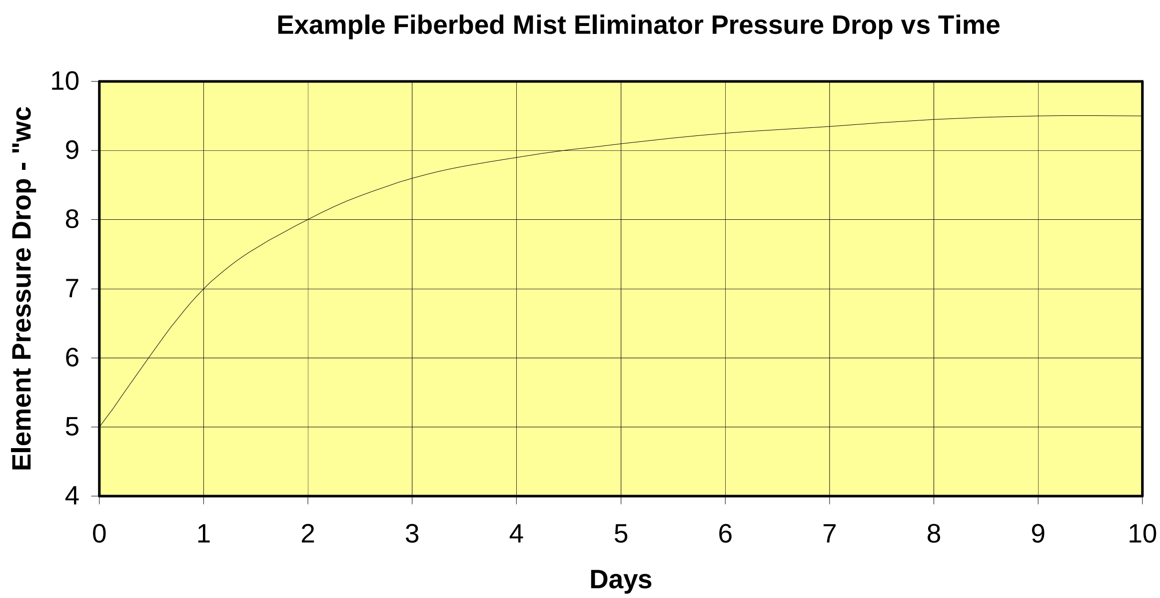
Most all Brink mist eliminators operate in a similar manner. Gases containing mist and spray particles pass in a horizontal direction through the fiber bed. Clean gases emerge from the bed on the downstream side and rise upward to exit from the system. The liquid particles (mist and spray) are collected on the fibers in the bed (shown below) and coalesce into liquid films and large droplets which are moved horizontally through the fiber bed by the drag force of the gas and then downward by gravity as the liquid discharges from the collecting media. The collected liquid drains off the downstream face of the fiber bed and out through the drain legs.



If a bi-component fiber bed type is used, a special drainage control layer is utilized on the downstream side of the collecting fibers to eliminate reentrainment (shown below). If elements are installed in a separate tank or vessel, the drain legs are immersed below a liquid level in the bottom of the tank to maintain a liquid seal. If the Brink elements are suspended in the top of an absorbing tower, the drain legs are fitted with individual seal cups to maintain a liquid level.



The figure below is an example how element pressure differential increases over time as a fiber bed collects mist and reaches saturation. The actual time required reach to equilibrium saturation is a function of bed design, bed velocity, inlet mist loading and mist properties.

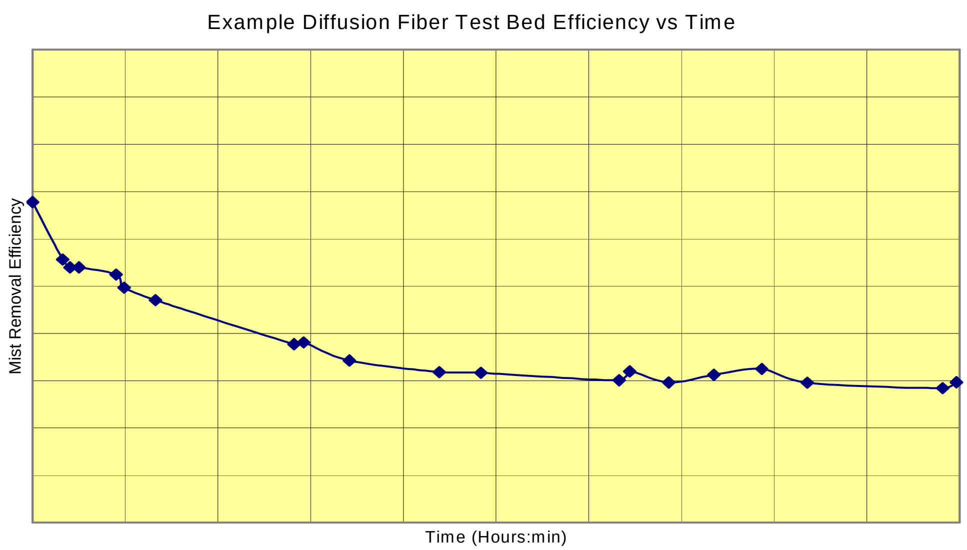


A fiberbed mist eliminator goes through four stages in the coalescence process when it is introduced into mist laden process gas:

1) Start-Up stage,
2) Loading Stage,
3) Unsteady coalescence stage &
4) Steady state coalescence stage.

Start-up is the period where the element saturation is negligible with no rise in pressure drop or change in collection efficiency. The loading stage is where element pressure drop rises and collection efficiency begins to change however no liquid drains from the media. The unsteady state coalescence stage is similar to the loading stage except collected liquid begins to drain from the bed while it is still accumulating in the media. Finally, steady state coalescence is when element drain is constant with no further liquid accumulation in the media and operating pressure drop and efficiency are constant. Steady state wetted pressure drop is essentially linear with gas velocity.

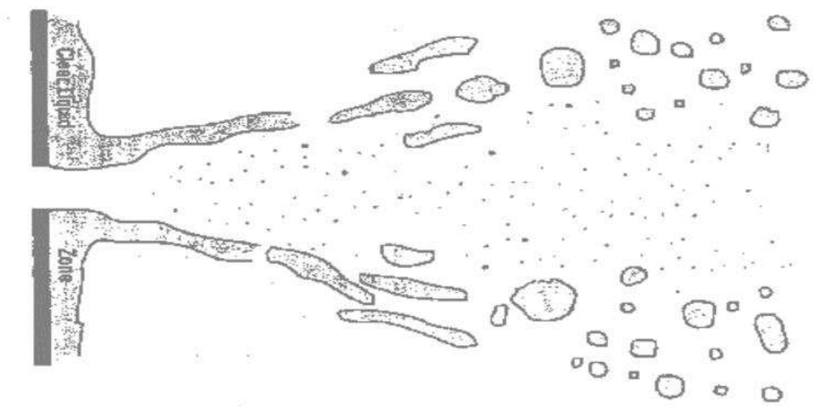
Steady state element pressure drop is important because it is represents expended energy in the process. The lowest operating pressure drop possible is desirable to minimize operating cost. Accurately predicting equilibrium element pressure drop is experiential. MECS experience with thousands of mist eliminator installations world-wide helps assure a properly designed mist eliminator installation with predictable performance.



One misconception about diffusion fiber beds is they “must be loaded” to operate properly. This is not exactly true. Diffusion fiber beds typically operate in the regime where bed velocity is less than 50 cm/sec and pressure ratio is less than five. In this regime as an element becomes saturated with liquid, collection efficiency actually decreases for submicron size particles while collection efficiency increases for micron size and larger particles.

The example above is a test element collecting a submicron mist. Notice as the bed reaches saturation, collection efficiency on small particles decreases. Thus it is important to understand how collection efficiency changes as a fiber bed becomes saturated. In properly designed installations, the MECS quoted or rated efficiency is the wetted efficiency at steady state saturation conditions.

Mist Eliminator Entrainment Control



Entrainment Example

One constraint with all mist eliminator operation is the potential to form entrainment on gas discharge surface as shown above. On a “macro” scale, entrainment is generated at high gas velocity and mist loading conditions. On a “micro” scale, entrainment can also be formed when localized flooding of the fiber bed occurs e.g., high concentrated spray in one location e.g., due to a process anomaly.

Often entrainment is called reentrainment since this refers to mist that has been previously captured, coalesced and then “reentrained” into the process gas. As gas velocity or liquid loading increase, portions of the bed where gas discharges can become flooded as shown above. This causes reentrainment typically in the form of large particles called “carry-over”. This is undesirable in corrosive applications where downstream equipment protection is critical. In this case reentrainment can significantly increase measured exit mass loading. As a result, an improved bi-component diffusion fiber bed was developed to eliminate entrainment.

The drainage layer suppresses entrainment generation since it is made of larger fibers and lower packing density resulting in less capillary forces. Consequently with the drainage layer, there is no significant bubble or film formation of the collected liquid as it drains vertically by gravity in the mist eliminator near the surface where gas discharges.