Liquid Distribution

Liquid distributors are used above each bed of packing in a packed column to provide uniform liquid distribution. The distributor, depending on its design features, is generally located 6 to 8 in. [150 to 200 mm] above the packing. The distributor type determines vertical spacing and the proper distance needed to disengage the vapor phase from the packing before the vapor passes through the distributor gas passage area.

An ideal distributor has the following attributes, each providing a specific effect on the overall performance of the packed tower:

• Uniform liquid distribution
• Resistance to plugging or fouling
• Wide operating range
• Low vapor phase pressure drop
• Minimal use of vessel height
• Strength for long life without sagging

These important attributes are well understood by Koch-Glitsch and have been incorporated in Koch-Glitsch distributors since the 1980s. They are an integral part of design of the plastic INTALOX® distributors.

Koch-Glitsch offers two categories of liquid distributors to meet the requirements of various services:

• INTALOX Distributors
• Traditional Distributors

In choosing which category to use, it is important to know whether the liquid distribution quality will significantly affect the overall tower performance.

INTALOX Distributors

INTALOX distributors are designed to high standards of distribution uniformity, with emphasis on a uniform pattern of distribution points and minimal variation of flow among points. They provide distribution quality close to that achieved in metal high-performance INTALOX distributors.

Koch-Glitsch plastic INTALOX distributors are used for absorption services with multiple transfer units, solvent desorption “back pressure,” close approach to phase equilibrium, or minimal solvent consumption. These columns can be sensitive to liquid distribution quality. In stripping and heat transfer services, similar issues of phase equilibrium and close temperature approach indicate INTALOX distributors should be used.

Because challenging services often use the best packing, INTALOX distributors are used with FLEXIPAC structured packing, INTALOX SNOWFLAKE and BETA RING high performance random packing, and CASCADE MINI-RINGS high capacity random packing.

Traditional packings may be used with INTALOX distributors, such as when a process is licensed and specified with a certain type of packing.

Traditional Distributors

Traditional distributors generally have less uniform distribution patterns and more flow variation between distribution points. In columns that are not sensitive to liquid distribution quality, they may be used for their versatility, fouling resistance, or low cost.

Koch-Glitsch plastic traditional distributors are used for absorption services with few transfer units, no solvent desorption “back pressure,” no significant approach to equilibrium, or excess solvent circulation. These columns are generally insensitive to liquid distribution quality. In stripping and heat transfer services, similar issues of no “back pressure,” excess quench liquid, or wide temperature approaches indicate that traditional distributors will work well.

Because simpler services often use long-established packings, traditional distributors are often used with FLEXIRING® Packing and Super INTALOX Saddles.

High performance packing may be used with traditional distributors when only certain aspects of high-performance packing are desired. Examples include use of INTALOX SNOWFLAKE packing for its high capacity or use of FLEXIPAC structured packing for its low pressure drop. In addition, severely fouling services may require large weirs, which are available only with traditional distributors.

Liquid Redistribution

There are six reasons to separate a single packed bed into two packed beds and redistribute the liquid:

• Feed introduction
• Product side draw
• High transfer unit count
• Desire to cross-mix the liquid
• Liquid maldistribution
• Physical weight of the packed bed

A conservative rule-of-thumb is to limit a single packed bed of plastic packing to no more than 10 transfer units. In addition, the depth of a single bed should be no more than 15 times the column diameter. Both of these limits can be exceeded in some cases.

Liquid redistribution in columns with multiple packed beds can be accomplished by either of the following methods:

• Using a liquid collector plate below the upper bed to feed a liquid distributor that is located above the lower bed.
• Using a liquid redistributor between the beds to combine the liquid collection and distribution into one device, as illustrated on page 19.
Distribution Point Density
The density of the distribution points can affect the efficiency of the top of a packed bed. For example, high point densities can make the distributor more prone to fouling because of smaller orifices. However, with the commonly used random and structured packings, the effect of point density is relatively minor. The difference between 5.5 and 14.5 points/ft² [60 to 155 pts/m²] has a slight effect on the packing Height of a Transfer Unit (HTU).

Point density is not the key to liquid distribution quality.

Cross Flow Capacity
At high liquid rate, the cross flow capability of a distributor and its pre-distribution system are important. Gravity-fed distributors are dependent on liquid level to determine flow; therefore, it is important to balance the liquid properly to provide uniform point-to-point flow. Pre-distribution is achieved by feed pipes and parting boxes. The pre-distribution system must properly meter liquid to one or more appropriate points on the distributor without inducing excessive horizontal velocity, gradients in liquid head, or turbulence. The design of the pre-distribution system becomes increasingly complex as the specific liquid rate and the column diameter increases.

Fouling
For a distributor to perform correctly, the metering device must not become fouled. There are several sources of fouling materials: polymerization, non-soluble deposits, scale, construction debris, sediment, and so forth. Precautions should be taken to keep fouling materials out of the column, because external strainers and filters are much easier to clean than distributors. If it is not possible to eliminate all external fouling sources, or if the source of the fouling material is within the column itself, then the distributor should be considered for its fouling resistance.

The order of fouling resistance of various metering devices on liquid distributors, starting with the most resistant is:

- V-notch weir
- Spray distributor
- Slotted weir
- Elevated orifice
- Bottom orifice

Orifice Size
In gravity-fed distributors, the orifice size depends on the distribution point density, the specific liquid rate and height of the liquid. For a single-level orifice with an operating range of 60 to 120% of the design flow, the approximate orifice size is shown in the chart below.

Approximate Orifice Size for Gravity Flow Distributors

<table>
<thead>
<tr>
<th>Normal Flow Rate (m³/m² h)</th>
<th>Orifice Diameter (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>25</td>
<td>0.25</td>
</tr>
<tr>
<td>50</td>
<td>0.50</td>
</tr>
<tr>
<td>75</td>
<td>0.75</td>
</tr>
<tr>
<td>100</td>
<td>1.00</td>
</tr>
<tr>
<td>125</td>
<td>1.25</td>
</tr>
<tr>
<td>150</td>
<td>1.50</td>
</tr>
</tbody>
</table>

Normal Flow Rate (gpm/ft²)
<table>
<thead>
<tr>
<th>Normal Flow Rate (gpm/ft²)</th>
<th>Orifice Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>0.25</td>
</tr>
<tr>
<td>20</td>
<td>0.50</td>
</tr>
<tr>
<td>30</td>
<td>0.75</td>
</tr>
<tr>
<td>40</td>
<td>1.00</td>
</tr>
<tr>
<td>50</td>
<td>1.25</td>
</tr>
<tr>
<td>60</td>
<td>1.50</td>
</tr>
</tbody>
</table>

Operating Range
A distributor performs best at its design liquid flow rate. As the rate decreases and the liquid head drops, levelness of the distributor and hydraulic gradients on the distributor become a larger percentage of the operating liquid head. At some turndown rate, the point-to-point flow variation will fall outside of acceptable limits. Plastic INTALOX distributors are designed for a maximum flow variation, defined as the coefficient of variation (Cv) of no more than 8% at design rates and no more than 15% at turndown rates. Special designs are available for many INTALOX distributors that will result in even lower flow variation. Turndown ranges for various distributor models are given in the description of each distributor.

Koch-Glitsch traditional distributors allow greater flow variations than INTALOX distributors and typically are rated for a broader range of operation. For high turndown requirements, multiple orifice levels or slotted weirs may be used with some INTALOX distributor designs as well as traditional distributor styles. When these metering styles are used, the flow variation will be higher through part of the operating range than with a single level orifice. In many cases, the higher flow variation will exceed the limits for an INTALOX distributor.
Model TP206, TS206 INTALOX® Pan Distributor (Model TP207/TS207 Redistributor)

- Diameters 10 - 48 in. [250 – 1200 mm]
- Liquid rates above 0.5 gpm/ft² [1.25 m³/m² h]
- Attached to clips or suspended from a ledge

Distribution points are arranged to provide optimum distribution quality, with gas risers positioned between the distribution points. Small diameter pans may not have gas risers because gas passage is provided in the gap between the pan and the vessel wall.

The Model 206 distributor uses standard pan-bottom distribution orifices or optional liquid conductor tubes passing through the pan floor. When conductor tubes are used, the metering orifices are located in the side of the tube, usually well above the pan floor.

Conductor tubes provide two benefits:
- Fouling resistance by allowing debris to settle in the bottom of the pan without clogging the raised orifices.
- Wide turndown ratio by utilizing orifices at two or three levels.

At high flow rates, the large bottom orifices of the standard Model 206 do not tend to foul. At lower flow rates, the smaller orifices may be prone to fouling, and the conductor tube option should be considered. Refer to the chart on page 4 to estimate an orifice size for your liquid rate, and to assess whether fouling is a concern for the bottom orifices. For example, if you need a distributor to flow between 60% and 120% of a normal flow rate of 4 gpm/ft² (10m³/m² h), you will need an approximate 0.25 in. (6 mm) diameter orifice. If the orifice size will foul in the bottom of the liquid distributor, choose the conductor tube option.

The turndown ratio of the standard pan-bottom orifice is 2.2:1. The optional conductor tubes can expand this ratio up to 8:1 with multi-level orifices.

Model TP236, TS236 INTALOX® Channel Distributor (Model TP237, TS237 Redistributor)

- Diameters larger than 36 in. [900 mm]
- Liquid rates between 0.5 and 12 gpm/ft² [1.25 – 30 m³/m² h]
- Flow equalization passages
- Elevated orifices
- Liquid overflow protection
- Fouling resistant

The Model 236 distributor features channel construction and distribution orifices in channel walls or liquid conductor tubes. It performs like the Model 276 distributor with conductor tubes, but it also includes liquid cross-flow between channels.

The Model 236 distributor is useful when column vertical space is limited and there is insufficient room for the taller Model 276. The liquid cross-flow also allows a useful redistributor form in the Model 237.

Construction Details
The Model 206 is bolted to clips (standard) or suspended from a ledge located between body flanges (optional). Setting the distributor on a ledge is not recommended.

All joints in multi-piece pans are gasketed.

In towers with smaller than 24 in. [600 mm] IDs, one-piece construction for installation through a body flange is the standard.

The standard design for a Model 207 redistributor includes gas riser covers and gasket wall wiper.

Design Options
- Conductor tubes rather than bottom orifices.
- Body flange mounted support ledge (Model 206)
- Suspended mounting
- Non-standard point count
- Multi-piece construction for tower IDs smaller than 24 in. [600 mm]
- Special gasketing material

The Model 236/237 is installed on a full support ledge (standard) or is suspended from beams (optional). All joints are gasketed.

The standard design for a Model 237 redistributor includes a wall wiper on the support ledge for the support above and gas riser covers to collect and redistribute liquid raining down from above.

Design Options
- Non-standard point count
- Multiple level orifices (for high turndown ratio)
- Leveling shims
- Special gasket material
- Suspended from beams
Diameters larger than 36 in. [900 mm]
Liquid rates above 0.5 gpm/ft² [1.25 m³/m² h]

Distribution points are positioned to optimize distribution quality. Vapor passage is provided by space between the troughs.

The Model 276 distributor uses standard trough-bottom distribution orifices or optional liquid conductor tubes passing through the trough floor. When conductor tubes are used, the metering orifices are located in the side of the tube, usually well above the pan floor.

Conductor tubes provide two benefits:
- Fouling resistance by allowing debris to settle in the bottom of the pan without clogging the raised orifices.
- Wide turndown ratio by utilizing orifices at two or three levels.

At high flow rates, the large bottom orifices of the standard Model 276 do not tend to foul. At lower flow rates, the smaller orifices may be prone to fouling, and the conductor tube option should be considered. Refer to the chart on page 4 to estimate an orifice size for your liquid rate, and to assess whether fouling is a concern for the bottom orifices. For example, if you need a distributor to flow between 60% and 120% of a normal flow rate of 4 gpm/ft² (10 m³/m² h), you will need an approximate 0.25 in. (6 mm) diameter orifice. If the orifice size will foul in the bottom of the liquid distributor, choose the conductor tube option.

The turndown ratio of the standard trough-bottom orifice is 2.2:1. The optional conductor tubes can expand this ratio up to 8:1 with multi-level orifices.
Model TP905, TS905 Weir Riser Pan Distributor

- Diameters 12 to 48 in. [300 to 1200 mm]
- Liquid rates between 1 and 8 gpm/ft²
  [2.5 – 20 m³/m² h]
- Weir in risers

The Model 905 pan distributor is used for highly fouling service in towers up to 48 in. [1200 mm] ID. Cylindrical risers with “V” notched weirs act as liquid downcomers as well as vapor risers. The weirs provide a high turndown ratio on liquid; however, the vapor capacity is limited. Also, high vapor flows reduce the liquid capacity and increase liquid entrainment because of the countercurrent flow in the small risers.

Distributors 19.4 in. [500 mm] and smaller are one-piece construction and are installed through a column body flange as the standard. Special multi-piece construction can be supplied. Larger sizes are multi-piece as the standard. Multi-piece pan sections are designed to pass through the vessel manway for installation.

Model TP906, TS906 Pan Distributor

- Diameters up to 48 in. [1200 mm]
- Liquid rates between 1 and 30 gpm/ft²
  [2.5 – 75 m³/m² h]
- Orifices in bottom

The Model 906 pan distributor uses bottom orifices for liquid metering/distribution. Larger diameter distributors include circular gas risers. Vapor passage is between the pan rim and the tower wall, and through the gas risers when included.

The standard turndown range is 2.5:1.

Distributors 19.4 in. [500 mm] and smaller are one-piece construction and are installed through a column body flange as the standard. Special multi-piece construction can be supplied. Larger sizes are multi-piece as the standard. Multi-piece pan sections are designed to pass through the vessel manway for installation.
Model TP985, TS985  Weir Trough Distributor

- Diameters larger than 36 in. [915 mm]
- Liquid rates between 2 and 40 gpm/ft² [5 – 100 m³/m² h]
- Weirs in troughs
- Fouling resistant

The Model 985, a weir-trough distributor, is effective for handling high liquid flow rates in towers with moderate to severe fouling services. The distributor is supplied in towers larger than 36 in. [915 mm] ID.

Model 985 distributors that are designed for the highest flow rates use triangular weirs, also called “V” weirs. If fouling is not severe, distributors that are designed for lower flow rates use slotted weirs for better flow control. Vapor passage is provided by the space between troughs.

Liquid is metered to the closed-end troughs by one or more parting boxes. The standard turndown ratio is 2.5:1. Higher turndown ratios can be achieved with special parting box design.

Standard designs require 16.2 in [410 mm] ID manways. Special turndown ratio designs with slotted weirs in parting boxes will require 18.7 in. [475 mm] ID manways.

Model TP985, TS985  Weir Trough Distributor

- Weirs in troughs
- Fouling resistant
- Diameters larger than 36 in. [915 mm]
- Liquid rates between 2 and 40 gpm/ft² [5 – 100 m³/m² h]

The Model 985 is installed on a support ledge (standard), or suspended from beams (optional). No gaskets are required.

Model TP916, TS916  Deck Distributor  (Model TP917/TS917 Redistributor)

- Diameters larger than 12 in. [300 mm]
- Liquid rates between 2 and 40 gpm/ft² [5 – 125 m³/m² h]
- Orifices in deck

The deck-type construction balances the liquid level over the distributor. Vapor passage is provided through long, rectangular gas risers.

The Model 916 distributor provides minimal fouling resistance at lower liquid rates because the distribution orifice diameters get smaller. A trough-type distributor with sidewall orifices, such as Model 986, should be considered as an alternative.

The deck sections are designed to pass through the vessel manway for installation. The maximum turndown range of flow is determined by the size of the manway access. The standard turndown range is 2.2:1.

In columns 24 in. [610 mm] ID or smaller, one-piece construction is standard and requires installation through a body flange. As an option, a special multi-piece construction is available.

Model TP916, TS916  Deck Distributor

- Diameters larger than 12 in. [300 mm]
- Liquid rates between 2 and 40 gpm/ft² [5 – 125 m³/m² h]
- Orifices in deck

The distributor is installed on a support ledge and secured with tray clamps. Thermoplastic clamps are standard on TS models. PP clamps are standard on TS models.

The standard design for a Model 917 redistributor includes gas riser covers to collect liquid raining from above.

Both models use gaskets as the standard. On small, one-piece construction, the plate is sealed to the tower wall with rope packing as the standard.

Model TP916, TS916  Deck Distributor

- Diameters larger than 12 in. [300 mm]
- Liquid rates between 2 and 50 gpm/ft² [5 – 125 m³/m² h]
- Orifices in deck

The deck-type construction balances the liquid level over the distributor. Vapor passage is provided through long, rectangular gas risers.

The Model 916 distributor provides minimal fouling resistance at lower liquid rates because the distribution orifice diameters get smaller. A trough-type distributor with sidewall orifices, such as Model 986, should be considered as an alternative.

The deck sections are designed to pass through the vessel manway for installation. The maximum turndown range of flow is determined by the size of the manway access. The standard turndown range is 2.2:1.

In columns 24 in. [610 mm] ID or smaller, one-piece construction is standard and requires installation through a body flange. As an option, a special multi-piece construction is available.

Model TP916, TS916  Deck Distributor

- Diameters larger than 12 in. [300 mm]
- Liquid rates between 2 and 50 gpm/ft² [5 – 125 m³/m² h]
- Orifices in deck

The distributor is installed on a support ledge and secured with tray clamps. Thermoplastic clamps are standard on TS models. PP clamps are standard on TS models.

The standard design for a Model 917 redistributor includes gas riser covers to collect liquid raining from above.

Both models use gaskets as the standard. On small, one-piece construction, the plate is sealed to the tower wall with rope packing as the standard.
† Diameters larger than 36 in. [915 mm]
† Liquid rates between 2 and 40 gpm/ft²
   [5 – 100 m³/m² h]
† Orifices in troughs
† Limited fouling resistance

The Model 976 is a versatile, general-purpose liquid distributor that performs well at high liquid rates. It is both inexpensive and easy to install.

In cases in which the extreme fouling resistance of the Model 985 is not needed, the Model 976 is a good choice for its better distribution quality. Refer to the approximate orifice sizing chart on page 4 to determine whether the Model 976 can be used instead of a Model 985.

Orifices are located in the base of the troughs. Vapor passage is provided by the space between the troughs.

The trough-type construction allows easy liquid sealing and distributor leveling. Troughs are fed with one or more parting boxes. The metering boxes have large orifices, which meter the liquid to individual troughs. For high liquid rates in a large diameter column, the Model 976 uses two or three parting boxes.

The standard turndown range is 2.2:1, but distributors designed for lower liquid rates can sometimes reach 2.5:1.

Standard designs require 16.2 in. [410 mm] ID manways. Special turndown ratio design with slotted weirs in metering boxes will require larger manways.

**Construction Details**

The Model 976 is installed on a full support ledge (standard) or is suspended from beams (optional). It does not require sealing.

For redistribution between packed beds, a separate liquid collector is required to collect the liquid from the bed above and feed it to the metering trough.

No gaskets are required.

**Design Options**

- Level shims
- Suspended from beams
- Ledge clamps (thermoplastic or metal)
Model TP941, TS941 Pipe-Arm Distributor

- Diameters larger than 17 in. [430 mm]
- Liquid rates between 1.5 and 10 gpm/ft² [4 – 25 m³/m² h]
- Limited fouling resistance
- Orifices in pipe

The Model 941 pipe-arm distributor requires little column elevation to accomplish its distribution task, and provides high open area for high vapor flow. This distributor uses orifices to meter the liquid onto the bed and should be used only with clean liquids or with a filter designed to remove any particles that could block the orifices.

The standard design of the Model 941 handles liquid rates up to 10 gpm/ft² [25 m³/m² h], but special designs can handle higher rates. The normal turndown ratio for the Model 941 is 2.5:1. The laterals are removable to permit passage through vessel manways.

### Construction Details

- Flanged laterals (standard on TS model)
- Vertical-feed header on tower centerline
- Threaded header (on TP model only)
- Support clips
- Support beams

### Design Options

Model TP943, TS943 Spray-Type Liquid Distributor

- Diameters 8 in. [200 mm] and larger
- Liquid rates between 0.2 and 50 gpm/ft² [0.5 – 120 m³/m² h]
- Spray nozzle
- Good fouling resistance at medium to high flow range

The Model 943 spray-type distributor can be designed for very low liquid rates because each spray nozzle covers a large area of the tower. Each nozzle passes a reasonable flow, even at low irrigation rates.

For most applications, the standard design uses full cone spray nozzles of 30° to 120° angles on triangular patterns. The laterals are removable for manway passage. The turndown ratio is 2:1. Higher turndown ratios may cause excessive liquid entrainment.

Material selection is limited on nozzle materials. FRP nozzles are not available. Specify a thermoplastic or metal nozzle material when ordering TS models.

### Construction Details

- The header section is flanged for standard horizontal feed from the side of the tower. The laterals are flange connected on TS models and pipe threaded on TP models.
- Inlet flange connects to an internal flange with a 150# bolt pattern as the standard. The end of the header opposite the flange connection is attached to a clip for support. Support clips, as required, are used to support the laterals. All support clips are part of the vessel and are not supplied as the standard. Beams can be used to support large distributors when necessary.

### Design Options

- Flanged laterals (standard on TP models)
- Vertical-feed header on tower centerline
- Threaded header (on TP models only)
- Support clips
- Support beams
- Bayonet headers for single nozzle distributors
- Special inlet flange