Gas/Liquid Separation Technology
Sulzer Chemtech – Separation Technology

Your partner in separation and mixing technology

The highest level of application know-how
Our team provides expert knowledge for more than 500 applications in 100 processes, enabling us to optimize the performance and your installation.

Fast and reliable turnaround services
We don’t shut-down, when you shut-down. You can rely on Sulzer professionals, expertise and procedures to get you back and running in the shortest possible time.

Comprehensive engineering and technology services
We provide a full scope of associated engineering and technology services to optimize or trouble-shoot your installation.

A broad range of innovative and high-performing products
More than 200 of our products cover a wide range of needs in the field of separation and mixing technology.

They have proven their performance in more than 100’000 columns, 50’000 gas/liquid or liquid/liquid separators and 100’000 static mixers in operations worldwide.

MellapakPlus™ packing
Often copied, never equaled

UFMPlus™ trays
One of the best high performance trays ever tested at FRI

NeXRing™
The next big thing in random packing

SMV™ static mixer
High mixing efficiency combined with large turn-down processing capabilities

Dusec Plus™ coalescer
High performance liquid/liquid coalescer
Sulzer is a major player in the field of gas/liquid and liquid/liquid separation technology, offering a full range of innovative products and related services. Our commitment to development of technology, combined with application skills and consistent fabrication standards ensures that a well-engineered solution is available for most separation problems.

Our expertise gained from thousands of successful installations in a broad spectrum of applications ensures that the best possible product is recommended for each individual duty.

Our strategic alliance agreement with Shell Global Solutions International B.V. provides access to state of the art separation technology, including the Shell VersiSwirl™ and Schoepentoeter™. The oil and gas industry is increasingly pursuing compact and lower weight processing technology to meet the technological and economic demands of offshore, onshore, remote and challenged gas processing. Compact Mass Transfer and Inline Separation Technology (cMIST™), incorporating our patented compact HiPer TwinLine™ Separator, can replace conventional TEG contactors and associated separators to meet pipeline dew point specifications. It allows significant reductions in weight, footprint and cost. cMIST™ is an innovative dehydration system licensed from ExxonMobil to Sulzer.

Another product is the Sulzer VIEC™ (Vessel Internal Electrostatic Coalescer), system that enhances liquid-liquid separation by using alternating high voltage electrical fields. With the ability to tolerate 100% water and 100% gas in a robust and stable process, the system is well-suited for the separation of water dispersed in oil and the handling of stable emulsions.
## Sulzer vessel based separator portfolio

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<tr>
<th>Type of separator</th>
<th>Stainless steels</th>
<th>Alloy C22</th>
<th>Alloy C276</th>
<th>Alloy 400</th>
<th>Alloy 625</th>
<th>Alloy 825</th>
<th>Alloy 20</th>
<th>Copper</th>
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<th>Glass fibers</th>
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<td>✓</td>
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<td></td>
<td></td>
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</table>

* other materials on request
** can contain PTFE multifilaments in addition to the metal wire
*** if not metallic then typically: PP, PP-TF, PVC, PVDF or FRP
Product overview

KnitMesh™ Mist Eliminator

FEATUERS AND BENEFITS

- Manufactured as a knitted wire mesh packing.
- Can be easily tailor-made to suit most vessel shapes and sizes.
- Cost effective and versatile solution for most mist elimination applications.

KEY CHARACTERISTICS

- Relatively low capacity with K-values typically up to 0.107 m/s (0.35 ft/s).
- High efficiency separation down to droplet sizes of 2 to 3 µm.
- Pressure drop typically less than 2.5 mbar.
- Designs available for installation in either horizontal or vertical gas flow.

KnitMesh V-MISTER™

FEATUERS AND BENEFITS

- Manufactured as a knitted wire mesh packing. Support grids fitted with special V-MISTER drainage channels to enhance drainage characteristics.
- Can be easily tailor-made to suit most vessel shapes and sizes.
- Cost effective and versatile solution for most mist elimination applications.

KEY CHARACTERISTICS

- Enhanced capacity with K-values typically up to 0.15 m/s (0.49 ft/s).
- Limited to horizontal installation with vertical gas flow.
- High efficiency separation down to droplet sizes of 2 to 3 µm.
- Pressure drop typically less than 2.5 mbar.
- Very effective for heavy liquid loadings/irrigated systems.

KnitMesh™ 9797 High Performance Mist Eliminator

FEATUERS AND BENEFITS

- Manufactured as a knitted wire mesh packing.
- Can be easily tailor-made to suit most vessel shapes and sizes.
- Provides optimized designs to meet the challenges of specific applications.

KEY CHARACTERISTICS

- Optimally designed capacity with K-values typically up to 0.12 m/s (0.4 ft/s).
- Optimized efficiency separation for selected applications down to droplet sizes of 1.5 to 3 µm.
- Pressure drop typically less than 2.5 mbar.
- Designs available for installation in either horizontal or vertical gas flow.

KEY AREAS OF APPLICATION

- Broad range of gas/liquid separation problems
- Scrubbing systems and absorbers
- Evaporators
- Steam drums
- Knock-out pots
- Glycol dehydration
- Inert gas scrubbers
- MSF/MED desalination
- Sulfuric acid absorbers and dryers

- Optimized coalescing and de-entrainment in critical services such as dew-point or LT separators
- Compressor knock-out drums
**Mellachevron™ Mist Eliminator**

**FEATURES AND BENEFITS**
- Constructed from banks of parallel corrugated, chevron profiles.
- High capacity designs provide compact separators - ideal for gas processing applications.
- Lower capacity designs available for fouling service and heavy liquid loadings.

**KEY CHARACTERISTICS**
- High capacity systems available with K-values up to 0.45 m/s (1.47 ft/s) at the vane face inlet.
- Effective droplet separation down to ~20 µm.
- Efficiency can be enhanced by combination with KnitMesh pre-conditioners.
- Generally for use at: - surface tension > 10 dynes/cm - operating pressure < 60 bar in hydrocarbon systems.
- Pressure drop is typically < 30 mbar.
- Designs available for installation in either horizontal or vertical gas flow.

**Shell VersiSwirl™**

**FEATURES AND BENEFITS**
- VersiSwirls arrayed in boxes or banks provide compact separators and are ideal for gas processing at all pressures.
- Suitable for use in fouling or waxy services.

**KEY CHARACTERISTICS**
- High capacity systems with column K-values of typically 0.15-0.3 m/s (0.5-1 ft/s) or higher for selected cases.
- Effective droplet separation down to ~10 µm.
- Efficiency can be enhanced by combination with KnitMesh or Mellachevron pre-conditioners.
- Pressure drop is typically < 30 mbar.

**Shell Swirltube Light™**

**FEATURES AND BENEFITS**
- Array of axial cyclones originated from the Shell ConSep™ Swirltube design.
- The device can be combined with a Sulzer Mellachevron or KnitMesh pre-conditioner.
- The separation efficiency of the Shell Swirltube Light is in the range of high performance vane packs or above.

**KEY CHARACTERISTICS**
- High capacity systems with column K-values up to 0.25 m/s (0.82 ft/s).
- The Shell Swirltube Light is suitable for higher operating pressures, offers higher capacities than vane packs installed for vertical gas flow and is therefore a useful complement to our Mellachevron mist eliminators.

**KEY AREAS OF APPLICATION**
- Gas processing applications;
- Scrubbing systems and absorbers
- Inlet separators
- Dew-point separators
- Compressor suction drums
- glycol contactors

**KEY AREAS OF APPLICATION**
- Broad range of gas/liquid separation problems
- Knock-out pots
- Glycol contactors
- Inert gas scrubbers
- MSF/MED desalination
- Sulfur condenser
- Flue-gas desulfurization (FGD)
**MKS Multi Cassette™ Mist Eliminator**

**FEATURES AND BENEFITS**
- The patented MKS Multi Cassette device combines axial cyclonic and cross flow separation Technology to create a very efficient and attractive mist eliminator.
- One or more MKS Multi Cassette candles are assembled on a support plate acting as liquid collector with drain pipes.

**KEY CHARACTERISTICS**
- High capacity device with column K-values of typically 0.1-0.3 m/s (0.33-1 ft/s) or higher for selected cases.
- High efficiency separation down to droplet sizes of 8 to 10 μm.
- Efficiency can be enhanced by combination with KnitMesh pre-conditioner.
- No limitation in operating pressure.
- Very suitable for glycol contactors (meets glycol losses ≤0.1 USgal/MMscf) and for systems with very low liquid densities and surface tensions.

**KEY AREAS OF APPLICATION**
- Gas processing applications;
- inlet separators;
- turbo-expander suction drums;
- compressor suction drums;
- glycol contactors;
- dew-point separators;
- steam drums;
- knock-out drums;
- discharge drums.

**Shell Schoepentoeter™ and Schoepentoeter Plus™ Inlet Device**

**FEATURES AND BENEFITS**
- Constructed from banks of swept vanes.
- Designs available for operation in most gas/liquid flow regimes.
- The Schoepentoeter Plus is equipped with sophisticated catching rims to minimize entrainment.

**KEY CHARACTERISTICS**
- Generally designed at dynamic pressures < 8000 Pa, but can perform well at higher values.
- Is typically used for feeds having a gas volume fraction of > 70 vol%.
- Suitable for installation in horizontal or vertical separators.
- Suitable for liquid slugs.

**KEY AREAS OF APPLICATION**
- The Schoepentoeter is the most commonly used vane inlet device for introducing gas/liquid mixtures into columns.
- The Schoepentoeter Plus is an advanced feed inlet vane device with considerably increased de-entrainment efficiency and first choice for all demanding tasks such as in vacuum towers, crude distillation and hydrocracker main fractionators and high pressure separators.

**Treelnlet™ Device**

**FEATURES AND BENEFITS**
- By installing a Treelnlet and a high efficiency KnitMesh mist eliminator, liquid carryover losses are reduced to virtually zero.

**KEY CHARACTERISTICS**
- The Treelnlet provides a superior liquid pre-separation and gas distribution and is normally effective up to dynamic pressures of about 10000 Pa.

**KEY AREAS OF APPLICATION**
- The Sulzer Treelnlet is an axial flow vane gas inlet device for vertical feed nozzles.
- Ideal for bulk liquid disengagement in a wide range of services and applications.
**HiPer™ Cyclone Inlet Device**

**FEATURES AND BENEFITS**
- The HiPer cyclone inlet device consists of an arrangement of one or more cyclones symmetrically arranged off a common, centrally located header box.
- The device can be installed in vertical or horizontal vessels.
- If required, special elements at the cyclone gas outlet will improve the distribution to the downstream device.

**KEY CHARACTERISTICS**
- The HiPer cyclonic inlet device utilizes the momentum of the feed stream inlet in order to generate high g-forces.
- Defoaming is achieved as gas bubbles are separated from the liquid phase by the centripetal forces in the cyclone tubes.
- Gas is released from the top of the device and the bottom opening of the cyclones is submerged below the liquid in the separator in order to avoid a gas ‘blowout’.

**KEY AREAS OF APPLICATION**
- The HiPer cyclone inlet device is applicable for high gas and liquid handling capacities. Useful to suppress and break many types of process foams.
- Some typical applications include FWKO drums, flash drums, test separators, 2 and 3-phase production separators.

**GiTV Vapor Horn**

**FEATURES AND BENEFITS**
- The gas distribution is performed by baffles according to a vane gas inlet device.
- The device is suitable for vessel inner diameters larger than 4 m.

**KEY CHARACTERISTICS**
- The tangential vane gas inlet device GiTV and GITD can be used for very high vapor velocities in the feed pipe of F-Factors up to 120 Pa.
- The feed flows radially around the vessel projecting and collecting the liquid droplets on the inner wall of the vessel.

**KEY AREAS OF APPLICATION**
- The Sulzer Vapor Horn GiTV as well as the new Sulzer Vanta™ inlet device GITD are primarily used in fractionators where flashing feeds require high pre-separation of any free liquids.
**Mist elimination**

Liquid entrainment in a process gas stream can be formed by either dynamic processes, such as contact between gas and liquid phases in a mass transfer operation, or thermal processes such as condensation. For example, droplets can result from bubbles bursting or jetting at a gas/liquid interface - typically in distillation columns, evaporators, bubble columns and flooded packed bed scrubbers. Where there is a high relative velocity between gas and liquid, droplets can be sheared from the wet surfaces. This type of problem is likely to occur in venturi scrubbers, two-phase flow in pipes and packings.

Droplets can also be formed by thermodynamic changes in a system. For example, vapor condenses when saturated gases are cooled in condensers and heat exchangers and, although most of the liquid will remain on the heat transfer surfaces, the gas can become supersaturated in places causing droplet formation. This type of condensation mist can occur during heat exchange processes, the sudden release of pressure or by mixing hot and cold gas streams. Similar mists can result from gas phase reactions which yield a liquid product. Typical applications suffering from mist contamination include sulfuric, phosphoric and nitric acid plants.

If the gas is travelling too fast to allow the liquid droplets to settle out under gravity, they become suspended (or entrained) in the gas or vapor. In most cases, the entrainment must be removed to purify the gas and prevent potential process or environmental contamination.

Sulzer mist eliminators provide an effective solution to liquid entrainment problems in many types of equipment including:

- scrubbing, absorption, stripping or distillation columns
- evaporators
- falling film condensers
- knock-out vessels
- 3 phase separators
- desalination plants
- refrigeration plants
- gas dehydration plants
- compression systems

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### Types and operating range of equipment

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<thead>
<tr>
<th>Droplet diameter (microns)</th>
<th>500</th>
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</table>

- **Entrainment from water cooling & spray cooling towers**
  - Entrainment from evaporators, distillation & absorption
  - Condensate from gas coolers
  - Condensate from intercoolers on compression plant
  - Condensate from high pressure compression plant
  - Knock out drums & collectors fitted mesh mist eliminators
  - Knitted mesh mist eliminators
  - Vane mist eliminators
  - Cyclonic devices
  - Baffles, louver separators
  - Fiber bed mist eliminators

- **Typical process applications**

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**Rain Drop Drizzle Mist Fog**

- Entrainment from water cooling & spray cooling towers
- Spray produced by bubble bursting at a liquid vapor interface
- Entrainment from evaporators, distillation & absorption
- Condensate from gas coolers
- Condensate from intercoolers on compression plant
- Condensate from high pressure compression plant
- Knock out drums & collectors fitted mesh mist eliminators
- Knitted mesh mist eliminators
- Vane mist eliminators
- Cyclonic devices
- Baffles, louver separators
- Fiber bed mist eliminators
Several types of mist eliminators are available for the separation of entrained liquid. To choose the appropriate equipment, the four basic mechanisms of droplet capture should be considered.

- **Diffusional Deposition** is only effective in the separation of very finely dispersed aerosols with droplets typically smaller than 1µm - that are small enough to be affected by Brownian Motion.
- **Direct Interception** assumes that a droplet of a given diameter and negligible mass follows the stream line around the 'target' wire or fiber and is separated as it touches the target or collection fiber.
- **Inertial Interception** considers the droplet mass and predicts how momentum will make it deviate from the gas stream.
- **Gravitational Deposition** works on the principle that large, slow moving droplets may separate from a gas stream under gravity. This is restricted to large droplet sizes and low superficial gas velocities – making separator dimensions both prohibitively large and uneconomical.

Each mechanism is critically dependent on the droplet size distribution for a given application. For example, in gas drying applications using glycol contactors, droplet size distributions are often in the range of 5-25 µm and high separation efficiency is critical. In these circumstances, direct and inertial interception are the most appropriate mechanisms and separation is best achieved by impingement of droplets on the wires and fibers of high performance mesh mist eliminators.

Diffusional deposition is an important mechanism in the design of fiber bed mist eliminators (candle filters) used for removal of sub-micron droplet dispersions found in applications such as acid mists.

Assuming that gravity separation can be disregarded as an effective option, the remaining mechanisms provide the design basis for Sulzer mist elimination equipment:

- **Sulzer Mellachevron™** – inertial interception
- **Shell VersiSwirl™ and Swirtube Light™** – inertial interception
- **Sulzer KnitMesh™** – inertial/direct interception
- **Sulzer MKS Multi Cassette™** – inertial/direct interception
Mist elimination

<table>
<thead>
<tr>
<th>Gravity separators/ knockout drums</th>
<th>Baffles/ louvers</th>
<th>Vane packs – simple vanes</th>
<th>Vane packs – with drainage channels</th>
<th>Axial cyclone separators</th>
<th>Knitted mesh mist eliminators</th>
<th>Candles/ fiber beds</th>
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<tbody>
<tr>
<td>Separation mechanism</td>
<td>Gravitational deposition</td>
<td>Inertial interception</td>
<td>Inertial interception</td>
<td>Inertial interception</td>
<td>Inertial/ direct interception</td>
<td>Direct interception/ diffusional deposition</td>
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<td>Very high</td>
<td>Moderate</td>
<td>Low</td>
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<tr>
<td>Turndown capacity</td>
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<td>30 % -50 %</td>
<td>30 %</td>
<td>25 %</td>
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<tr>
<td>Efficiency</td>
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<td>High down to approx. 25 µm</td>
<td>High down to approx. 25 µm</td>
<td>High down to approx. 10 µm</td>
<td>Very high down to 2-5 µm</td>
<td>Very high at sub-micron droplet sizes</td>
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<td>Liquid load capacity</td>
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<td>Very high</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
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<tr>
<td>Solids handling capability</td>
<td>Very high</td>
<td>Very high</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate-high</td>
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<tr>
<td>Liquid viscosity</td>
<td>Suitable for high viscosity</td>
<td>Suitable for high viscosity</td>
<td>Suitable for high viscosities/ waxes</td>
<td>Suitable for high viscosities/ waxes</td>
<td>Prone to fouling with high liquid viscosities/ waxes</td>
<td>Unsuitable for high liquid viscosities</td>
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<tr>
<td>Pressure drop</td>
<td>Very low</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
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</table>

Table A: Summary of relative performance characteristics for mist elimination

Design advice

Comprehensive performance information is available on a wide range of standard designs, enabling Sulzer engineering staff to tailor the mist eliminator design to suit most applications.

For best performance, it is important to achieve uniform gas flow distribution and maximum effective area, and recommendation can be given on the most appropriate positioning, in terms of disengagement distances from vessel inlet, outlet and other vessel internals.

Sizing

For equipment based on direct and/or inertial interception, gas stream velocity affects all three principles involved in separation (impingement, coalescence and drainage). Flooding, or re-entrainment of liquid, can occur if the flow of gas prevents drainage, and the effective area of the mist eliminator is therefore established by determining an appropriate superficial velocity for the equipment. The overall performance of the mist eliminator is then a balance between efficiency and pressure drop.

\[ v = K \cdot \sqrt{\frac{\rho_l - \rho_v}{\rho_v}} \]

\( v \) = maximum superficial gas velocity  
\( \rho_l \) = liquid density  
\( \rho_v \) = gas density  
\( K \) = a constant which is specific to the separation equipment and is a function of process parameters such as:
- Liquid loading
- Gas and liquid viscosity
- Gas pressure
- Surface tension

Derating factors are often applied to allow a safety margin for exceptional conditions such as liquid slugs and gas surges, and the K-value can be optimized to suit specific process conditions, and challenging physical properties such as low surface tension systems. The selection of K-value is therefore critical and we recommend that designs should be checked by our engineering team.

<table>
<thead>
<tr>
<th>Equipment type</th>
<th>K-Value m/s</th>
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<tbody>
<tr>
<td>Gravity</td>
<td>0.07</td>
<td>0.23</td>
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<tr>
<td>Sulzer Mellachevron – simple profiles</td>
<td>0.13 – 0.17</td>
<td>0.42 – 0.56</td>
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<tr>
<td>Sulzer Mellachevron – high capacity profiles with drainage channels</td>
<td>0.15 – 0.45</td>
<td>0.49 – 1.46</td>
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<td>0.08 – 0.12</td>
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<td>0.08 – 0.15</td>
<td>0.26 – 0.49</td>
</tr>
<tr>
<td>Sulzer MKS Multi Cassette</td>
<td>0.10 – 0.30</td>
<td>0.33 – 1</td>
</tr>
<tr>
<td>Shell VersiSwirl</td>
<td>0.15 – 0.30</td>
<td>0.5 – 1</td>
</tr>
</tbody>
</table>
KnitMesh mist eliminators

Sulzer KnitMesh™ wire mesh mist eliminators

Sulzer KnitMesh mist eliminators have an excellent track record as a low cost, highly versatile and efficient method of removing liquid entrainment from gas streams. They are produced as a bed of knitted mesh which presents a tortuous path and large surface area to the droplets entrained in the gas stream. Separation is achieved by impingement on, and capture by, the filaments of the mesh where the droplets coalesce and drain. Installation can be made in a variety of ways but gas flow is usually either vertically upwards, with the liquid draining counter-current to gas flow, or horizontal, with the liquid draining in a direction perpendicular to the gas flow.

Each mist eliminator is tailor-made to suit the dimensions of the vessel or housing into which it will be installed. Most KnitMesh wire mesh mist eliminators are supplied complete with rigid support grids, which allow direct installation onto appropriate supports such as beams and rings within the vessel. Sectional installation allows ease of handling and access through vessel manways.

Accessories such as tie wire, bolting, clamps and support beams can be supplied where necessary.

Standard designs are available for routine applications, providing excellent separation efficiency down to droplet sizes as small as 2 µm, and with a pressure drop typically less than 2.5mbar. A selection of standard styles is described in Table B. Alternatively, we can provide optimized designs to suit specific duties using sophisticated design tools.

### Metal Designs

<table>
<thead>
<tr>
<th>Material</th>
<th>Type number</th>
<th>Free volume</th>
<th>Density (lb/ft³)</th>
<th>Specific surface area (ft²/ft³)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal</td>
<td>9001</td>
<td>97.5%</td>
<td>12</td>
<td>192</td>
<td>196 643</td>
</tr>
<tr>
<td>Metal</td>
<td>9033</td>
<td>97.5%</td>
<td>12</td>
<td>192</td>
<td>110 350</td>
</tr>
<tr>
<td>Metal</td>
<td>9032</td>
<td>97.75%</td>
<td>10.5</td>
<td>170</td>
<td>93 305</td>
</tr>
<tr>
<td>Metal</td>
<td>9030</td>
<td>98%</td>
<td>9</td>
<td>144</td>
<td>79 258</td>
</tr>
<tr>
<td>Metal</td>
<td>9030-L2</td>
<td>96%</td>
<td>9</td>
<td>144</td>
<td>147 482</td>
</tr>
<tr>
<td>Metal</td>
<td>9069</td>
<td>98.5%</td>
<td>7</td>
<td>107</td>
<td>109 358</td>
</tr>
<tr>
<td>Metal</td>
<td>9036</td>
<td>98.75%</td>
<td>6</td>
<td>96</td>
<td>52 172</td>
</tr>
<tr>
<td>Metal</td>
<td>4530</td>
<td>96%</td>
<td>6</td>
<td>96</td>
<td>52 172</td>
</tr>
<tr>
<td>Metal</td>
<td>4540</td>
<td>99%</td>
<td>5</td>
<td>80</td>
<td>44 145</td>
</tr>
<tr>
<td>Plastic and other materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass Wool</td>
<td>9036</td>
<td>93%</td>
<td>12</td>
<td>195</td>
<td>450 1500</td>
</tr>
<tr>
<td>Glass Wool</td>
<td>9048</td>
<td>95%</td>
<td>8.25</td>
<td>135</td>
<td>300 1000</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>9008</td>
<td>95%</td>
<td>2.75</td>
<td>45.5</td>
<td>320 1050</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>9030</td>
<td>93%</td>
<td>4.5</td>
<td>74</td>
<td>250 820</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>9036</td>
<td>95%</td>
<td>2.75</td>
<td>44.5</td>
<td>150 495</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>9048</td>
<td>97%</td>
<td>2</td>
<td>41</td>
<td>110 360</td>
</tr>
<tr>
<td>Multifilament</td>
<td>9033</td>
<td>94%</td>
<td>19</td>
<td>305</td>
<td>340 1115</td>
</tr>
<tr>
<td>Multifilament</td>
<td>9030</td>
<td>95%</td>
<td>13.5</td>
<td>215</td>
<td>250 820</td>
</tr>
<tr>
<td>Multifilament</td>
<td>9036</td>
<td>96%</td>
<td>9</td>
<td>145</td>
<td>160 525</td>
</tr>
<tr>
<td>Multifilament</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEP</td>
<td>9048</td>
<td>94%</td>
<td>8</td>
<td>128</td>
<td>250 820</td>
</tr>
<tr>
<td>ETFE</td>
<td>9048</td>
<td>95%</td>
<td>5.25</td>
<td>85</td>
<td>220 725</td>
</tr>
</tbody>
</table>

Table B: Standard Sulzer KnitMesh mist eliminator types
KnitMesh mist eliminators

Sulzer KnitMesh V-MISTER™

The Sulzer KnitMesh V-MISTER provides high performance wherever liquid entrainment must be removed from a vertically flowing gas stream. Mist eliminators with Sulzer KnitMesh V-MISTER technology employ the mechanism of a Von Karman Roll around a bluff body (see Figure 1a) to obtain high vapor and liquid handling capacity. A vortex develops in a low pressure zone downstream of the channel that has been attached to the bottom of the mesh pad. Collected droplets deposit in the trough and form a flowing liquid stream there. Contrast this with the standard mesh pad (see Figure 1b) where a two phase "fluidized" zone of gas and liquid develops in the bottom third to half of the pad and from which large coalesced droplets must ultimately drain counter-current to the ascending stream. The high capacity channels of the Sulzer KnitMesh V-MISTER shield the collected liquid and then drain it in steady streams from two sides of the mist eliminator at the column wall, where gas velocity is so low that re-entrainment is limited (see Figure 2).

This simple enhancement to a standard mesh pad improves mist elimination because the higher velocities increase the droplets' inertial impaction with the wires or filaments. Summarized the V-MISTER collecting channels provide an increased liquid capacity of up to 300 % and a higher gas throughput of up to 20 %.

The unique Sulzer KnitMesh XCOAT™ mist eliminator: the perfect solution for corrosive services

Sulzer has developed a completely new KnitMesh mist eliminator for corrosive services. The Sulzer KnitMesh XCOAT is based on a metal wire which is coated with 100% pure PTFE. This new mesh material is unique and available exclusively through Sulzer.

Sulzer KnitMesh XCOAT mist eliminators are characterized by a high deformation, corrosion and temperature resistance, and are therefore ideal for applications which have to deal with acids such as sulfuric, acetic and nitric acid.

The advantage of longer service time of the Sulzer KnitMesh XCOAT mist eliminator compared to common wire mesh pads using Teflon filaments or higher alloyed and acid-resistant steel wires has been demonstrated in several industrial applications.
KnitMesh mist eliminators

High performance Sulzer KnitMesh™ 9797 mist eliminators

The Sulzer KnitMesh 9797 Mist Eliminator technology provides means of optimizing designs to meet the challenges of specific applications.

Unlike ‘industry standard’ mist eliminator design methods, which predict performance using bulk density and filament diameter of the separation media, the 9797 modeling techniques consider the characteristics of individual mesh layers as a mathematical model so that the entire process within the separator (capture, coalescence and drainage) can be predicted on a layer by layer basis. This enables Sulzer to produce unique structures where the free volume and mesh free area can be varied through the depth of the pad, giving the best balance of mist eliminator characteristics, such as liquid hold-up and efficiency, from inlet to outlet. Additionally, separation efficiency can be predicted in terms of liquid entrainment concentration providing meaningful, measurable information on separator performance; a considerable improvement on droplet size efficiency predictions which are extremely difficult to verify in practice.

Fig. 3 illustrates one layer of mesh within the mist eliminator and stages of separation considered by the performance model:
• D1 avoids capture and moves in to the next layer of mesh.
• D2 is captured by the mesh.

An extensive range of mesh styles have been analyzed for a variety of process systems ranging from air/water to more challenging hydrocarbon conditions. The performance of the mist eliminator is established by calculating the cumulative effect of combined mesh layers and their characteristics. The model allows a high degree of optimization so that layer specifications can be varied to meet specific process challenges. For example, high free volume/low liquid hold-up may be an important feature of the inlet region of the mist eliminator with a gradual increase in separation efficiency towards the outlet.

Existing applications for Sulzer KnitMesh 9797 Mist Eliminators include:
• glycol contactors – minimization of TEG entrainment from natural gas dehydration columns (see p 21).
• gas sweetening – installation in amine absorbers
• dew-point separators – 9797 designs have helped reduce water and hydrocarbon dew-points in natural gas processing (see p 23).
• rotary screw compressors – reduction of entrainment of synthetic oil from compressor system knock-out drums
• steam drums – guaranteed steam dryness can be achieved using Sulzer KnitMesh 9797 mist eliminators

Fig. 4 represents a bed with N layers of mesh.

By assuming that:
\[ V_0 \] is the volume of droplets entering Layer 1
\[ V_n \] is the volume of droplets leaving layer N
\[ E_i \] is the individual layer efficiency.

then the overall efficiency of the mist eliminator can be expressed as:
\[ V_N = V_0 \prod_{i=1}^{N} (1 - E_i) \]
Mellachevron

Sulzer Mellachevron™ mist eliminators

Sulzer Mellachevron vane mist eliminators are high capacity inertial separators constructed as banks of parallel, chevron profiles which cause the gas to change direction several times from inlet to outlet. Momentum forces entrained liquid droplets to impinge on the vane surfaces where they form a liquid film and drain.

The Sulzer Mellachevron range is divided into a number of categories depending on direction of gas flow and the complexity of the vane profile.

Simple Sulzer Mellachevron profiles separate liquid by impingement, coalescence and drainage on the vane surface with no disengagement of the liquid from the gas stream. They are particularly suitable for applications with a significant risk of fouling due to solid particles or high viscosity liquids in the feed but have relatively low gas handling capacity.

More sophisticated designs provide special separation channels to allow disengagement of liquid and drainage from the vane surface. This increases the capacity of the separator and gas load factors of up to 0.45 m/s are possible. This makes them an excellent choice when equipment size is critical, for example, in offshore applications or for de-bottlenecking existing equipment.

Complex Mellachevron profiles require housings which ensure that the vanes are assembled accurately and provide a liquid sump for drainage of liquid into the vessel or column.

Sulzer Mellachevrons are available in various profiles and materials such as stainless steels, alloys or plastics.

Simple Mellachevron profile with countercurrent drainage of liquid from vane surface.
Mellachevron designs are available for installation in either vertical or horizontal gas flow. When gas flow is horizontal, the liquid film on the surface of the vane drains vertically downwards into a liquid sump. Complex Mellachevron profiles are used with hooks or drainage channels which help to disengage the liquid from the gas stream and prevent re-entrainment from the downstream face.

Typical housing arrangement for cross-flow Mellachevron. Sectional installation allows installation and removal through manway and vane profiles can be dismantled individually for cleaning if necessary. Liquid is collected in the sump and drained through the downcomer pipe connection.

### Table C: Sulzer Mellachevron mist eliminator styles

<table>
<thead>
<tr>
<th>Type</th>
<th>C - profile</th>
<th>Z - profile</th>
<th>C or Z - profile with large vane spacing</th>
<th>Complex profile - integral drainage channel</th>
<th>Z-profile with drainage hooks</th>
<th>Z-profile with large vane spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Direction</td>
<td>Vertical</td>
<td>Vertical</td>
<td>Vertical or horizontal</td>
<td>Housing and drainage system required.</td>
<td>Housing and drainage system required.</td>
<td>Housing and drainage system required.</td>
</tr>
<tr>
<td>Installation</td>
<td>No housing</td>
<td>No housing</td>
<td>No housing</td>
<td>Housing and drainage system required.</td>
<td>Housing and drainage system required.</td>
<td>Housing and drainage system required.</td>
</tr>
<tr>
<td>Gas handling capacity</td>
<td>0.17 m/s</td>
<td>0.14 m/s</td>
<td>0.14 – 0.17 m/s</td>
<td>0.17 – 0.45 m/s</td>
<td>0.35 m/s</td>
<td>0.35 m/s</td>
</tr>
<tr>
<td>(K-values)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turndown capability</td>
<td>≈ 30 - 50 %</td>
<td>≈ 30 - 50 %</td>
<td>≈ 30 - 50 %</td>
<td>≈ 30 - 50 %</td>
<td>≈ 30 - 50 %</td>
<td>≈ 30 - 50 %</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Medium down to ≈ 30 – 40 μ</td>
<td>Medium – High down to = 25 μ</td>
<td>Low – Medium down to = 30 – 50 μ</td>
<td>High down to = 10 – 15 μ</td>
<td>Medium down to = 25 – 30 μ</td>
<td>Low – Medium down to = 35 – 40 μ</td>
</tr>
<tr>
<td>Liquid load capacity</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate to High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Solids handling capability</td>
<td>Moderate to High</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low to Moderate</td>
</tr>
<tr>
<td>Liquid viscosity</td>
<td>Suitable for high viscosities/waxes</td>
<td>Suitable for high viscosities/waxes</td>
<td>Very suitable for high viscosities/waxes</td>
<td>Prone to fouling with high viscosities/waxes</td>
<td>Prone to fouling with viscosities/waxes</td>
<td>Suitable for high viscosities/waxes</td>
</tr>
<tr>
<td>Typical applications</td>
<td>Vacuum, general use, fouling service</td>
<td>Desalination, general use, fouling service</td>
<td>As for C and Z profiles but high fouling/low pressure drop services</td>
<td>Debottlenecking, off-shore, clean services, gas &amp; steam processing</td>
<td>Horizontal scrubbers</td>
<td>As for C and Z profiles but high fouling / low pressure drop services</td>
</tr>
<tr>
<td>Pressure drop</td>
<td>Very low</td>
<td>Low</td>
<td>Very low</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Typical applications for C and Z profiles include vacuum, general use, and fouling service. Desalination, general use, and fouling service are also common applications. Debottlenecking, off-shore, clean services, gas & steam processing, and horizontal scrubbers are potential applications for C and Z profiles, but these applications may be limited by high fouling or low pressure drop services.
Sulzer Mellachevrons can be installed in a variety of vessel configurations and as arrangement of multiple vane boxes to provide optimum flow and drainage characteristics within the space available. Typical box and vessel arrangements are illustrated below in Fig. 5a and 5b.

The sophisticated vane profile with integral drainage channels of our Mellachevron H45D and V35D high performance vane packs provide significant advantages over conventional vane mist eliminators, including:

- reduced pressure drop at high gas load factors
- improved liquid drainage and gas streamlining based on hollow blade concept
- up to 40 % higher gas load capacity

Fig. 5a

Double Box with KnitMesh pre-conditioner

Four Box

V-bank

Fig. 5b

1. Vertical flow
2. Cross flow – horizontal vessel
3. Cross flow – two-stage separator
4. V-bank
5. Cross flow – in-line separator
Axial cyclonic devices

Shell VersiSwirl™

Shell VersiSwirl axial cyclone represents an evolution of the long established SMS, SVS, SMSM and SMMSM family of separators. In comparison with the previous generations of technologies, Shell VersiSwirl gives a step-change in performance in terms of efficiency and capacity allowing for either smaller vessel or greater capacity. The numerous technological improvements incorporated in the Shell VersiSwirl include a new aerodynamic swirler, optimized secondary gas handling and liquid film drainage. In the Shell VersiSwirl, liquid is separated from the gas stream by impact of liquid droplets on axial cyclone tube wall which are then drained via slits into a collection chamber. The droplets are forced to the wall by centrifugal forces induced by the gas vortex generated by the swirler.

For the most demanding duties, the Shell VersiSwirl can be combined with other technologies which provide an Edge over its already impressive performance. For non-critical duties, a Shell Schoepentoeter™ is used as standard, but in challenging applications, a Schoepentoeter Plus™ will greatly reduce entrainment from the inlet zone.

Shell Swirltube Light™

The Shell Swirltube Light is available as an attractive alternative to vane packs for high capacity bulk separation. The Swirltube Light is based on the sophisticated de-entrainment device used in the Shell ConSep™ Tray.

Recommended use:
- comparable efficiency but higher capacity compared to vane packs
- operation possible at higher pressures/ lower surface tensions than vane packs
- compact design makes it suitable for offshore industry or in general for high pressure conditions
- for debottlenecking of existing separators
- for high turndowns with pre-conditioner (up to factor 10)
- application for slightly fouling service and may be used where complex vanes or wire mesh mist eliminators may become plugged
Combined systems

Selection of the appropriate primary separator is key to the system’s overall performance, whether the intention is to optimize the droplet size reaching the Shell VersiSwirl or reduce liquid from the internals and prevent re-entrainment.

New combinations
- Shell VersiSwirl/Schoepentoeter Plus: optimized inlet device performance
- Shell VersiSwirl/V-MISTER: improved performance over the widest range of operation
- Shell VersiSwirl/Drainable KnitMesh, SLR + Schoepentoeter Plus: extra drainage capacity reduces the overall load in the vessel internals where critical guaranteed performance is a must.
- Shell VersiSwirl gives high performance for demanding applications and when combined with optimized technologies from Sulzer’s portfolio a tailored solution can be provided to meet the needs of the customer. For example, Shell VersiSwirl followed by a Sulzer MKS Multi Cassette deck to meet extra high separation efficiencies.
Combined systems

Increasing gas capacities and higher performance requirements in mass transfer equipment are challenging the capabilities of conventional mist eliminator equipment.

To solve this, Sulzer offers combined systems which optimize the benefits of individual types of equipment and improve overall performance.

For example, KnitMesh mist eliminators can be used in combination with Sulzer Mellachevron vane packs or Shell VersiSwirl to produce very high separation efficiencies at high gas loadings. By using the KnitMesh mist eliminator as a pre-conditioner for the Mellachevron, it is operated above its normal re-entrainment or flooding point and consequently liquid is stripped away from the downstream surface.

The liquid dispersion re-entrained from the mesh mist eliminator has a larger mean diameter (see Fig. 6) and is suitable for subsequent separation by secondary, high capacity equipment.

By analysis of the inlet fluid conditions, Sulzer can design optimized mesh structures to provide the best possible outlet conditions for the downstream separator.

Additional benefits of combined systems include:
- The ability to design the equipment to provide very high turndown capabilities.
- At low gas velocities, where high capacity separators tend to be ineffective, the mesh pre-conditioners behave as conventional mist eliminators.

High capacity separators with Sulzer Mellachevrons™

The diagrams illustrate the flow and separation processes in vertical, in-line, and two-stage separators.
### Applications

**Natural gas dehydration with TEG**

<table>
<thead>
<tr>
<th>Old fashioned</th>
<th>State of the art</th>
<th>High capacity</th>
<th>The ultimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubble Cap trays and KnitMesh™ mist eliminators</td>
<td>Mellapak™ and KnitMesh™ mist eliminators incl. the sophisticated KnitMesh 9797 type</td>
<td>MellapakPlus™, MellalGlycol™ and our high capacity mist eliminators such as MKS Multi Cassette™.</td>
<td>cMIST™ Compact Mass Transfer and Inline Separation Technology, incorporating our patented compact HiPer TwinLine™ Separator</td>
</tr>
</tbody>
</table>

**Characteristics**

<table>
<thead>
<tr>
<th>Old fashioned</th>
<th>State of the art</th>
<th>High capacity</th>
<th>The ultimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 1.8 F-Factor (√ (10^a))</td>
<td>~ 2.9 F-Factor</td>
<td>up to ~ 5 F-Factor</td>
<td>n/a</td>
</tr>
<tr>
<td>167% column diameter</td>
<td>131% column diameter</td>
<td>100% column diameter</td>
<td>21% column diameter</td>
</tr>
<tr>
<td>100% weight of column</td>
<td>73% weight of column</td>
<td>51% weight of column</td>
<td>35% weight of column</td>
</tr>
</tbody>
</table>

**Using Sulzer’s sophisticated KnitMesh 9797 technology in glycol contactors**

The first application for Sulzer KnitMesh 9797 mist eliminators was for installation on an offshore platform in the North Sea. The requirement was to control and reduce the glycol entrainment (as liquid drops) in the gas prior to compression and export. In offshore facilities the implications of entrainment from the dehydration columns are not only on the value of the glycol lost (and re-supply from shore), but also the consequences of admitting the excess glycol into the gas export pipeline. Notwithstanding possible operational problems for the pipeline, the increased separation load at the shore terminal to separate gas condensate and glycol, and disposal of the glycol phase, are significant costs. The “industry standard” figure defining the maximum entrainment of 0.1 US gallons per MMSCF gas was therefore challenged and had to be improved upon. The mist eliminator supplied with this application was shown to significantly reduce the free glycol loss in the exit to < 0.05 US gallons per MMSCF gas, a figure verified after measurement of total glycol loss from the dehydration unit.
Applications

Using Sulzer’s MKS Multi Cassette™ technology in glycol contactors

The first application for Sulzer MKS Multi Cassette mist eliminators was for installation in Glycol Contactors in Russia. The contactors were revamped from trays to Sulzer MellapakPlus and were operated at very high gas loading factors. In order to keep the glycol loss low at this high column gas throughput the MKS Multi Cassette mist eliminators were installed in the contactor top section. The application has shown to meet measured glycol losses of < 0.1US gallons per MMSCF gas.

The patented Sulzer MKS Multi Cassette mist eliminator combines the useful centrifugal forces in cyclones with the high separation efficiency of wire mesh packings to give a new superior demisting device.

Glycol dehydration process using Shell SMSM internals in the feed inlet scrubber and MKS Multi Cassette in the glycol contactor

Highly efficient liquid scrubbing from the gas feed to glycol contactors is needed in order to avoid bottlenecks in the dehydration system caused by hydrocarbon carry over which can lead to foaming and excessive overall glycol losses. Sulzer’s mist elimination products such as Sulzer KnitMesh, Sulzer MKS Multi Cassette and Shell Separators meet for these high process demands.

Condensate treatment unit
Application of Sulzer’s liquid/liquid separator products such as:
- Sulzer Mellaplate™ plate pack

Glycol regeneration unit
Application of Sulzer’s mass transfer products in the glycol regeneration facility.
- Sulzer DC Coalescer™
- Sulzer Dusec™ and Dusec Plus™
- Sulzer Static Mixers
Applications

**Low Temperature Separation (LTS) Process**
The performance of the gas separators in LTS Processes is crucial in order to meet the hydrocarbon and water dew point specifications. The dew point separator is especially essential for the overall performance of the plant. Even small amounts of entrained liquids will rapidly appear as increased dew point in the sales gas. To obtain the best from the LTS Process, the high performance Shell VersiSwirl 231 or Sulzer MKS Multi Cassette or the combination of both is used in the Expander Suction Drum and in the Dew Point Control Separator, and the Shell VersiSwirl 211 or Sulzer MKS Multi Cassette or a combination of both in the Inlet Separator and in the Export Compressor Suction Drum.

**Molecular sieve dehydration process**
The effect of a high performing Feed Inlet Separator on the deactivation rate of the molecular sieves is substantial. The water absorption capacity deteriorates badly over time as the co-adsorbed hydrocarbons accumulate in the molecular sieve. Sulzer recommends the use of a drum with Schoepentoeter and a high efficiency KnitMesh mist eliminator or the Shell VersiSwirl 211/231 or the Sulzer MKS Multi Cassette when high capacity and efficiency are required.
Applications

Mist eliminators in desalination processes

Desalination by multi-stage flash evaporation or multiple effect distillation unit is by far the most widely used method of generating fresh water from brine or sea water in the world. It is extremely reliable and can produce high purity water from almost all forms of feed. The process involves evaporating water from a brine solution and condensing the vapor as fresh water.

However, the performance of any flash evaporator can deteriorate if liquid entrainment is carried over from the flash chambers into the condenser tube bundles. This is a very likely occurrence in view of the high velocities and volumetric flowrates experienced in these plants, and can lead to problems such as:

- Reduced water purity
- Scaling of condenser tube bundle and downstream equipment such as boilers
- Corrosion of downstream equipment

Sulzer Mist Eliminators are designed to reduce these problems and are installed in most desalination systems.

Our experience in desalination has helped us develop a range of equipment to meet the specific process needs of our customers, and great care is taken to ensure that the optimum design is offered for any particular duty. The main factors to consider in desalination applications are:

- Efficiency
- Pressure drop
- Fouling characteristics and the tendency to scale
- Materials of construction

Sulzer KnitMesh mist eliminators

Sulzer KnitMesh mist eliminators are ideally suited to most desalination applications. In multi-stage flash evaporators the mist eliminators are installed directly above the flash chambers. Water vapor rises vertically upwards through the mist eliminator and passes into the condenser tube bundle. Any entrained liquid droplets are captured on the wires where they coalesce and drain, counter-current to the vapor flow, back into the flash chambers. The separation mechanism is similar to this in multiple effect distillation systems.

The combination of high free volume and specific surface area mean that excellent efficiencies can be achieved for droplets as small as 5 µm while presenting minimum pressure drop.

High capacity designs

To achieve the required capacity, the evaporators are often very large and the mist eliminators usually cover a large effective free area above the flash chambers. The total area required is determined by calculation of the mist eliminator capacity and is a very important part of the plant design. Clearly, any opportunity to reduce the capital cost of the evaporators is very attractive and the capacity of the mist elimination equipment is of vital importance in this calculation.

Most installations are designed using a conventional K-value of 0.107 m/s but Sulzer has developed the novel high capacity type 4540NS KnitMesh mist eliminator which can operate at up to 20% higher K-values, providing the opportunity for either reduced equipment size or an increase in capacity. Major projects have been successfully commissioned using the Sulzer KnitMesh 4540NS mist eliminators in Oman, Algeria and the UAE.

Sulzer Mellachevron mist eliminators

Precipitation of salts and scale on the wires of KnitMesh mist eliminators can be a problem in some plants, particularly in the first two or three effects of the evaporation. In these circumstances, the Mellachevron Type V20Z has been used to overcome the problem. This simple vane profile provides high separation efficiency performance for droplets larger than 30 µm, and its ability to withstand heavy scaling applications makes it an ideal alternative to the KnitMesh mist eliminators when fouling is of concern. Its robust construction makes it easy to clean, and the Mellachevron V20Z also has a relatively low pressure drop compared to the more complex Mellachevron designs with drainage hooks and channels – an important factor when designing for large volumetric flowrates at low pressure.
Comprehensive engineering services markets

Development and technology

Sulzer makes every effort to support our customers and continuously improve our design tools. Engineers in the R&D lab develop new and improved products, analyze and optimize processes.

We maintain close relationships to universities and independent research organizations to support these efforts.

Engineering and manufacturing

Sulzer has a long-standing manufacturing tradition. Sulzer owns dedicated factories in many regions to produce mixers, columns, reactors, and heat exchangers.

For certain sizes and certain countries, we work with well-known and proven subcontractors who are bound by Sulzer manufacturing policies and quality standards.

Capabilities

Manufacturing according to PED 97/23/EC, ASME VIII Div.1, and ASME B31.3/U-Stamp, Gost (TR), China Stamp, Norsok, or NACE

Design codes acc. to AD2000, EN 13445, ASME Broad selection of material for construction available

Non-destructive testing (LPT, X-ray, pressure testing up to 500 bar, PMI, MT, UT etc. acc. EN and ASME)

Designing with SolidWorks

Strength calculations, FEM analysis, nozzle loads etc.

Certification for ISO 9001, ISO 14001 and ISO 18001

Experienced project management team

CFD Analysis

CFD calculations done in advance of fabrication can support the decision to go for a particular technology, and can save on the time required for commissioning and testing later. Sulzer uses CFD technology both for the modeling of existing and the development of new products.