NEXT GENERATION MIST ELIMINATOR SELECTION IN SULFURIC ACID PLANT DRYING AND ABSORPTION TOWERS

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Abstract

There has never been a wider variety of alternatives to choose from to solve the mist elimination challenges that exist in the sulfuric acid drying and absorption towers. The specific needs of each plant depend on the type of plant and the priorities of its technical and operations management.

The principal types of mist eliminators employed to date have been the knitted wire mesh pad, the impaction-type candle, and the Brownian Diffusion-type candle. This paper discusses the benefits and limitations of each type to assist managers in making informed decisions about the best technology for their specific needs. It also compares the installation, maintenance, and operating costs that should be anticipated for the various options.

Also introduced are three new product developments that offer significant improvements over current technology:

- Newly introduced DEMISTER® style 713 knitted wire mesh mist eliminator provides increased efficiency with low pressure drop in drying towers.
- Newly introduced FLEXIFIBER® BD-LdP Brownian Diffusion candle mist eliminator provides reduced pressure drop with no loss in efficiency in absorber towers.
- Newly introduced FLEXIFIBER® ICK-LF impaction candle mist eliminator provides increased service life with no loss in efficiency in drying and final absorber towers.

Background

Sulfuric acid tower mist elimination selection starts with an understanding of the causes of mist and the downstream problems it may create.

Causes of Sulfuric Acid Mist

Sulfuric acid mist in sulfuric acid plant towers can be formed by three methods.

- **Method 1: Mechanical –** The mechanical shearing of drops as acid discharges from liquid distributors and entrains off the surface of the tower packing results in mist spray that ranges from 2 microns to greater than 1000 microns diameter, although some amount of smaller droplets will occur due to droplet shattering. This type of mist will occur regardless of the type of plant. In mist eliminator terms, droplets larger than 10 microns diameter are considered large, easy-to-remove entrainment.

- **Method 2: Reaction –** When both SO_3 and H_2O exist in the vapor phase, the two gases can react to form sulfuric acid. These droplets are always formed as sub-micron fog, although some small drops will agglomerate to larger droplets as they flow through the process. In mist eliminator terms, the drops created by this process are considered small and difficult-to-remove entrainment.

- **Method 3: Condensation –** The vapor-liquid equilibrium of sulfuric acid always results in some vapor phase sulfuric acid. The amount of acid in the vapor phase is reported to be insignificant at temperatures below approximately 300° to 350° F (150° to 175° C)[(1)]. Whenever vapor phase acid is present and the gas is cooled below its dew point, acid condensation will occur. When condensation occurs directly on surfaces cooler than the gas (such as wetted packing, heat exchangers and duct walls), the condensed acid collects on the surface. If the gas velocity is high enough, it may be re-entrained as large (>10 micron diameter) easy-to-remove droplets. However, when the gas is cooled rapidly, acid condensation occurs in the vapor phase away from these cooler surfaces, which creates sub-micron sulfuric acid fogs. Again, some coalescing into larger drops can be expected, but the continued presence of the sub-micron droplets make this entrainment difficult to remove.

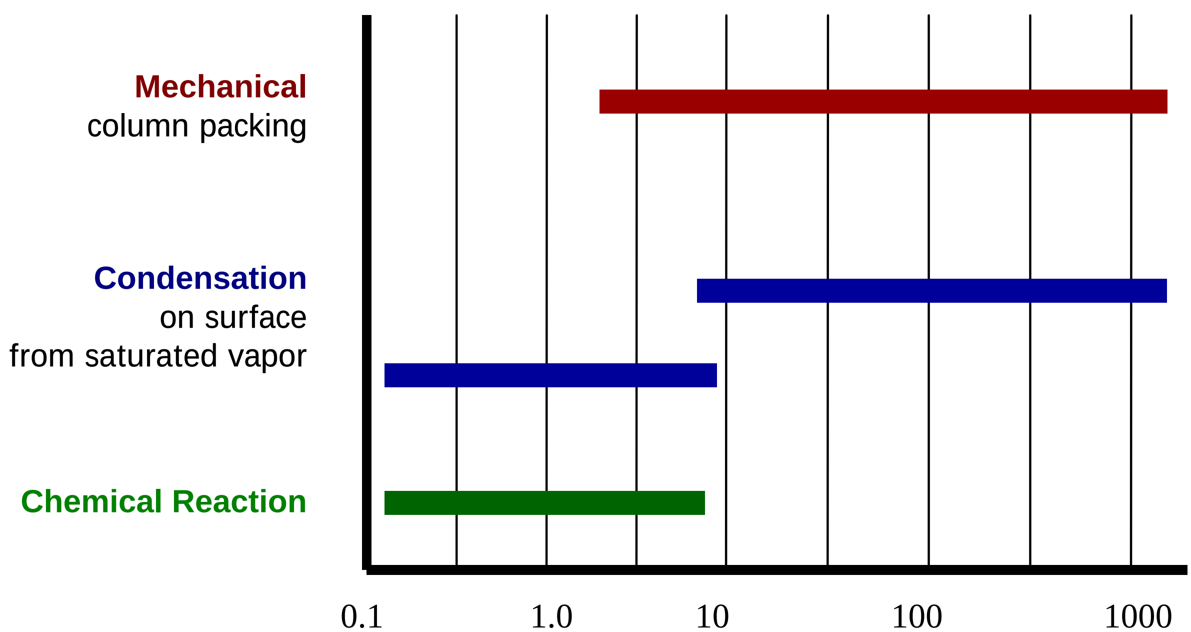


Figure 1 - Particle Size

[1]Duros, D. R. & Kennedy, E. D., CEP, September 1978, pages 70 – 78.

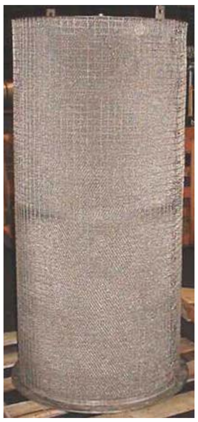
Types of Equipment Commonly Considered

In current day sulfuric acid plants, most towers include one of the following types of mist eliminators.

Table 1 – Mist Eliminator Types and Common Materials of Construction

Type of Mist Eliminator	Common Materials
Traditional, all-metal DEMISTER® knitted wire mesh mist eliminator	Alloy 20 or Alloy 66 materials
Traditional all-plastic DEMISTER® knitted wire mesh mist eliminator	FEP (Teflon®) or ECTFE (Halar®) materials
High efficiency co-knit DEMISTER® knitted wire mesh mist eliminator	Combination of the above metal or plastic, interwoven with PTFE (Teflon®) or glass fiber
High efficiency FLEXIFIBER® impaction elements*	316L or Alloy 20 knitted mesh with PTFE (Teflon®) or glass fiber
High efficiency FLEXIFIBER® Brownian Diffusion elements	316L or Alloy 20 screens with glass fiber
* These are most commonly cylindrical designs, often 30” (762 mm) OD by 66” (1676 mm) tall. Occasionally flat panel impaction elements are still used in drying towers as well.	

DEMISTER® Mist Eliminators



FLEXIFIBER® Mist Eliminator

FLEXIFIBER® Type BD Mist Eliminator

Research and Development at Koch-Glitsch, LP

Koch-Glitsch, LP maintains a fully equipped mist elimination research and development facility at its headquarters in Wichita, Kansas. These towers are shown in the photo below and include towers specifically designed for experiments on both mesh pad and fiberbed type mist eliminators. Also available are state-of-the-art analytical facilities including laser-based Phase Doppler Particle Analyzer (PDPA) to measure mist elimination efficiency. The newly introduced DEMISTER® style 713 knitted wire mesh mist eliminator and FLEXIFIBER®

BD-LdP candle mist eliminator designs presented in this paper came directly from experiments in this R&D facility.

These two test towers are devoted to the research and development of new mist eliminator designs. The latest FLEXIFIBER BD-LdP low pressure drop designs came from test work performed in these towers.

Mist Elimination Selection Criteria

The following broad areas form a basis for the decision process to select the appropriate mist elimination equipment.

- Plant Type
- Efficiency
- Operating Cost
- Safety
- Capacity
- Service life
- Initial and Replacement Costs

Sulfuric Acid Plant Type

Depending on the type of sulfuric acid plant, mist entrainment in the towers is caused to varying degrees by any of the three methods described on pages 1 and 2. The following sections describe the three types of sulfuric acid plants and the methods that create the mist entrainment for the type of plant.

Elemental Sulfur

These plants produce acid by burning elemental sulfur in a furnace downstream of the drying tower. Outside air at ambient temperature is pulled into the drying tower with a blower. When the blower is located before the drying tower, it typically increases the air temperature entering the drying tower by about 100° F (40° C). With temperatures in these ranges (less than 200° F (95° C)), the mist generated in the tower is created almost entirely by Method 1 above, which means that most entrainment is greater than 2 to 3 microns diameter.

Plants that give priority to maximizing waste heat recovery may preheat the air in the drying tower by increasing the acid feed temperature. This will increase the sulfuric acid in the gas phase. When the air is cooled below its dew point, fine sulfuric acid mist will condense by Method 3.

Any sulfuric acid or water molecules contained in the gas downstream of the drying tower will lead to generation of sub-micron mist in the absorber towers. Sulfuric acid entrainment from the drying tower is vaporized in the sulfur burner and recondenses (Method 3) as the gas cools in the intermediate absorbing tower. Poorly designed or maintained acid distributors, and corroded or fouled drying tower mist eliminators, are common sources of excessive entrainment. Therefore, mist loading in the intermediate absorber is significantly influenced by the drying tower mist eliminator.

In addition, poor air drying performance of the drying tower, small leaks in the heat exchanger tubes, and organics entering the process with the elemental sulfur can also be potential sources of water molecules. These sources lead to very small mist (Method 2) in the intermediate absorber.

Similar entrainment sources cause fine entrainment in the final absorbing tower, but sub-micron droplet loading for common acid plants is normally much lower than exists in the intermediate absorber.

Oleum production, when present, significantly increases the acid entrainment loading and reduces the droplet size. Nitrogen compounds, commonly from poor sulfur burner operation or nitrogen compounds in the acid feed, are another cause of high loadings of sub-micron mist.

Metallurgical Ore Roasting

A second common sulfuric acid plant design processes off-gases generated during roasting of metal-sulfide ores, such as copper, nickel, molybdenum, lead, zinc and gold. SO_2 in the furnace off-gas is at temperatures high enough to partially convert to SO_3. The gas also contains substantial solid particulates. Gas cleaning systems located after the furnace are designed to scrub both the solid particulate and the SO_3, but some H_2SO_4 may escape this scrubbing system. As a result, the mist in metallurgical drying towers often includes some sub-micron mist formed by Methods 2 and 3 above, depending on the gas cleaning system performance, in addition to the larger droplets created by Method 1.

Plant upsets sufficient to overload these dust-scrubbing systems can and will occur. In this type of plant, the drying tower mist eliminators must also be designed with careful consideration to handling significant solids loading. The tradeoff between the efficiency demands and the fouling concerns need to be weighed during the mist elimination selection process.

The absorbing tower mist eliminators must deal with acid entrainment caused by sources similar to those in a sulfur burning plant (except no sulfur is burned, eliminating the possibility of water vapor from this source). Because the drying tower mist eliminators must deal with a much smaller droplet size distribution than in a sulfur burning plant and must also be selected to deal with solids fouling, the amount of acid carryover downstream is usually much higher. This leads to higher sub-micron entrainment caused by methods 2 and 3 in both the intermediate and final absorbing towers.

Spent Acid Regeneration

The third plant design regenerates spent sulfuric acid, commonly from oil refining (alkylation) or chemical manufacturing (methyl methacrylate and explosives). This spent acid has commonly been diluted and often contains significant amounts of organics. The spent acid is burned in a furnace located upstream of the drying tower, primarily producing SO_2 and some SO_3. Following quenching, the gas enters the drying tower and may include sub-micron acid mist, which was generated by Methods 2 and 3, and larger mist droplets created by Method 1.

The intermediate absorbing tower mist eliminator loadings are again established by factors similar to the above plant designs. In many cases high performance mist eliminators are used in the drying tower to minimize the sub-micron entrainment reaching the absorbers.

Mechanisms of Mist Removal

Mist eliminators separate droplets from the gas stream by one or more of three mechanisms.

- **Inertial Impaction** – As the gas approaches the mist elimination target, the gas streamlines spread out and flow around the target. Depending on the gas velocity and the physical properties of the gas and liquid, droplets larger than a certain size will leave the gas streamline due to their inertia and impact on the target. In sulfuric acid plants, droplets larger than 5 to 10 microns diameter are removed from the gas stream by this mechanism. Efficiency of this mechanism increases as either the velocity increases and/or the target diameters decrease.

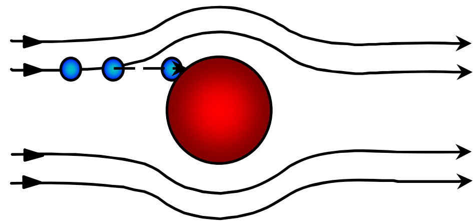


Figure 2 - Inertial Impaction

- **Direct Interception** – Smaller droplets continue to follow the gas streamlines because of their lower inertia. If these droplets pass close enough to touch the target, they will be collected. In sulfuric acid plants, droplets 5 to 10 microns diameter and some smaller than 1 micron diameter can be collected by this means depending on the mist eliminator design. Smaller targets and more targets increase the efficiency of this collection mechanism.

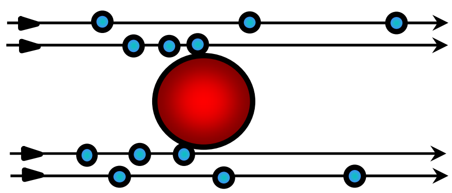


Figure 3 - Direct Interception

- **Brownian Diffusion** – Droplets well below 1 micron diameter cannot be collected efficiently by either of the above two mechanisms. However, because of their low mass, these droplets exhibit random Brownian motion caused by collisions with gas molecules. This random motion increases the probability that these droplets will collide with the targets. More targets, smaller targets and more residence time (lower velocity) increase removal efficiency from Brownian diffusion.

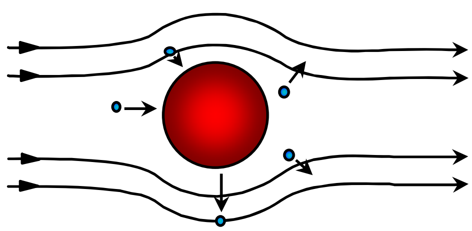


Figure 4 - Brownian Diffusion

Efficient removal of mist in the mist eliminator by the above mechanisms is important to protect downstream equipment. Any mist carried downstream from the tower can create significant potential for operating and maintenance problems.

- **Corrosion** – Depending on the plant configuration, ducts and blowers are all susceptible to damage from acid mist carried out of the tower. In particular, acid entrained into heat exchangers can cause severe corrosion downstream of the drying and intermediate absorbing towers.
- **Emissions** – Acid entrained from the final absorbing tower goes to the atmosphere. Performance of mist eliminators in all three towers contributes to achieving the necessary efficiency to meet environmental expectations.
- **Blower Damage** – When located downstream of the drying tower, the corrosion and erosion that the acid causes on the rotating fan blades can result in out-of-balance problems that require expensive downtime and repair costs.

Drying Tower

Figure 5 provides typical efficiency vs. particle size comparison for the mist elimination equipment designs commonly used in drying towers. All commonly considered designs remove essentially 100% of the entrainment larger than 5 microns diameter, and the most efficient designs remove significant percentages of droplets below 1 micron diameter. Many plant operators recognize the advantages of high performance separation, and this is their primary mist eliminator selection priority.

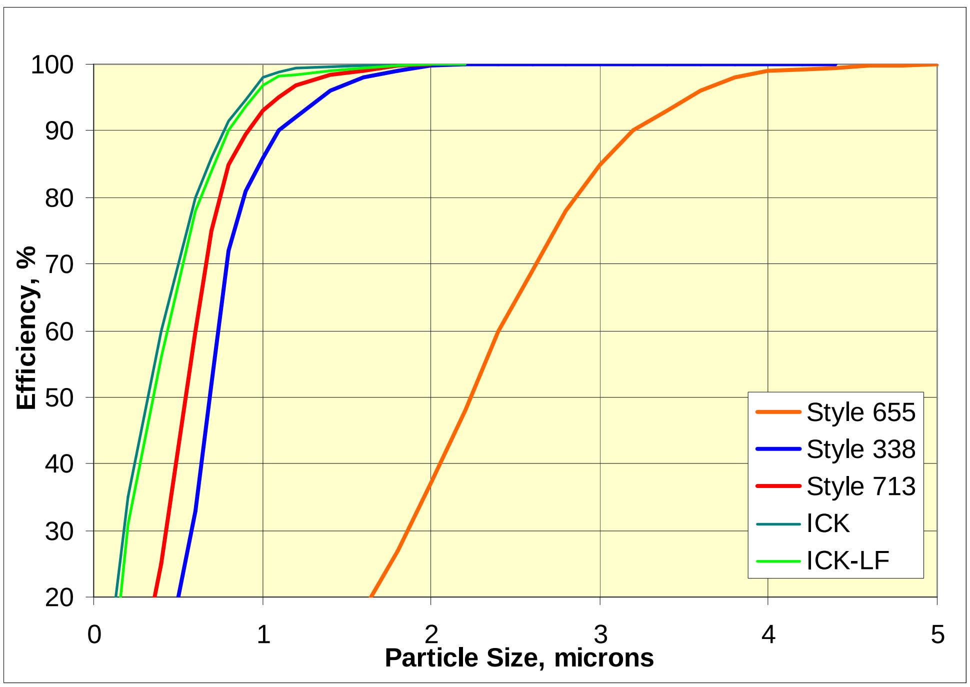


Figure 5 – Efficiency vs. Particle Size

Intermediate and Final Absorption Towers

Figure 6 shows typical efficiencies for a standard design Brownian Diffusion fiberbed mist eliminator (baseline curve) compared with the recently developed FLEXIFIBER BD-LdP mist eliminators. Compared to the conventional design, the FLEXIFIBER BD-LdP mist eliminators have a high efficiency and at the same time have a significantly lower pressure drop as shown in Figure 7. This results in a reduction in operating costs which is covered in more detail below.

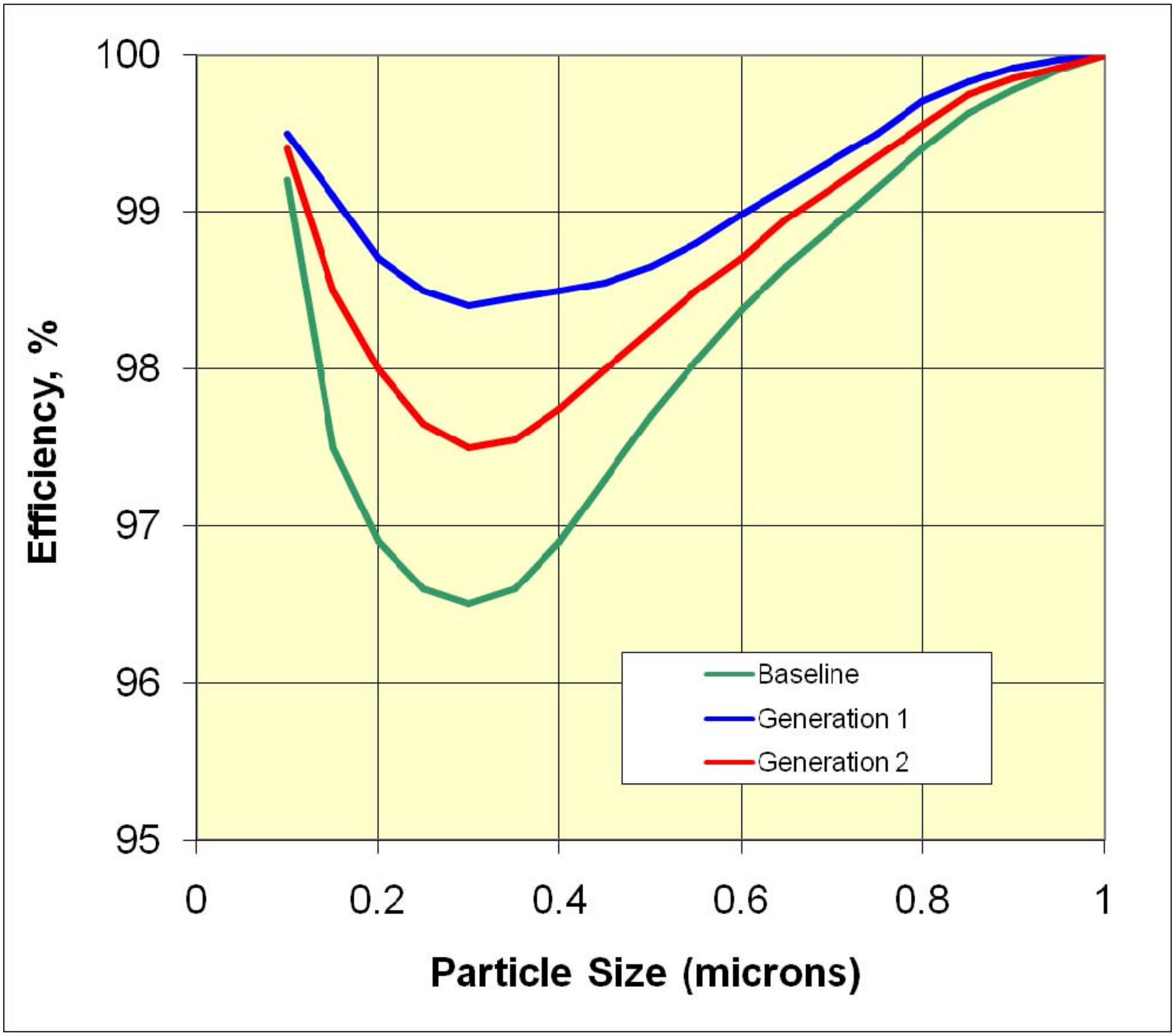


Figure 6. Efficiency vs. Particle Size. Intermediate and Final Absorption Towers

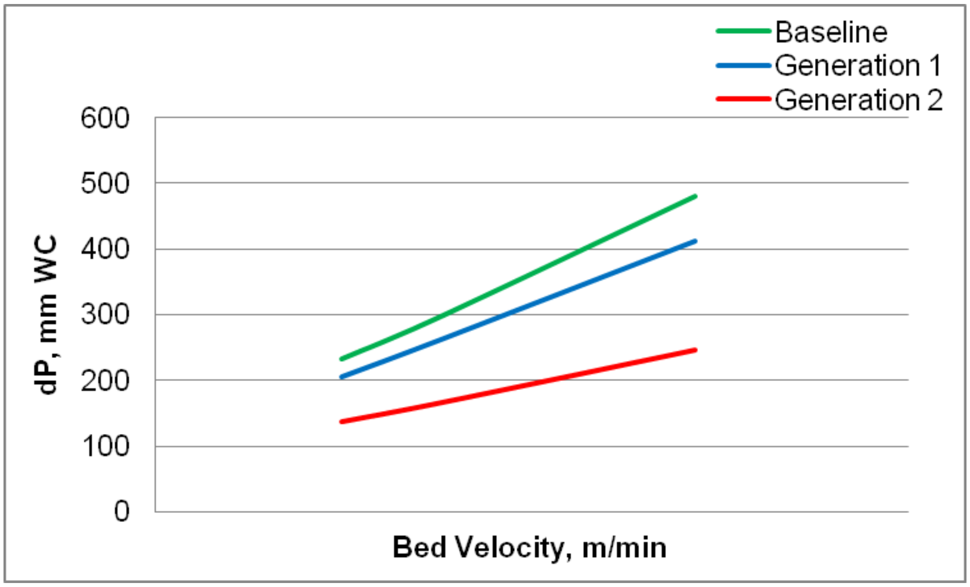


Figure 7. Pressure Drop. Baseline +Generations 1 and 2

Operating Costs

The primary operating cost consideration for mist elimination equipment is its pressure drop. Table 2 provides the clean pressure drops typical for commonly used equipment at the equipment's design capacity. Contrary to what you would expect, higher efficiency does not always require higher clean operating pressure drop.

Table 2 – Mist Eliminator Types and Clean Pressure Drop

Product	Koch-Glitsch Style	Clean Pressure Drop	
		In. WC	mm WC
Traditional, all metal mesh	655	0.6	15
Traditional, all plastic mesh	255	0.65	17
High Efficiency, metal mesh	338	2.9	75
High Efficiency, plastic mesh	339	3.0	76
Highest Efficiency, metal mesh	713	2.9	75
Impaction Candle	ICK	2.75	70
Impaction Candle – Low Fouling	ICK-LF	1.5	37
Brownian Diffusion Candle	BD	10	250
Brownian Diffusion Candle – Low Pressure Drop	Bd-LdP	8	200

Figure 8 shows the impact on operating costs of lower pressure drop for a typical 1500 TPD sulfuric acid plant as a function of power cost. Figure 9 shows additional product possible from pressure drop.

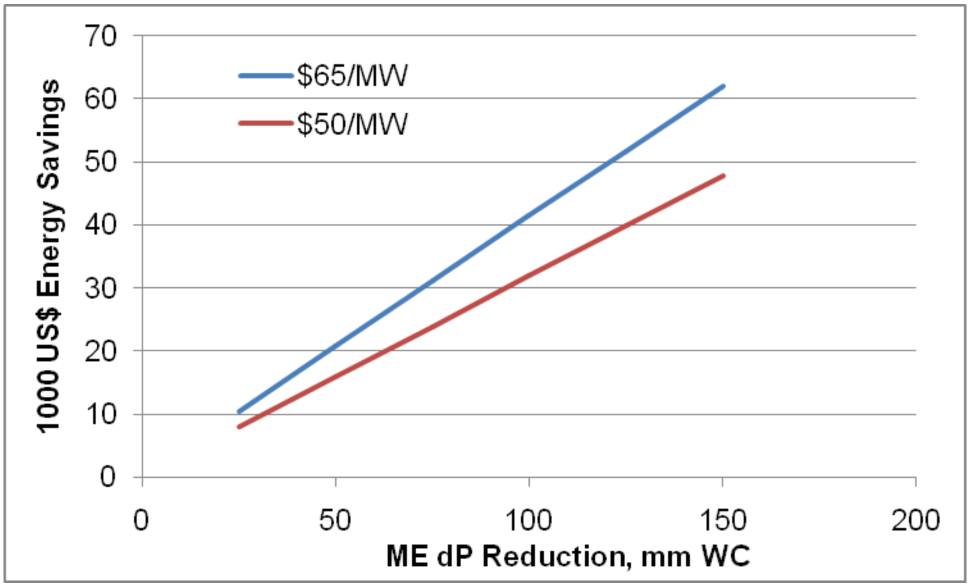


Figure 8. Estimated Energy Savings / mm W.C. Reduction in 1,500 TPD Acid Plant

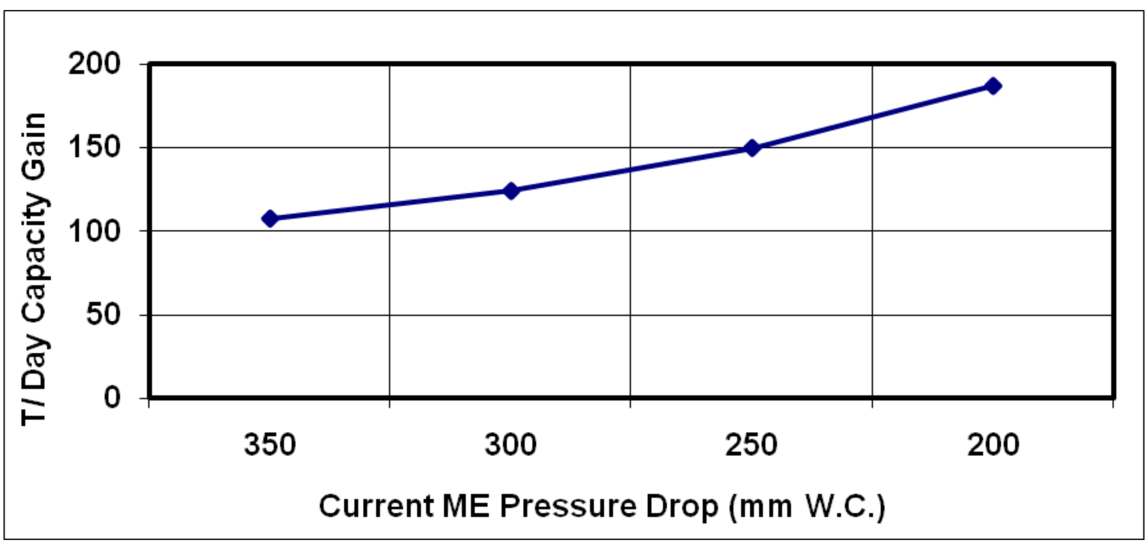


Figure 9. Theoretical Production Increase for Each 25 mm W.C. Decrease in 1,500 TPD Plant

Because mist eliminators can also be very good filters, another factor to consider regarding pressure drop is the potential for increases due to fouling during the operating life of the mist eliminator. The rate of pressure drop increase depends significantly on both the type of acid plant (sulfur burning, metallurgical or spent acid) and the type of mist elimination equipment selected.

Corrosion products (iron sulfate) are always present in every drying tower and usually in significant quantities. Dust carried by the incoming gas is always present to varying degrees.

- In sulfur burning and spent acid plants, the incoming outside air is commonly pre-filtered to remove excessive dust, but this filtration is never completely effective, and the drying tower mist eliminator is the common location where this material eventually accumulates.
- In metallurgical plants, dust carried out of the roasting operations can also be significant, and the dust loading in the drying tower is very dependent on the quality of the gas cleaning system. In some cases, solids loading from this source can be quite severe, and this has become a challenging operating problem requiring special consideration. Malfunctions in the gas cleaning system and roasting plant upsets have both been known to plug drying tower mist eliminators in a matter of hours.
- In spent acid regeneration plants, depending on feed quality, coke solids in significant quantities can find their way to the drying tower mist eliminators.

Except in the most severe cases, knitted wire mist eliminators (such as DEMISTER® mist eliminators from Koch-Otto York) withstand the solids from these sources with little pressure drop buildup over the commonly targeted 24 to 30-month plant operating cycles. The higher performance mesh styles (YORKMESH™ styles 338 and 339) were developed specifically for the sulfuric acid drying tower. They have a slightly higher tendency to retain solids because the fibers are more closely spaced in these designs; however, very good operating experience has been consistently reported since this family of styles was introduced approximately 15 years ago. Recently introduced style 713 that uses higher-efficiency fibers is based on the same successful formula.

Traditional high-efficiency impaction-candle-shaped mist eliminators (such as ICK impaction candles from Koch-Otto York) are especially susceptible to fouling and the resulting pressure drop rise. These mist eliminators achieve the high efficiency by packing the metal and glass fiber separation media much more tightly than in DEMISTER® pads. Compounding this is the candle shape, which requires the liquids (and, therefore, the solids) collected at the top of the candle to drain down the full 66” (1676 mm) height of the element. This combination of factors results in solids accumulation at a rate that often creates substantial pressure drop buildup long before the operators want to shut down for maintenance. Reports of pressure drop building from 10” (250 mm) to well above 20” (500 mm) WC in 18 months are common. Not only is the premature shutdown expensive, but the extra operating cost associated with this additional pressure drop adds up quickly.

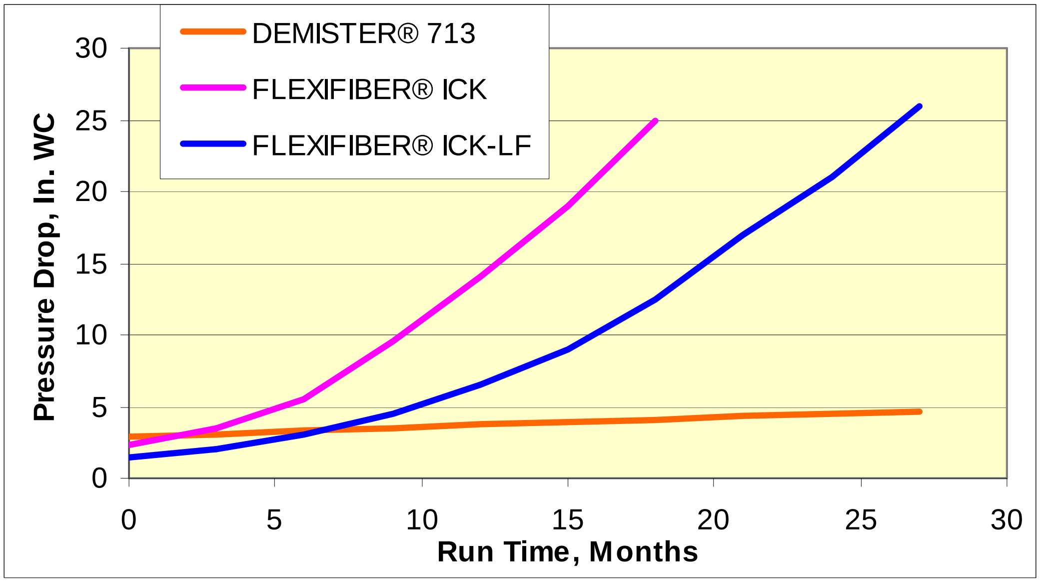


Figure 10 - Typical Pressure Buildup Curve

To respond to this expensive operating problem, Koch-Glitsch, utilizing our combined expertise in wire mesh and fiberbed mist eliminators, recently introduced an improved version of the impaction-cylinder-type mist eliminator. The improved design of the mesh structure significantly extends the run length of these elements as shown in Figure 10. The new ICK-LF impaction candle provides the same high separation efficiency currently demonstrated with our traditional ICK elements but incorporates modifications to the internal structure that promote better flushing of solids out of the element with the collected liquid. This new generation unit is completely interchangeable with current elements.

Safety

Clearly the sulfuric acid industry gives high priority to providing a safe work environment, especially for its maintenance workers. Some plant operators no longer allow workers inside the towers without fully enclosed work suits and external breathing air. While this protects workers, it can also make productivity drop; and due to the bulky suits, workers must exercise more caution when maneuvering inside the tower. Finding ways to reduce the amount of time spent inside the towers and making the environment inside the towers safer can be a significant consideration in equipment selection.

In typical drying towers, the traditional DEMISTER® knitted mesh mist eliminator is installed many feet above the packed bed and is supported on intermediate beams that reduce the unsupported span to less than 6 to 8 feet (1.75 to 2.5 meters). During maintenance, a common practice is to first flush out the pad to minimize acid dripping on the workers below, and then either assemble scaffolding to work from below or lay planks across the supports to work from above. Either situation can result in a potentially slippery environment inside the tower, and there is always concern for worker safety.

Two drying tower mist eliminator options offer significant safety benefits. Both are well- proven approaches.

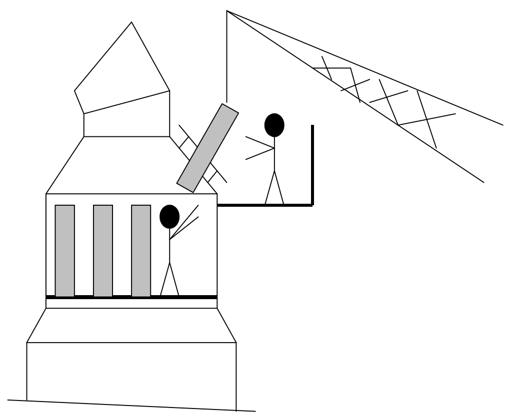


Figure 11. Impaction candles allow standing on the tubesheet.

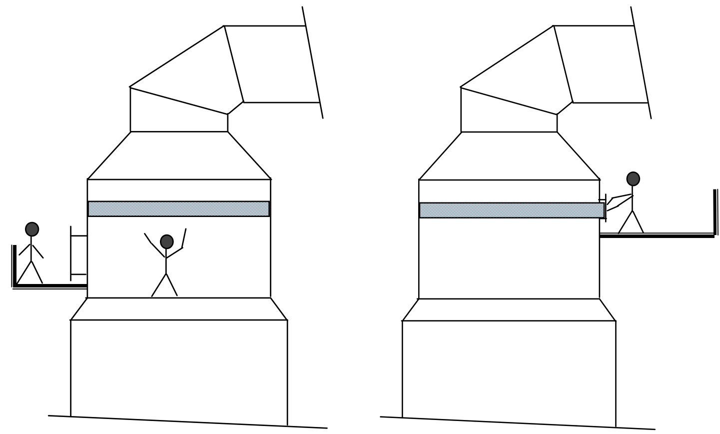


Figure 12. TYPE D SAFETY SCRUBBER™ Housing allows maintenance from outside the vessel.

When impaction candles are mounted standing upward above a tubesheet, workers can stand on the tubesheet to service the units, which provides relatively little risk of injury. In some instances, plants prefer impaction candles because of this reason.

In metallurgical plants, the use of our TYPE D SAFETY SCRUBBER™ design has become quite common. With this approach, the housing is built with doors that allow all the mist elimination sections to be removed (like pulling out the drawers of a desk) while the workers remain safely outside the tower. The doors on these designs must be carefully engineered because air leakage into or out of the tower is not acceptable. Another area for careful consideration is the proper design of the platforms outside the tower to allow sufficient clearances and to protect workers below. Where safety is a primary concern for choosing the mist eliminator, sulfur burning and spent acid regeneration plants would also benefit from this design. In addition to safety, this design allows inspection, cleaning, and/or replacement in a matter of a few hours, even when the plant is still hot. This benefit is an important consideration in plants where the gas cleaning system does not provide consistent performance.

Capacity

Drying Tower

All drying tower mist eliminators operate by the impaction and interception mechanisms, which means the performance will increase as the velocity increases until the flooding capacity is reached. The design velocity is based on the modified Souders-Brown equation:

$$\mathbf{V = K\,[\rho_L / \rho_G - 1]^{1/2}}$$

where:

V = Design gas velocity, ft / s (m / s)
ρ_L = Liquid density, lb / ft^3 (kg / m^3)
ρ_G = Gas density, lb / ft^3 (kg / m^3)
K = Design factor that accounts for the mesh geometry, process physical properties (including gas and liquid viscosity and liquid surface tension) and for the effects of liquid loading

Today, we use advanced design correlations that account individually for each of the variables that affect the traditional K value above. While design experience is still a critical factor, these correlations allow us to eliminate the excessive built-in safety factors of the old rule-of-thumb designs. These correlations have been well proven with the experience of hundreds of global installations and upgrades.

All of the mist elimination designs normally considered for drying towers can be easily accommodated in housings that are mounted on top of the tower and are smaller in diameter than the main tower body. A size comparison of typical housing designs for a 1500 tons / day plant is provided in the cost comparison section below.

For locations that need to be retrofitted to gain more gas handling capacity, such as when the blower is relocated from upstream to downstream of the drying tower, well-proven designs are available to gain more than 20% capacity over the highest capacity designs. Refer to Table 3 in the cost comparison section below for additional information.

Intermediate and Final Absorption Towers

In contrast to the drying tower mist eliminators, which work on the mechanisms of impaction and interception, the mist eliminators used in the intermediate and final towers work on the principle of Brownian Diffusion. This means that efficiency actually increases as the velocity decreases, and mist eliminators using the Brownian Diffusion principle have infinite turndown capacity.

However, the Brownian Diffusion-type mist eliminators have limited turnup capacity usually because of pressure drop limitations. Recognizing this limitation, several years ago Koch-Glitsch embarked on an R&D program to develop a new mist eliminator that would have a capacity and efficiency equivalent to the most efficient designs used currently, but with a lower pressure drop. The result of this effort is the latest generation of FLEXIFIBER® BD-LdP mist eliminators, which, as shown previously, have a higher efficiency and lower pressure drop compared to conventional designs. These new designs are completely interchangeable with existing installations allowing either a reduction in pressure drop by approximately 20% at current capacity or an increase in throughput by 20%, while at the same time providing equal or higher droplet removal efficiency.

Service Life

The operating life of mist eliminators is affected by two primary factors: fouling and corrosion. Both of these factors often come into play in the drying tower.

Solids fouling was discussed in detail in the operating cost section above.

For corrosion, material selection plays a primary role in the operating life of drying tower mist eliminators. Because all common drying tower mist eliminators include small diameter wire (normally about 0.011" (0.28 mm) diameter), there is very little room left for corrosion. By the time the wire is corroded to about 0.007" (0.18 mm) diameter, it has reached its useful service life. Because the wire is corroded from all sides, only 0.002" (0.05 mm) of corrosion allowance exists.

Operating evidence also supports the fact that the gas-liquid interface is among the most susceptible regions for corrosion. Since mist eliminators clearly operate in this regime, this makes it one of the most challenging corrosion environments in the plant.

From a corrosion perspective, drying tower mist eliminators face dangers from decreases in acid concentration and increases in temperature. Both will cause significant acceleration in the rate of corrosion. Trace contaminants in the acid have also been reported to affect corrosion rates.

The above factors have a direct impact on selection of the material of construction for the mist eliminator summarized below:

- 316 SS is rarely used for the wire of the mist eliminator. However, it is a common choice for the support grids or candle housing where there is sufficient material to provide more corrosion allowance.
- Alloy 20 has been a reliable selection for the mist eliminator wire for many years. Our experience is that alloy 20 will have, on average, a two to four year service life in 98% acid at 120° F (50° C). It is not forgiving to temperature or acid concentration swings that can occur in some plants.
- Alloy 66 is a nickel-based alloy specifically designed for difficult sulfuric acid environments. For many years it has been a widely used mesh material in drying tower mist eliminators. Samples we have retrieved from drying tower mist eliminators in actual service exhibit wire diameter reductions of less than 0.0004" (0.01 mm) per year. This translates to a 10-year service life. While still affected by temperature and acid concentration swings, it appears to be much more forgiving than alloy 20 when this occurs.
- Iron-based alloys, such as SARAMET®, SX® and other proprietary metals, have been used in a variety of applications in sulfuric acid plants, including acid distributors, towers and acid pump tanks. These locations certainly operate at severe conditions, but care should

be used in extrapolating experience from these locations, where high corrosion allowances are built in, to mist eliminator wires where only 0.05 mm (0.002”) of corrosion allowance exists.

- Fluoropolymers, such as FEP (Teflon®) or ECTFE (Halar®) have been used in drying tower mist eliminators for more than 40 years. Operating experience has shown that they are totally resistant to sulfuric acid attack. Their primary limitation is temperature. Even short term exposure to temperatures above 300° F (150° C) results in wire shrinkage, which leads to gaps between sections and gas bypassing. In sulfur burning plants, the potential for heat from the sulfur furnace that backs up into the drying tower during flow interruptions must be considered. Also, the low mechanical strength of the plastic wire results in a construction that is more susceptible to premature collapse. Typical experience is service life of approximately 4 years.

Intermediate and Final Towers

Because the mist elimination media for the intermediate and final absorption towers is typically fiberglass, which is highly resistant to acid corrosion, this is usually not an issue unless the mist eliminators are exposed to other corrosive elements, such as fluorides. This is usually prevented by gas scrubbers upstream of the acid plant. When fluorides cannot be avoided, our carbon fiber designs have been in operation for many years without signs of deterioration. Also, the screens used in these elements are typically 316L SS or Alloy 20, and are thicker in gauge than those used in the drying tower.

Initial and Replacement Costs

Although it is difficult to provide useful cost estimates for the many combinations of mist elimination designs, housings and construction materials discussed above, we have prepared Tables 3 and 4 based on a 1,500 T/day plant. Table 3 summarizes the housing size requirements and special internal structure for the common mist elimination designs in a drying tower.

Table 3 – Housing Size Requirements

Product	Housing Diameter	Special Internals
Traditional metal	144” (3700 mm)	Center support beam and support ring
High efficiency metal	156” (4000 mm)	Center support beam and support ring
High efficiency metal + TYPE D SAFETY SCRUBBER™ design	168” (4300 mm)	Special drawer assembly
Impaction candles	192” (4900 mm)	Tubesheet

The choices for mist elimination internals are varied. Table 4 provides relative costs for some of the most commonly selected approaches. With material costs changing almost daily, these should be used only as a preliminary screening tool to scope out the options available for your specific plant’s operating situation and priorities.

Table 4 – Mist Eliminators and Relative Cost

Internals	Material	Relative Cost
Traditional DEMISTER® pad	Alloy 20	1.0
Traditional DEMISTER® pad	Teflon®	2.0
Traditional DEMISTER® pad	Alloy 66	1.5
DEMISTER® pad Style 338	Alloy 66	1.75
DEMISTER® pad Style 713	Alloy 66	1.75
FLEXIFIBER® candles Style ICK	Alloy 20	3.5
FLEXIFIBER® candles Style ICK-LF	Alloy 20	4.0

Service life is a major factor in the annual cost, and mist eliminators that last for many years can save on the labor and equipment costs needed to remove and replace shorter service-life alternatives. Mist eliminators with longer service life also can generally be counted on to provide assurance that expensive downstream equipment will be protected through the full operating cycle.

Summary

Sulfuric acid mist elimination selection starts with an understanding of the causes of the mist and the downstream problems it will cause. Each plant is operated differently, which affects efficiency, pressure drop and service life. This must be factored into the decision process.

The relative priorities set by plant management regarding benefits of longer turnaround cycles, competing priorities for capital, payback for energy recovery as well as the plant safety culture will all factor into the selection process.

The comparative information on efficiency, capacity, operating costs, service life and safety benefits provided here should help engineering, operations and maintenance to select the mist elimination solution best suited to each plant's needs.

Several important new product introductions offer improvements in efficiency, service life, cost, and safety:

- The newly introduced DEMISTER® style 713 mist eliminator offers significantly increased efficiency at the same pressure drop and cost.
- The upgraded FLEXIFIBER® ICK-LF mist eliminator offers significant improvements in operating service life.
- The TYPE D SAFETY SCRUBBER™ housing allows mist eliminator maintenance without tower entry.
- The newly introduced FLEXIFIBER® BD-LdP mist eliminator offers significant decrease in pressure drop or increase in capacity without any loss of efficiency.

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