



The B-GON[®] Solution

*to Mist Elimination
in Sulfuric Acid Plants*

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B-GON[®] Mist Eliminators are widely used in the gas cleaning and contact section of sulfuric acid plants. Metallurgical, Oleum Producing, Sulfur Burning, and Regeneration Plants rely on the mist eliminators in the drying towers, absorption towers, and many other units to protect the quality of the product acid, protect downstream equipment from corrosion, protect the catalysts, and ultimately protect the environment.



Presentation Topics

- Kimre™ Technology in Sulfuric Acid
- Typical Installation Methods
- Troubleshooting

This presentation is designed to give our customers who are already familiar with the basic concepts of mist elimination specific examples of Kimre™ technology in the sulfuric acid industry. Typical installation methods and general troubleshooting topics will be discussed throughout the paper.

Kimre has assisted numerous end users with troubleshooting the performance of their existing knitted mesh mist eliminators or candle-type mist eliminators and improved their process operations through the use of our products.

WE ENGINEER THE PRODUCT TO THE PROCESS.

WE DO NOT LIMIT THE PROCESS TO FIT THE PRODUCT.

- Custom Engineered Solutions
- Stage-wise Particle Separation



Drying Tower

- Modern Sulfur Burning
- 98% Acid
- Entrained Spray ($> 10 \mu$)
 - Liquid Loading 175-350 mg/m³
- Mist .6 - 10 μ
 - Liquid Loading 175-3500 mg/m³

Mist eliminators in drying towers in modern sulfur burning plants operating with 98% sulfuric acid typically see 175-350 mg/m³ of entrained spray.

The typical mist size handled in the drying towers is 0.6-10 microns in diameter.



Drying Tower

- B-GON[®] Mist Eliminator Pad
- 6 Layers Style 16/96 ETFE
- 99+% at 5 μ
- Pressure Drop 25mm WC

Kimre, Inc. has offered mist eliminators comparable to the knitted mesh mist eliminators for the sulfur burning drying towers. The typical efficiency quoted is 99% collection at 5 microns with a pressure drop of approximately 1" WC.

Additional layers of material can be added to the design to increase the efficiency, with little effect on the pressure drop.



Drying Tower

- Cold Gas Operating on Spent Acid
- Metallurgical Gas
- 93% Acid
- Mist and Plugging
- Liquid Loading 175 - 3500 mg/m³

Mist eliminators installed in drying towers in metallurgical plants are designed to resist plugging. Kimre, Inc. offers coarse mesh styles that can be combined with finer styles to offer the end user equivalent efficiencies to the original knitted mesh with longer life and better resistance to plugging and flooding.



Drying Tower

- B-GON[®] Mist Eliminator Pad
- 2 Layers Style 37/94 ETFE
- 4 Layers Style 16/96 ETFE
- 99% at 5 μ
- 25mm WC

A composite B-GON[®] Mist Eliminator designed for 99% collection of 5 micron droplets is available with only a 1" WC pressure drop. Styles 37/94 and 16/96 ETFE combine to give the customer a mist eliminator with a thickness of 2.8", nominal and excellent resistance to plugging and flooding.



Drying Tower

Can a drying tower mist eliminator
replace and/or augment
effective acid removal by an
ESP or a wet scrubber?

Acid removal and solid collection is best addressed upstream of the drying tower in the gas cleaning process of a metallurgical sulfuric acid plant. Many believe that the ESP's and wet scrubbers should be designed for 99% collection of particles less than one micron in order to protect the contact section equipment from acid corrosion, product acid from contamination, and catalysts from plugging.

B-GON[®] Mist Eliminators are the most pluggage resistant mist eliminator available. The hardy structural design ranks the B-GON[®] Mist Eliminator as the number one choice for plants with less than desirable gas cleaning. The easy maintenance and high efficiency of the B-GON[®] Mist Eliminators promote Kimre[™] technology as the best option for drying tower mist eliminators.



Primary Absorption Tower

The Following Requirements Must Be Balanced:

- Protection of Downstream Equipment (Removal Efficiency, Flooding Resistance)
- Production (Pressure Drop)
- Capital (Size)
- Running Cost (Pressure Drop, Maintainability)

The successful operation of a plant requires the following basic characteristics from mist eliminators.

A mist eliminator must have adequate collection efficiency of the appropriate droplet size and must resist flooding in order to protect downstream equipment.

The pressure drop across the mist eliminator section must not impede production.

The size of the mist eliminator must make economical sense. This cost must be balanced with the running cost of the tower. The maintenance of the mist eliminator as well as the pressure drop of the mist eliminator should not require unnecessary attention in the operation of the tower.



Primary Absorption Tower

- Liquid Loading
 - Spray 175 - 350 mg/m³
 - Mist 325 - 1400 mg/m³
- Droplet Size
 - Non-Oleum Producing, 1-2 μ
 - Oleum Producing, 0.6 μ

The typical liquid load for a mist eliminator in a primary absorption tower ranges from 175-350 mg/m³ for spray (droplets over 10 μ m) and 325-1400 mg/m³ for mist (droplets below 10 μ m). The range of mist sizes vary depending on the type of plant. Non-oleum producing facilities can face mists ranging 1-2 microns in diameter and larger. Oleum producing plants should install mist eliminators with good efficiencies down to 0.6 microns in diameter.



Primary Absorption Tower

Non-Oleum Producing B-GON[®] Mist Eliminator:

- Stage 1 Coalescer
 - 2 Layers Style 8/96 ETFE
 - 3 Layers Style 4/96 ETFE
 - 6 Layers Style 2/96 ETFE
- Stage 2 Entrainment Separator
 - 6 Layers Style 16/96 ETFE

A typical B-GON[®] Mist Eliminator for a non-oleum producing absorption tower is comprised of two-stages. The first stage is a coalescer pad made of very fine media designed for excellent collection efficiencies as low as 1 micron in diameter.

The second stage mist eliminator is designed to collect entrained spray from the first stage. This mist eliminator is equivalent in performance to a traditional knitted mesh mist eliminator, 99% collection of 5 micron droplets with 1" WC pressure drop.



Primary Absorption Tower

Non-Oleum Producing B-GON[®] Mist Eliminator:

- 99.99% at 3 Microns and 89% at 1 μ
- 60mm WC
- Power Savings US\$ 3,000/yr
- 10,000 m³/h at \$.115/mWh

A two-stage B-GON[®] Mist Eliminator System was designed for 99+% collection of 3 micron droplets with excellent collection efficiencies down to 1 micron in diameter.

The total pressure loss across both stages was approximately 2.4" WC. The installation of the mist eliminator system resulted in a power savings for the customer.



Primary Absorption Tower

Non-Oleum Producing B-GON[®] Mist Eliminator:

- Reduced Penetration by H_2SO_4
- 4500 kg/yr @ (10,000 m³/h)

In addition to the power savings for the customer, the mist eliminator system reduced the sulfuric acid penetration through the tower. This translates to significant savings from reduction of corrosion of downstream equipment.



Final Absorption Tower

- Liquid Loading 175-350 mg/m³
- Droplet Size 2-3 μ

The typical liquid loading a mist eliminator must handle in a final absorption tower ranges from 175-350 mg/m³. The mist eliminator should be designed to handle mist 2-3 microns in diameter.

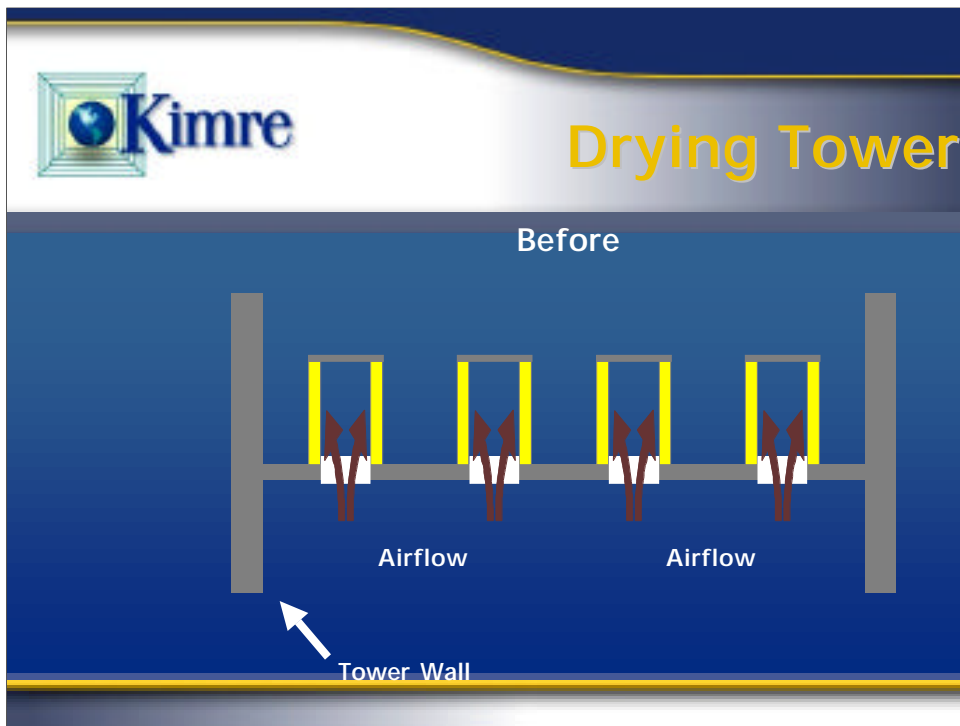
A single stage mist eliminator can be installed to collect the two micron droplets effectively.



Final Absorption Tower

- B-GON[®] Mist Eliminator Pad
- 12 Layers Style 8/96 ETFE
- 1 Layer Style 35/94 ETFE
- 99.7% at 2 μ
- 65mm WC

Kimre, Inc. has recommended single stage B-GON[®] Mist Eliminators for the 99.7% collection of 2 micron droplets in final absorption towers. The composite mist eliminator combines coarse and fine styles of material into one pad for a pressure drop of 2.6" WC.



The drying tower mist eliminators should be easy to clean in metallurgical plants. Mist eliminators in sulfur burning plants should have good liquid handling abilities and enable good throughput.

Kimre, Inc. addressed the cleanability issue for a customer at a South American copper smelter. Empresa Nacional de Minería (ENAMI) is a government-owned company in Copiapó, Chile. Its smelter operates 24 hours a day, 49 weeks a year. In late 1992, the company installed two sets of fiber bed, candle mist eliminators for the purposes of stopping airborne sulfuric acid emissions. One set of candles was installed in the absorption tower and the other in the drying tower. After installation, the company learned that the drying tower mist eliminators were plugging. Through the local Kimre representative, Fibra Limitada, Kimre was asked to make a competitive presentation and solve the problem.



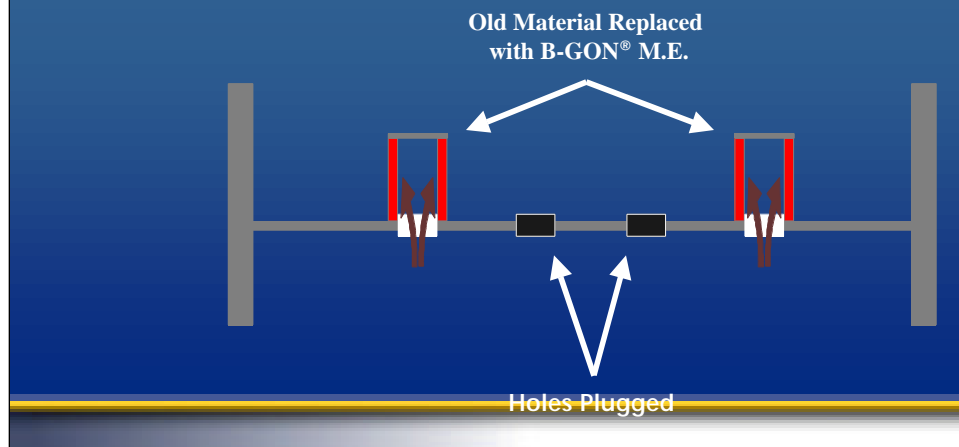
Kimre, Inc. designed a new mist eliminator upstream of the existing candles to protect the media from plugging. This mist eliminator was designed for 99% collection of 3 microns. Coarse B-GON® Mist Eliminator styles were recommended in the composite pad design to solve the frequent plugging. The plugged candles were replaced with the cleaner candles from the absorption tower and ran for a couple of years before they were modified.

Before the candle protection was installed the candles had to be cleaned every two weeks and replaced quite frequently. The pressure drop increased from 200 mm WC to 800 mm WC in this short time period. After the B-GON® Mist Eliminator was installed upstream of the candles, the pressure drop did not increase to 800 mm WC for one full year. The existing candles lasted for two years before ENAMI decided to approach Kimre, Inc. for a candle re-wrap.



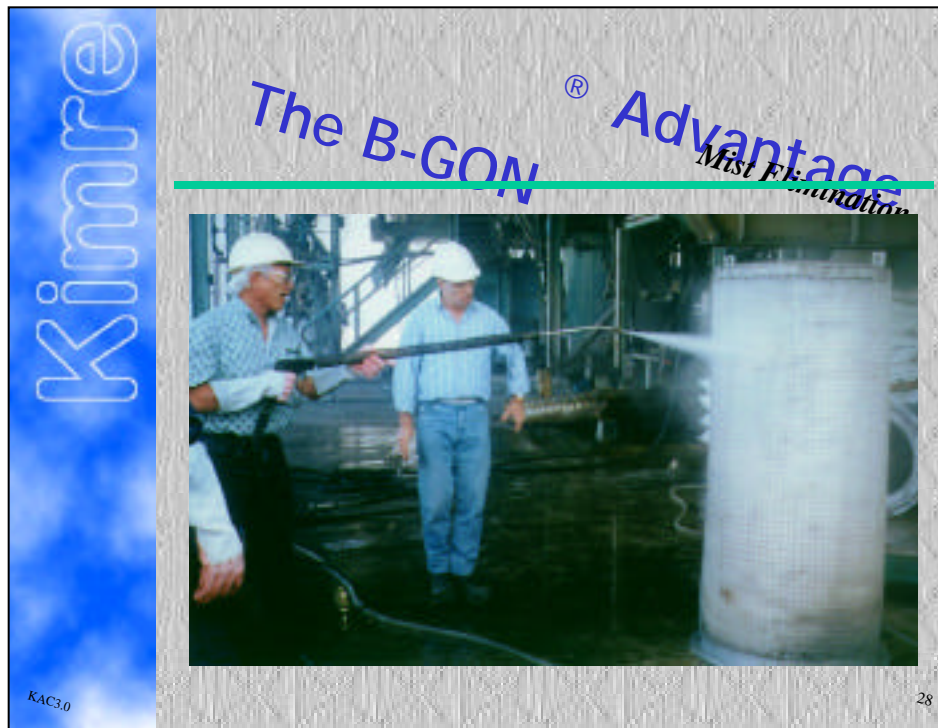
Drying Tower

Solution- Step 2- Candle Rewrap



The eight existing candles were re-wrapped with Kimre media. The existing cages were reused in the installation. This installation has been in service for over three years without replacement of the Kimre media.

The plant manager boasts that the Kimre candles are easy to handle and friendly to maintain. The media maintains its height and is still like new after three years of service. The flat first stage and the candle stage are cleaned once a year.

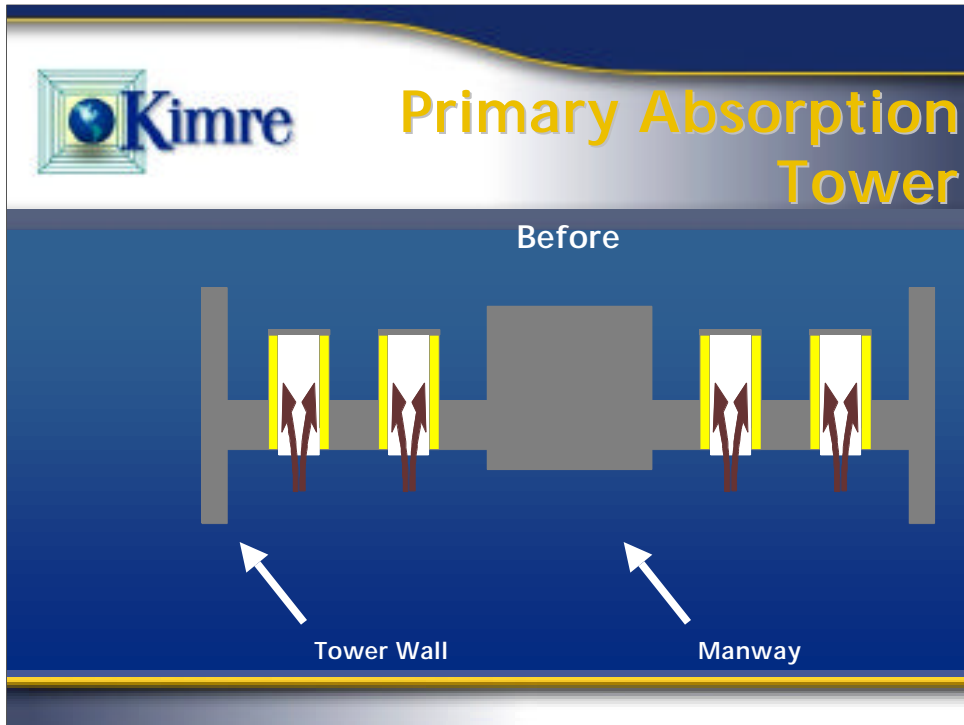


A similar installation took place at another ENAMI location based on the success of the installation of the pre-cleaning pad at ENAMI Paipote. This particular location had 10 candles installed in a 98% drying tower.

The design of this candle re-wrap was based on the operation of the pre-cleaning stage at Paipote. The successful operation of the first stage pad lead Kimre, Inc. to offer equivalent efficiencies and pluggage resistances to the new customer.

Kimre, Inc. sold 4 B-GON® Mist Eliminators to be installed in the existing candle cages to achieve 99% collection efficiency of 3 micron droplets under the current operating conditions. The customer was informed that if the flow through the tower would be increased in the future, additional candles could be added to the four. The holes for the unused six candles were covered for the modification.

One year later, the gas flow at this ENAMI location was increased. Two additional B-GON® Mist Eliminators were supplied. Four more candle re-wraps were sold two years later.



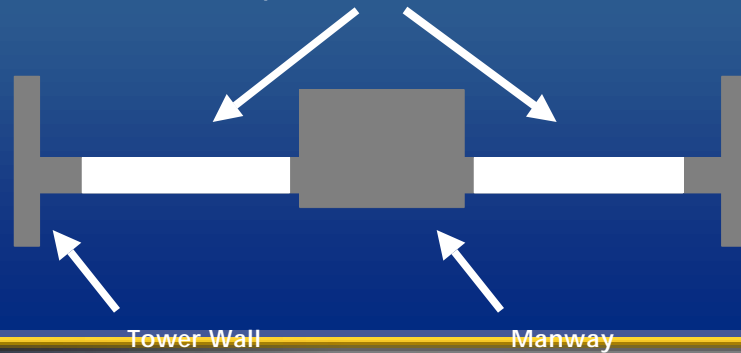
ENAMI at Copiapó, Chile also had a set of candles installed in the primary absorption tower. Kimre, Inc. designed a flat B-GON[®] Mist Eliminator for the tower to solve a re-entrainment problem. The mist eliminator was also designed with 80% turn down capability.



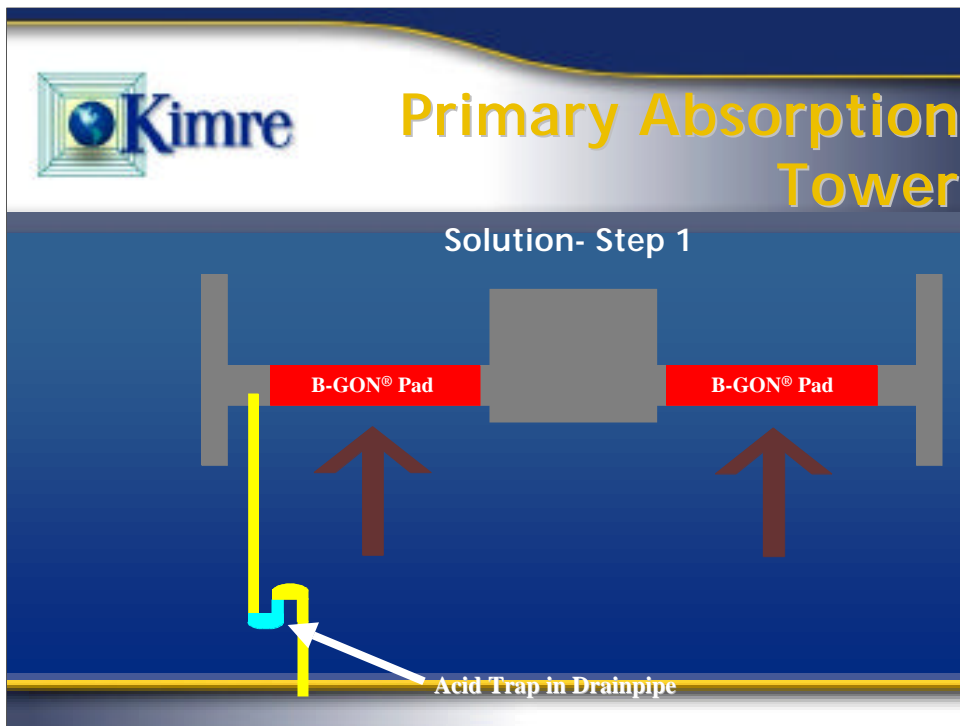
Primary Absorption Tower

Solution- Step 1- During

Areas cut away to make space for B-GON® M.E.



The existing candles were removed and the tube sheet was opened up to provide adequate area for the composite B-GON® Mist Eliminator.



Kimre, Inc. installed a mist eliminator with greater liquid-handling in the absorption tower. The pressure drop was not a factor as was the case with the existing mist eliminators. A composite mist eliminator was installed to yield high efficiencies at both high and low gas flow rates.

The installation took place approximately five years ago. Minor modifications have been made over the past few years to improve the performance of the mist eliminator in the tower.



Primary Absorption Tower

Solution- Step 2

- After installing the donut shaped mist eliminator, Kimre, Inc. installed a second stage entrainment separator.
- Second stage mist eliminator ensures zero entrainment from tower.

Kimre, Inc. worked closely with Fibra to offer ENAMI a second stage entrainment separator to collect the re-entrainment from the first stage B-GON[®] Mist Eliminator. The first stage mist eliminator experienced problems with flooding when the through put of the plant was increased to the full capacity.

To combat this problem, Kimre, Inc. designed a very coarse entrainment separator to install downstream of the first stage mist eliminator. After more than a year in service, the Two-Stage B-GON[®] Mist Eliminator System is working successfully.

Both stages were recently cleaned and reinstalled with no problems.



Primary Absorption Tower



The installation of the second stage B-GON[®] Mist Eliminator at ENAMI took six people approximately one hour to complete.

The mist eliminator was supplied in individual layers, in two pieces. Each piece was unrolled in the tower and rotated so that no two joints lined up to create a channel for by-pass.



Primary Absorption Tower



After all of the layers were installed, the top grid was put in place.

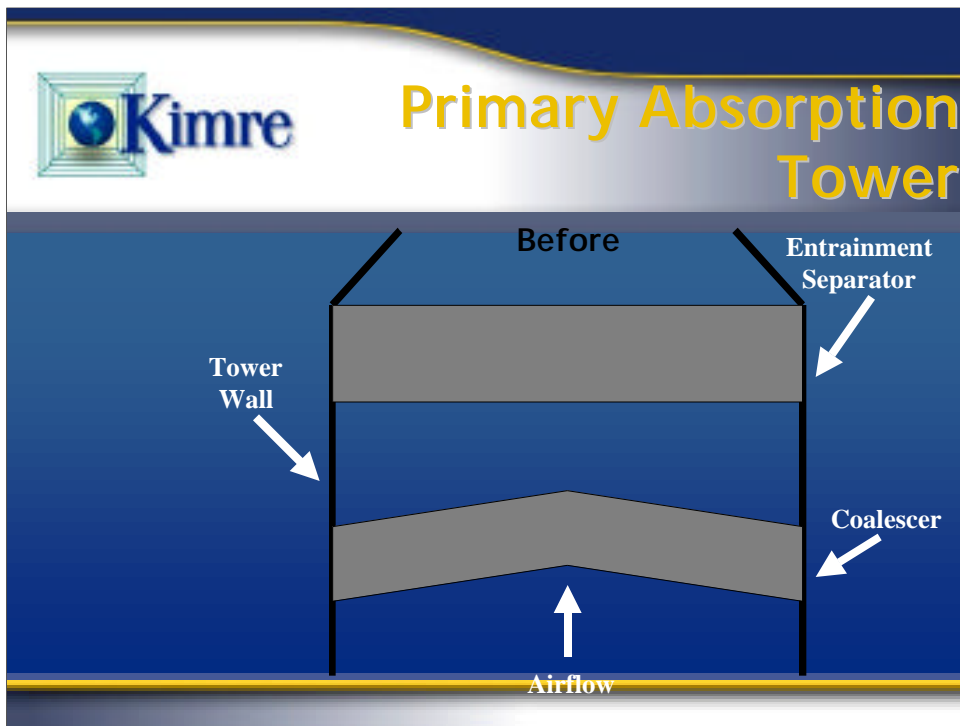


Primary Absorption Tower



Kimre, Inc. can also supply grids for the towers in sulfuric acid plants. If the installation is a retro-fit of an existing system, the Kimre products can be used with the existing grid work.

Kimre, Inc. requires that the grids have at least 80% open area to allow for good flow distribution. Kimre, Inc. supplies grids with at least 90% open area.



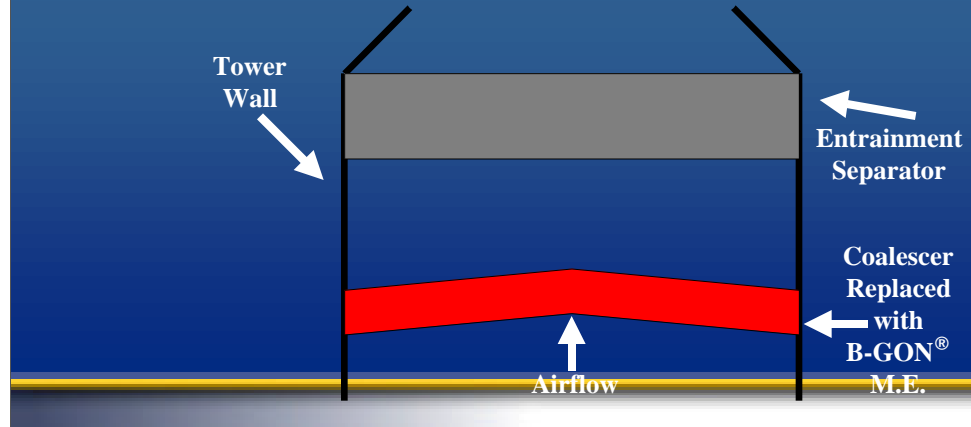
Another customer in South America decided to retro-fit the absorption tower. The customer contacted Kimre, Inc. in 1994 in need of a new first stage coalescer pad. The original mist eliminator was damaged by maintenance procedures at the plant.

Kimre, Inc. offered to provide similar, if not better, performance than the existing pads while maintaining the very low pressure drop limits. The existing mist eliminator system promised efficiency levels and pressure drops that were not accurate. Kimre, Inc. did not opt to mislead the customer with empty promises. In order to stay within the specified pressure drop, Kimre, Inc. offered 99.9% collection of 5 micron droplets, 93% of 3 micron droplets, and 75% of 2 micron droplets with a pressure drop of 11mm WC.



Primary Absorption Tower

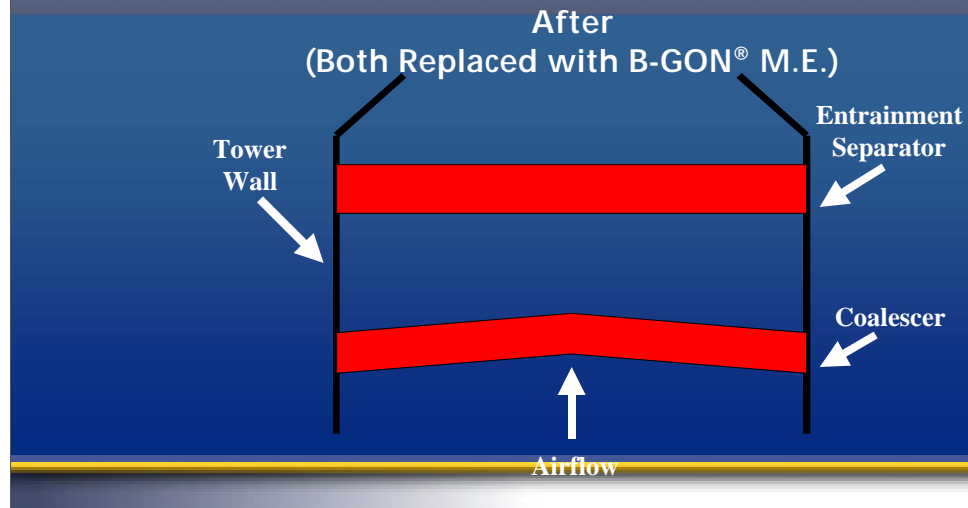
After Installation of Kimre First Stage
(Coalescer Replaced with B-GON[®] M.E.)



The B-GON[®] Mist Eliminator installed in the absorption tower was promised to save the customer approximately \$25,000.00 per year with pressure drop improvements.



Primary Absorption Tower



The second stage mist eliminator is also a perfect retrofit with Kimre media. The B-GON[®] Mist Eliminators offered for entrainment separators will have better drainage abilities than the traditional knitted mesh. Also, the performance per unit of pressure drop, ease of maintenance, and life expectancy should improve with the use of the unique inter-locking Kimre media.



Mercury Tower

Retrofit

- Traditional knitted mesh mist eliminator replaced with B-GON[®] Mist Eliminator
- Improved pluggage resistance and liquid-handling ability
- Coarse thermoplastic mesh easier and faster to install

Recently in the Western United States, Kimre, Inc. worked with a client on improving the pluggage resistance of the mist eliminator in a mercury scrubber.

The mist eliminator in the Boliden/Norzinc reactor for removal of mercury in the gas cleaning section of the plant was plugging. Mercurous chloride is a white, clumpy, sticky substance that is not easily cleaned from the knitted mesh mist eliminators. Sprays were installed in the top of the tower to clean the pad during shut-down. The pressure drop through the mist eliminator never completely returned to normal indicating that the pad was still plugged.

Kimre installed a very coarse B-GON[®] Mist Eliminator in a Norzinc Mercury Scrubber in Indonesia a few years ago. The coarse mist eliminator comprised of style 37/97 PP is working great. Based on the successful operation of the retrofit, the sister company in the United States decided to switch to the same type of B-GON[®] Mist Eliminator.

Both companies are satisfied with the operation of the B-GON[®] Mist Eliminators and have continued buying other Kimre products. This is an excellent example of Kimre's capabilities to custom design pads to fit the requirements of the process.



SO₂ Stripper

Retrofit

- B-GON[®] Mist Eliminator replaced traditional knitted mesh
- Easy and fast installation
- Equivalent efficiency with a lower pressure drop

The same US customer with the successful mercury tower installation decided to retrofit the SO₂ Stripper with a B-GON[®] Mist Eliminator.

This mist eliminator was designed to offer the customer the same level of performance as the original mist eliminators. The major advantages of the B-GON[®] Mist Eliminators are the easy and fast installation and the equivalent efficiencies with lower pressure drops.



Drying Tower

Retrofit - Step 1

- Replace knitted mesh with easy-to-install, easy-to-fit B-GON® Mist Eliminator
- Improve pluggage resistance of mist eliminator
- Improve fit of mist eliminator

The drying tower mist eliminator experienced poor fit problems which were noticed in the corrosion of downstream equipment (SO₂ blower). The customer originally thought that the mist eliminator should be extremely more pluggage resistant. However, based on further discussions and high levels of confidence in Kimre™ technology, the customer decided to improve the collection efficiency of the system



Drying Tower

Retrofit - Step 2

- Install higher efficiency composite B-GON[®] Mist Eliminator
- Protect downstream equipment

Kimre, Inc. is in the process of replacing the B-GON[®] Mist Eliminator in the drying tower with a second, more efficient composite B-GON[®] Mist Eliminator. The new installation will result in higher efficiencies for droplets lower than 3 microns in diameter. This mist eliminator will not require any modifications to the vessel and will not unnecessarily increase the pressure drop.



SO₂ Scrubber

Retrofit

- Replace three-stage knitted mesh mist eliminator system with three-stage B-GON[®] Mist Eliminator System
- Improve fit of mist eliminators
- Prevent by-pass
- Provide equivalent efficiency with lower pressure drop

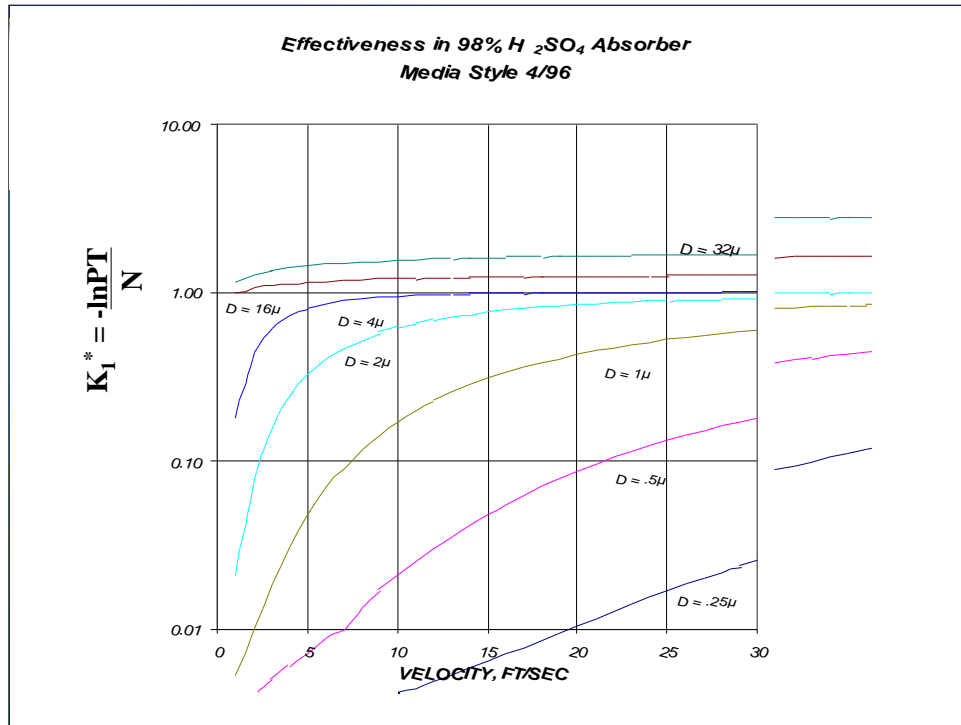
The three-stage knitted mesh mist eliminator in the SO₂ scrubber never seemed to fit in the tower up-to-specifications.

The customer's drawings for the tower internals were inconsistent causing further concern for the supply of a proper installation. Kimre, Inc. decided with the customer to supply a pad that could be modified during installation if necessary. If the pad did not fit correctly, Kimre would be ready at the time of installation to send additional layers of material to act as "filler media".

The second stage mist eliminator was a particularly tricky fit. The mist eliminator is elevated in the center and supplied in pie-shaped pieces. The narrow center of the pieces created a fit problem at the center. In addition to the difficult fit, the pie shapes were difficult to hold in place during operation.

Kimre, Inc. stuck with the same design, based on the customer's request. However the fit of the B-GON[®] Mist Eliminators was superior to the knitted mesh due to the Edge-Seal[™] material supplied on each of the pie shaped pieces.

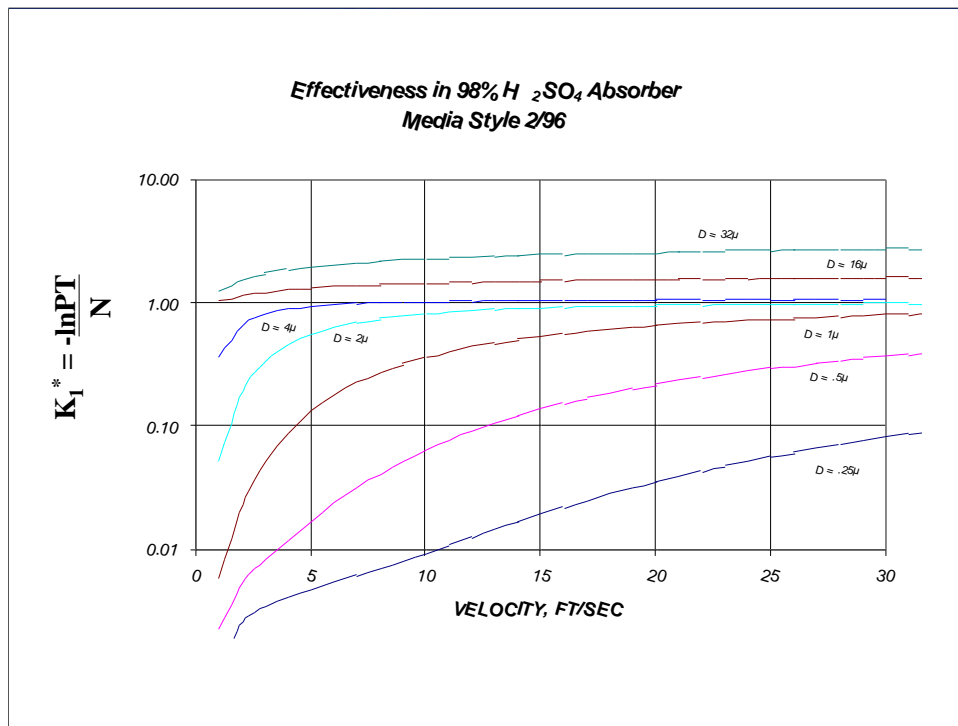
The entire tower was retro-fitted during one shift with no difficulties.



Kimre, Inc. has also been working with an engineering and construction company on specifying B-GON[®] Mist Eliminators for new Final Absorption Towers.

The graph of the effectiveness factor K_1^* vs.. velocity for style 4/96 displays the B-GON[®] Mist Eliminators effectiveness to 0.5 microns.

Using the equation of K_1^* , the number of layers required for 99% collection efficiency of .5 microns at 25 fps is 23 layers. The pressure drop for this number of layers and velocity, leads us to look at style 2/96.



The same droplet diameter, efficiency, and velocity lead to only 9 layers of style 2/96. The pressure drop at 25 fps and 9 layers of style 2/96 leads us to specify slower velocities and additional layers of material for less efficiency at .5 microns.

At 900 fpm, 99+% collection efficiency of 1 micron droplets and 98.5% collection of .8 micron droplets can be achieved with 7" WC pressure drop. This displays the good efficiency of the impaction and interception collection concepts into the submicron range normally reserved for Brownian Diffusion-type devices, like candles. The graph also displays the superiority of the monofilament design of the B-GON[®] Mist Eliminators in the collection of this fine droplet size.

The following properties for sulfuric acid mist and air were assumed for the K1* vs. Velocity graphs:

rg = 0.91 kg/m ³	μl = 5.25 cP
μg = 0.021 cP	T = 80° C
rl = 1772 kg/m ³	P = 0.9 atm



Primary Absorption Tower

Possible Coalescer Performance

- 99.7% Collection of 1 μ @ 900 fpm
- 98.5% Collection of 0.8 μ @ 900 fpm
- 7" WC Pressure Drop @ 900 fpm
- 99% Collection of 1 μ @ 690 fpm
- 95% Collection of 0.8 μ @ 690 fpm
- 4.4" WC Pressure Drop @ 690 fpm

Recently, Kimre, Inc. developed several options for an engineering and construction company to install B-GON[®] Mist Eliminators in a new final absorption tower of a double absorption sulfuric acid plant. This slide is an example of the guarantee made to the customer.

A two-stage mist eliminator system was offered to collect 99+% of 1 micron droplets at 900 fpm with a 7" WC pressure drop. The pressure drop lowers to 4.4" WC pressure drop at 690 fpm with a collection efficiency of 99% at 1 micron.

Alternatively, a two-stage system with slightly more fine material will achieve 99% collection of 0.8 micron droplets at 800 fpm with a 6.5" WC pressure drop.

This example displays the many options with the various styles of Kimre, Inc. material. The initial capital costs can be balanced with the operating costs of the systems depending on the level of efficiency and allowable pressure drop required.



The two-stage mist eliminator system displayed in the previous guarantee utilizes either a 2/96 or a 4/96 coalescer followed by an entrainment separator. The 2/96 or 4/96 coalescer will be comprised of multiple layers tied into a composite pad designed to operate in a flooded state and agglomerate finer droplets into larger droplets.

The style 2/96 will operate above 7 fps (usually above 10 fps) and the 4/96 will operate above 11 fps. Kimre, Inc. will offer coalescer arrangements designed with the most effective K_1^* vs.. Pressure drop vs.. Price. Any constraints set by the user will also be factored into the design process.



Installation Methods



This is an example of an installation method for the coalescer stage of a B-GON[®] Mist Eliminator System. Kimre, Inc. would like to angle coalescer pads as shown above. A pitch of 5-15° helps reduce pressure drop by getting liquid head to drain away.

This particular picture is not a sulfuric acid application. High efficiency candles were replaced to improve performance. A 750 mega watt power plant in Europe achieved improved results with the use of the AEROSEP[®] Multi-Stage Aerosol Separation System.