Removing Liquid from Gas

Liquid entrainment in a gas stream can be a disturbance in many industrial processes. In natural-gas processing, higher-order hydrocarbons, water, or impurities have to be separated from the main methane stream. Upstream of gas compressors, droplets that can damage the impellers, have to be removed. With the recently acquired Knitmesh technology and the strategic alliance with Shell Global Solutions, Sulzer Chemtech can supply a broad portfolio of advanced, tailor-made systems for gas/liquid separation to customers in all industries.
In many industrial processes, liquid has to be separated from process gas, e.g., in the dehydration of liquefied natural gas (LNG). Sulzer Chemtech offers a wide range of mist eliminators.

Liquid entrainment in a gas stream can be caused 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 bursting bubbles, e.g., in distillation columns. When saturated gases are cooled, the vapor condenses and the gas can become locally supersaturated, causing droplet formation. This type of condensation mist can occur in heat exchange processes, during a sudden release of pressure, or by mixing hot and cold gas streams.

Removing Liquid Entrainment

If the gas is traveling too fast for the liquid droplets to settle out under gravity, they become suspended, or entrained. In most cases, the entrainment must be removed to prevent process disturbance or environmental contamination. Installation of mist eliminators is an effective solution to liquid entrainment problems in process applications including scrubbing, absorption, stripping, or distillation columns, evaporators, as well as desalination, refrigeration, and gas dehydration plants (Fig. 1).

Equipment for all Cases

Several types of mist eliminators exist for the separation of entrained liquid. In order to choose the appropriate equipment, it is necessary to consider the different mechanisms used to capture droplets on a wire or other surfaces (Fig. 2). Industrial gas/liquid separators rely upon diffusional deposition, direct or inertial interception, or a combination of these mechanisms (Fig. 3).

The droplet size distribution determines the suitable mechanism for each application. One example is gas drying using glycol contactors, where droplet sizes often lie in the range of 5–25 µm. Here, direct and inertial interception are the most appropriate mechanisms and separation is best achieved by impingement of droplets in high-performance mist eliminators. Conversely, this type is often inappropriate for separation of acid mists in sulfuric-acid plants, where sub-micron droplets are formed and diffusional deposition must be considered.

Finding the Right Size

For equipment based on direct or inertial interception or a combination of both, gas stream velocity affects all 3 principles involved in separation (impingement, coalescence, and drainage). A relation between gas/vapor density, liquid density, and gas velocity, expressed as K-value, governs the required area for such mist eliminators. For diffusional interception to occur, superficial gas velocities have to be low, typically they are one-tenth of that for inertial interception. On the other hand, pressure drop across candle filters is up to 10 times higher than that across vane pack and wire-mesh mist eliminators and usually determines their sizing. This constraint often leads to large surface areas and consequently large vessel sizes.

Demisting Devices

Baffles, louvers, and vane packs rely upon inertial interception of droplets on the separator surface, usually banks of plates or blades around which the gas must pass. Because of their mass, large droplets deviate from the gas flow and are captured and separated on the plates. Vane packs, like the Sulzer Mellachevron™, are more sophisticated and specifically designed to handle high-volume gas flow and reduce fouling. They are ideal for duties with heavy liquid loads or where the capacity of conventional wire mesh mist eliminators is exceeded. Sulzer Chemtech now offers the Sulzer Knitmesh™ range, knitted...
Wire-mesh mist eliminators that are a low cost, highly versatile, and efficient method of removing liquid entrainment from gas streams. In typical vertical-flow applications, separation is achieved by impingement on and capture by the filaments where the droplets coalesce and drain towards the lower face of the mist eliminator, before disengaging and draining away from the pad against the flow of incoming gas.

Combined Systems
Increasing gas capacities and higher performance requirements are challenging the capabilities of conventional mist eliminator equipment. To solve this, Sulzer Chemtech offers combined systems which employ 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 (Fig. 4) or with Shell Swirltubes axial-flow cyclones (see STR 2/2005, p. 11) to produce very high separation efficiencies at high gas loadings.

When using the Knitmesh mist eliminator as a preconditioner for the Mellachevron or Swirltubes, it is operated above its normal flooding point and consequently liquid is stripped away from the downstream surface. However, the liquid dispersion re-entrained from the preconditioner has a larger mean diameter and is suitable for subsequent separation by secondary, high-capacity equipment such as vane packs (Fig. 5). At low gas velocities, where vane packs tend to be ineffective, preconditioners behave as conventional wire mesh mist eliminators.

Sulzer Chemtech supports customers with its engineering expertise allowing proper selection of equipment and its design philosophy. The division’s experts are also able to provide assistance with complex product separation processes, construction and engineering drawings, as well as on-site consultations during the construction and installation phase.

Tailor-Made Knitmesh Mist Eliminators
Industry standard designs are ideal for routine applications. For more demanding applications, Sulzer Chemtech uses sophisticated modeling techniques to tailor the wire-mesh mist eliminator structure to specific process requirements. This moves the design of wire mist eliminators away from conventional industry rules and provides a more precise method of predicting performance over a range of possible inlet conditions, so that the effects of changing drop size distribution and liquid holdup can be considered.

Depending on droplet size and gas velocity in the process, industrial mist eliminators rely upon a combination of physical mechanisms for droplet collection.