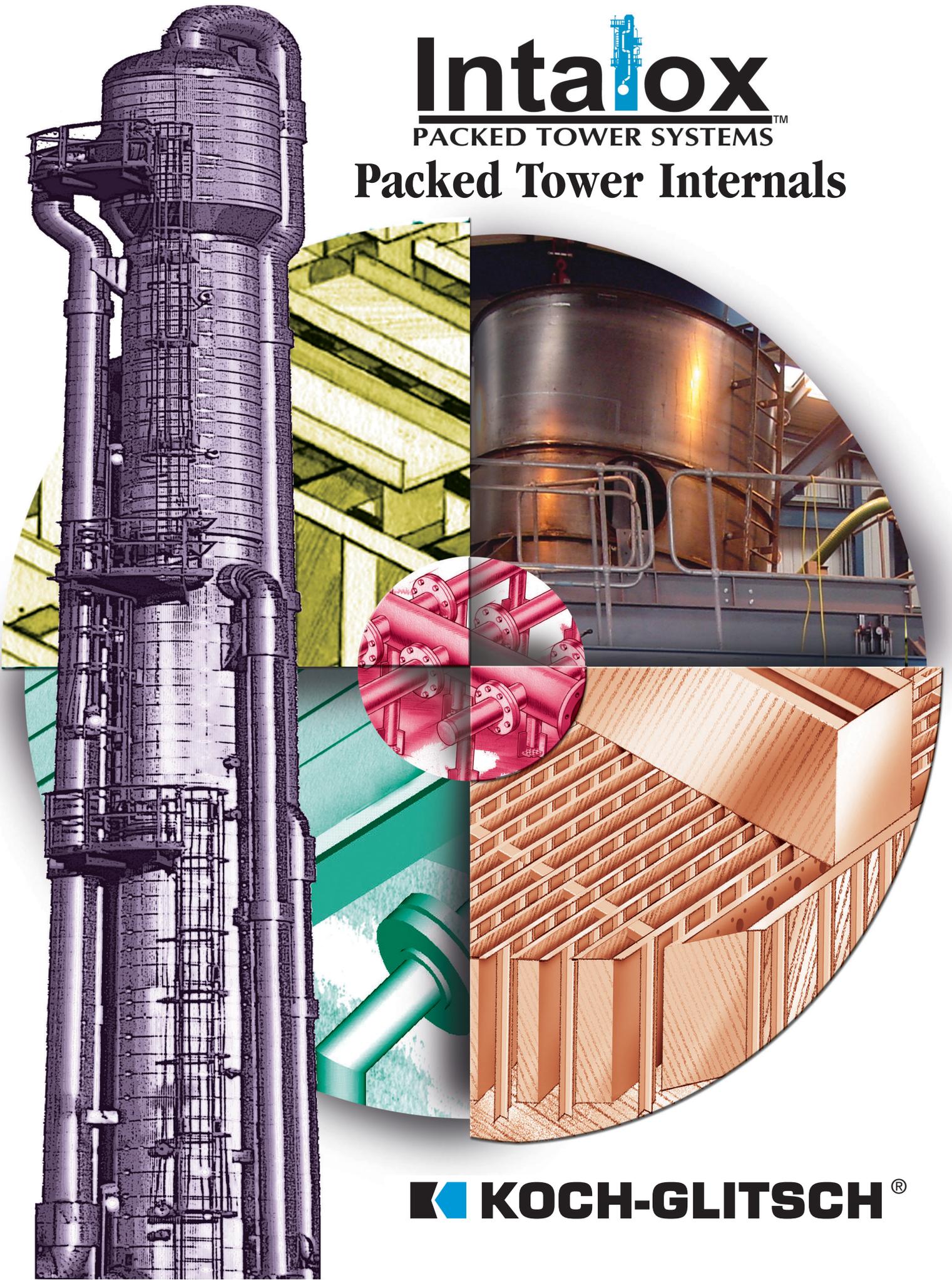


# Intalox™

PACKED TOWER SYSTEMS™

## Packed Tower Internals



**KOCH-GLITSCH®**

# Packed Tower Internals Guide

Koch-Glitsch's dedication to provide state-of-the-art mass transfer equipment is demonstrated in a complete line of packed tower internals, developed through extensive testing and years of experience with mass transfer equipment, such as **INTALOX®** High Performance Distribution Systems. By understanding the important role of liquid and vapor distribution, Koch-Glitsch can confidently design packed columns to provide predictable performance.

**INTALOX®** Packed Tower Systems combine INTALOX high performance liquid and vapor distribution with high performance packings such as:

- **FLEXIPAC®**, **FLEXIPAC® HC®**, **INTALOX®** or Wire Gauze Structured Packings
- **IMTP®** or **SNOWFLAKE®** High Performance Random Packing
- **CASCADE MINI RINGS®** or **β-ETA RING®** Random Packings

*For information regarding Koch-Glitsch random and structured packings, please ask for brochures KGRP-1, KGIMTP-1 and KGSP-1.*

Hydraulic flow testing is used to confirm the performance of INTALOX liquid distributors. Computational Fluid Dynamics (CFD) analysis is available for verification of vapor distribution designs. Ask your Koch-Glitsch representative about these optional services.

Koch-Glitsch recognizes that not all packed towers require state-of-the-art liquid distribution uniformity. Koch-Glitsch offers a wide range of traditional style internals, used over many years in less demanding services. This brochure describes the importance of liquid and vapor distribution and the circumstances in which INTALOX Packed Tower Systems should be applied.

Over the years, Koch Engineering Company, Inc., now Koch-Glitsch, has

developed and acquired proven internals and technology for packed columns from Glitsch and Saint-Gobain NorPro. As a result of these acquisitions, Koch-Glitsch has identified and now offers the best products and technology from each company. Because of these changes, product model designations have also changed. The column internals models listed in this brochure represent the majority of recommended column internals for use today.

Of course, exact replacements of any column internal formerly sold by Koch, Glitsch or Norton (NorPro) are available upon request and can be supplied, designed and built to their original specifications.

*Versions of many of the internals described in this catalog are also available in a variety of FRP and thermoplastic materials. For information regarding these products, please ask for brochure KGPTIG-1.*

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# Liquid Distribution

## Liquid Distribution

Liquid distributors are used in packed columns above each bed of packing. The distributor, depending upon its design features, is elevated between 0 to 8 in. [0-200mm] above the packing. The space is determined by the distributor type and the vertical height required to disengage the vapor phase from the packing before it flows through the distributor gas passage area.

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

- Uniform liquid distribution
- Proper operation through its turn-down range
- Low vapor phase pressure drop
- Resistance to plugging or fouling
- Optimal use of vessel height for proper performance
- Minimal liquid residence time
- Mixing capability for redistribution to the next bed

The introduction of high performance tower packings in the 1970's and 1980's accentuated the design deficiencies of distributors available at the time. In response, Koch-Glitsch introduced distributors with features to correct these deficiencies. These important features are well understood by Koch-Glitsch and have been incorporated in the family of INTALOX high performance distributors.

Koch-Glitsch offers two categories of liquid distributors to meet the requirements of specific applications. In determining which category to choose, it is necessary to know the sensitivity of the process and whether the liquid distribution will significantly affect the overall tower performance.

As a general rule:

- Koch-Glitsch INTALOX high performance distributors are used typically with FLEXIPAC, FLEXIPAC HC, INTALOX and wire gauze structured packings or IMTP, SNOWFLAKE, CMR and  $\beta$ -ETA RING high performance random packings in the following services: distillation, processes approaching equilibrium or heat-transfer applications with close approach temperature.
- Koch-Glitsch "traditional" distributors are generally used with traditional packings (**FLEXIRING**<sup>®</sup> and **HY-PAK**<sup>®</sup> Random Packings, plastic Super **INTALOX**<sup>®</sup> Saddles, **FLEXIGRID**<sup>®</sup> and **GLITSCH GRID**<sup>®</sup> Structured Packings) in general absorption, stripping and heat transfer applications. Traditional distributors take advantage of standardized, pre-engineered design and the optimal use of raw materials. These distributors do not generally provide liquid flow uniformity comparable to INTALOX high performance distributors.

As always, there are exceptions to the general rules. Occasionally...

- High performance packing may be used with traditional distributors in cases when only certain aspects of a high performance packing are desired. An example would be to take advantage of the high capacity of IMTP packing or the low pressure drop of FLEXIPAC HC structured packing, when the separation efficiency demands are not high.
- Traditional packing may be used with high performance distributors in cases when a process is licensed and specified with a certain type of packing.

## Redistribution

The decision of when to install more than one packed bed and redistribute the liquid is somewhat more involved. There are six major reasons to split a packed bed and redistribute the liquid:

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

Introduction of a liquid or vapor feed to a column requires a space in the packing and redistribution of the liquid phase. Important factors to keep in mind with the introduction of a liquid feed are the temperature and composition of the feed stream compared to the internal column liquid. Normally, unless the feed rate is small compared to the flow rate of the internal column liquid, it is desirable to mix the feed with the internal liquid to provide compositional uniformity before distributing it to the packed bed below. It is also advisable to mix the feed stream and internal liquid when their temperatures are significantly different. The degree of the thoroughness of the mixing depends upon the magnitude of the differences and to what extent the gradients are expected to affect the overall performance.

Liquid cross-mixing and maldistribution correction often go hand-in-hand. When a packed column is designed with a large number of theoretical stages or transfer units, a constant liquid to vapor ratio (L/V) is needed to achieve the best overall column performance. Redistribution of the liquid ensures that the L/V ratio is maintained, while cross-mixing between beds ensures uniform composition.

Based on Koch-Glitsch's operating experience, a rule-of-thumb is to limit a single packed bed to no more than 20 theoretical stages or transfer units. Consult a Koch-Glitsch technical representative for further details. Note that in some special circumstances, Koch-Glitsch applies more restrictive rules than those discussed above.

# Liquid Distribution Quality

Perfect liquid distribution is defined as providing equal liquid per unit area of the packed bed surface. Theoretically this would require an infinite number of liquid streams, all at identical flow. This is clearly impossible. A number of factors such as orifice size, fouling potential and mechanical construction limit the ability to make the "perfect" distributor. INTALOX high performance distributors approach perfection by applying the following criteria:

- Drip points located in a uniform pattern
- Drip point positions uninterrupted by vapor chimneys or mechanical supports
- Drip points properly spaced with respect to the vessel wall
- Minimal variation in flow between drip points

Koch-Glitsch "traditional" distributors have less uniform distribution patterns and liquid flow than the INTALOX high performance distributors. This is due to significant standardization and pre-engineering of the traditional internals to optimize their construction and to fit them for a wide range of conditions. This optimized, standardized design makes traditional distributors an economical alternative. Traditional distributors have been used successfully for many years in a wide range of applications.

Koch-Glitsch developed a distributor rating system to quantify distributor performance or "distribution quality". The rating uses a percentage scale with theoretical perfection set at 100%. Low percentage ratings reflect areas of the column that are receiving liquid flow significantly different from other areas.

INTALOX high performance distributors are always recommended for:

- Distillation services with high stage count per bed
- Distillation systems with a low relative volatility
- High purity product distillation services
- Distillation services operating near the minimum reflux ratio or close to a pinch point
- Absorption or stripping applications with close approach to equilibrium
- Heat transfer applications with close approach temperatures

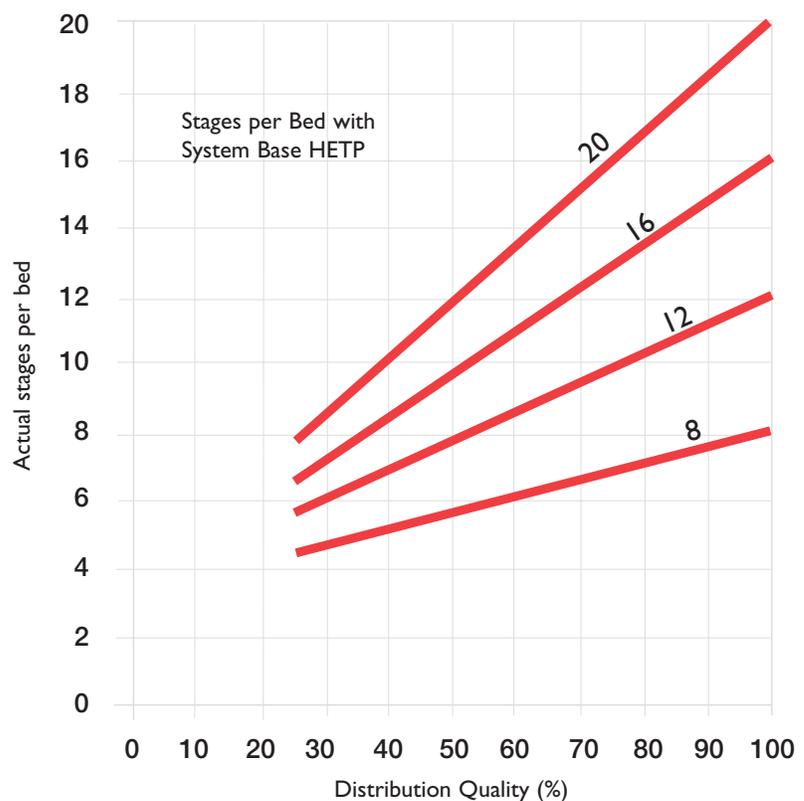
The chart below demonstrates the overall effect that can be expected with various levels of distribution quality. The maximum maldistribution that can be tolerated in a packed bed is strongly dependent on the product composition, the relative volatility, the liquid to vapor ratio, etc. Koch-Glitsch considers all these aspects as well as others while designing packed columns.

## Liquid Rate and Cross Flow Capability

As the liquid rate on a distributor is increased, the cross flow capability of the distributor and its pre-distribution system become more critical. Since gravity fed distributors are dependent on liquid level to determine flow, the liquid must be carefully balanced in order to provide point-to-point flow uniformity. It is important that the pre-distribution system

properly meters liquid flow to the distributor without inducing excessive horizontal velocities, gradients in liquid head or turbulence. Pre-distribution is achieved by the use of feed pipes, pre-distribution channels and/or parting boxes. The design of the pre-distribution system becomes increasingly complex as the specific liquid rate and/or the column diameter increases.

## The Effect of Liquid Distribution Quality



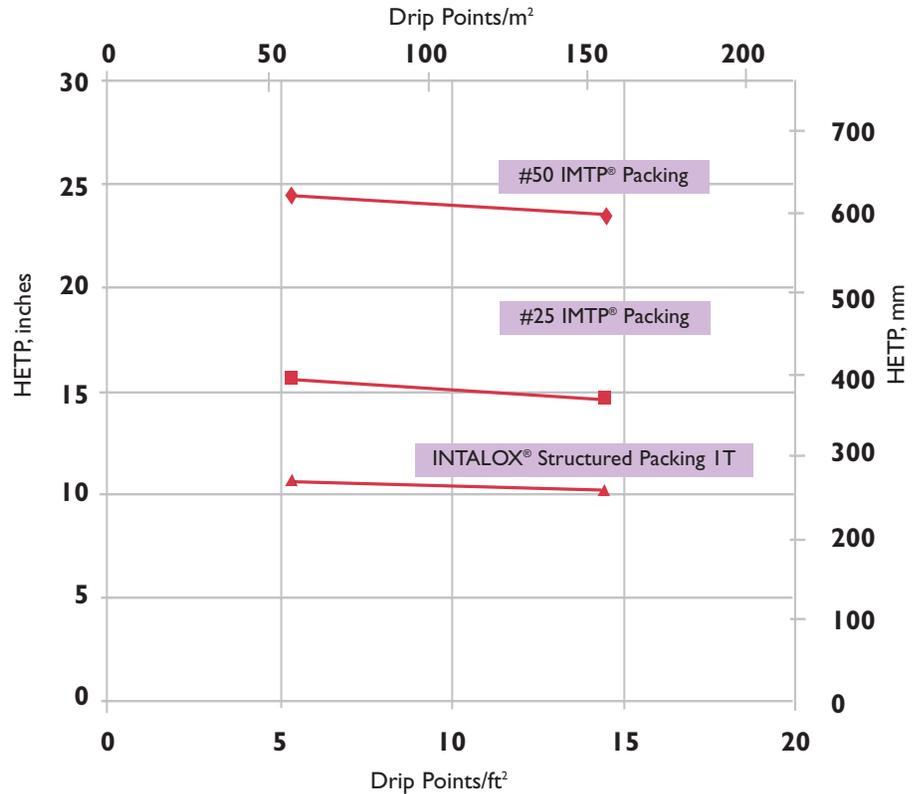
# Drip Point Density

The drip point density has an influence on the efficiency of the uppermost part of a packed bed. With the most commonly used sizes of random and structured packings, the effect of the drip point density is relatively minor. In actual laboratory testing, three packings tested under identical conditions, with the exception of drip point density, indicated the effect shown on the right.

The change from 5.5 to 14.5 points/ft<sup>2</sup> [60 to 155 pts/m<sup>2</sup>] has a relatively minor effect on the Height Equivalent to a Theoretical Plate (HETP). High drip point densities can greatly affect the cost of a high performance distributor and can also limit the vapor capacity for some distributor types. In addition, distributors with high drip point densities can be prone to fouling due to small orifice diameters (See page 6).

However, drip point density does have a considerable effect on the performance of high surface area, very high efficiency packings. The table below details the guidelines for drip point count based on the high performance packing to be used.

## Effect of Drip Point Density on HETP



## Minimum Recommended Drip Point Density

Packing Type	Minimum Recommended Drip Point Density		
	5.5 pts/ft <sup>2</sup> [60 pts/m <sup>2</sup> ]	8 pts/ft <sup>2</sup> [85 pts/m <sup>2</sup> ]	12 pts/ft <sup>2</sup> [130 pts/m <sup>2</sup> ]
Wire Gauze Packing			BX or CY
<b>FLEXIPAC<sup>®</sup></b> and <b>FLEXIPAC<sup>®</sup> HC<sup>®</sup></b> Structured Packing	250Y and larger	1.6Y & 1.4Y/350Y	1Y and smaller
<b>INTALOX<sup>®</sup></b> Structured Packing	1.5T and larger	IT and smaller	
<b>IMTP<sup>®</sup></b> Random Packing	#25 and larger	#15	
<b>CMR<sup>™</sup></b> Random Packing	#1.5 and larger	#1	
<b>β-ETA Ring<sup>®</sup></b> Random Packing	#2 and larger	#1	

# Distributor Orifice Sizing

## Fouling

For a distributor to perform correctly, it is important that the metering devices do not become fouled. There are several mechanisms and sources of fouling materials: polymerization, coking, scale, construction debris, sediment, rust flakes, etc. All precautions should be taken to eliminate fouling materials outside of the column since external strainers and filters are far easier to clean than distributors. In some cases it is not possible to eliminate all external fouling sources. In other cases the source of the fouling material can be within the column itself. Therefore, the choice of the distributor should be dependent on the nature of any fouling.

The list below ranks the fouling resistance of various metering devices and arrangements for liquid distributors, starting at the top with the most resistant:

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

Optional strainers and filter boxes can be provided to protect orifices from small quantities of particulate matter such as vessel wall or pipe scale. These devices are not effective if the fouling material coats, pastes or sticks to metal surfaces. Distributors with weirs for liquid metering will not meet the criteria for flow variation for an INTALOX high performance distributor.

## Operating Range

A distributor will give its best performance at and around 100% of the design liquid flow rate. As the rate decreases and the liquid head drops, levelness of the distributor as well as gradients in liquid level become a larger percentage of the operating liquid head. At some turndown rate, the flow variation from point-to-point will fall outside of acceptable limits.

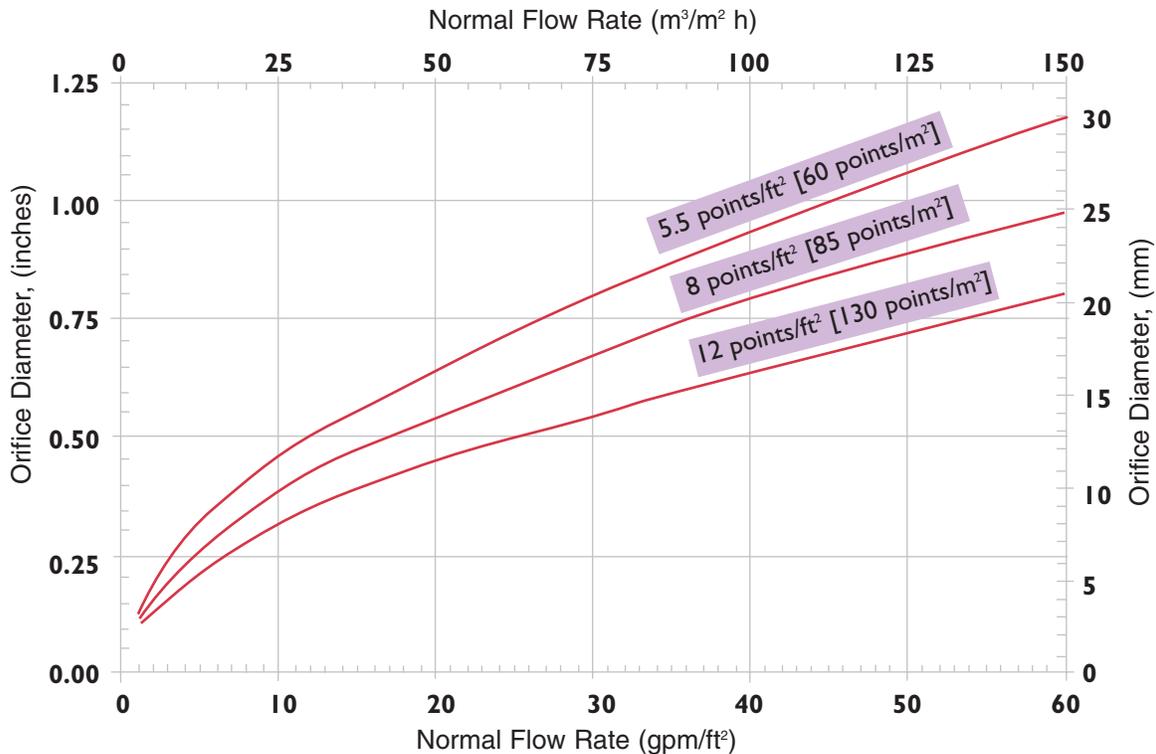
INTALOX distributors are designed to have a maximum flow variation, defined as the coefficient of variation (Cv), equal to no more than 3% at design rates and no more than 5% at turndown rates. Special designs are available for many INTALOX high performance distributors that will result in even lower flow variation. Typical turndown ranges are given in the description for the various distributor models.

Koch-Glitsch "traditional" distributors allow greater flow variations than INTALOX high performance distributors and typically have a broader range of operation. For high turndown requirements, multi-level orifices or slotted weirs may be used with some INTALOX distributor designs as well as traditional distributor styles. It should be noted, however, that when using these metering devices, the flow variation will be higher throughout all or part of the operating range than with a single orifice. While the liquid level is in the area of transition between multi-level orifices, there will be a zone of high flow variation that will significantly exceed the limits allowable for an INTALOX high performance distributor.

## Orifice Size

In gravity-fed distributors, the orifice size is dependent upon the drip point density, the specific liquid rate and the 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 indicated in the graph below.

## Approximate Orifice Size for Gravity Flow Distributors



# Liquid Distributors

Depending on the flow rates, column configuration and general mechanical preferences, there are several ways to achieve good liquid distribution.

## Deck Type Distributors

Deck style distributors are clamped on an annular ring that is seal welded to the tower wall. For revamp applications of trayed columns, most often an existing tray ring is utilized and seal welded segments are added as needed. In the case where welding is not permitted, bolt-in segments are available by special request but provide a less reliable liquid seal. Leakage from and around bolt-in support ring segments can be a significant portion of the total liquid flow, resulting in poor distribution quality. In this case, a trough or channel type distributor should be considered.

## Channel Type Distributors

The center channel is designed as a structural member allowing the distributors to rest on a support ring and span columns up to 20 ft [6 m] without the need for additional beams.

Locating the distributor on existing support ring in revamp work often makes it easy to determine the tower layout. Supporting a channel type distributor on an annular ring generally requires a more complex design and construction in order to provide drip points at the proper proximity to the tower wall. This increased complexity can be avoided by supporting channel type distributor with the center channel resting on a seat and the channel troughs hung from beams or a ring above. Both beam and ring supported channel distributors can be designed to accommodate uplift conditions. The center channel of a channel type distributor provides cross flow capacity between troughs, to enable liquid head equalization.

The addition of covers or hats over the gas riser area provides the ability to turn the device into a redistributor for use between packed beds. This design is especially useful when tower elevation is tight and minimal height for redistribution is required.

## Trough Type Distributors

Trough type distributors are usually hung from beams. When used in conjunction with structured packings, in special circumstances, the trough distributor may be supported from an integral support system resting directly on the packing. Trough type distributors are easily installed and leveled, do not require gaskets and have no annular ring below to interfere with the distribution pattern.

Each trough is fed a metered amount of liquid from one or more parting boxes. Because there is no flow communication between troughs, the performance of the parting box is critical. Koch-Glitsch's years of experience ensure parting box designs for proper flow metering.

When used between packed beds for redistribution, a trough type distributor requires the use of a collector to catch the liquid from the bed above. The use of a separate collector provides complete cross mixing of the liquid before redistribution and also allows mixing of feed streams with the internal column liquid. A separate collector requires more column height than a channel type redistributor.

## Model 106 INTALOX® Pan Distributor (Model 107 Redistributor)

- ▶ Diameters 6 - 36 in. [150 - 900 mm]
- ▶ Orifices in pan floor
- ▶ Liquid rates above 2 gpm/ft<sup>2</sup> [5 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Limited fouling resistance

Orifices in the pan bottom are arranged to provide optimum distribution quality, with gas risers positioned between the drip points. Small diameter pans may not require gas risers as gas passage is provided in the gap between the pan and the vessel wall.

When used for higher flow rates, this distributor will have large orifices that will tend not to foul. Orifice strainer caps, raised orifices or a Model 136/137 should be considered for low flow rates in combination with fouling concerns. For rates lower than 2 gpm/ft<sup>2</sup> [5 m<sup>3</sup>/m<sup>2</sup> h] a Model 136/137 should be considered first. This distributor has a standard turndown range of 2 : 1 and can be leveled during installation.

In towers less than 24 in. [600 mm] diameter, one-piece construction, for installation through a body flange, is standard. A special multi-piece construction is available upon request.

### Construction Details

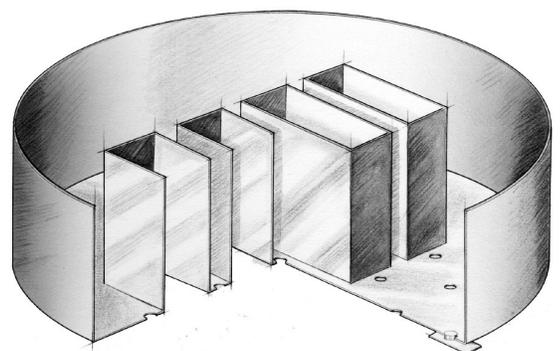
Standard connection to the tower wall is by bolting to clips. As an option, the distributor can be suspended from clips or a ring trapped between body flanges. Setting the distributor on an annular ring is not recommended.

All joints in multi-piece pans are gasketed.

The standard design for a Model 107 redistributor includes gas riser covers and a weld-on wall wiper.

### Design Options

- Orifice strainers
- Expandable and gasketed wall wiper (Model 107)
- Suspended mounting
- Raised tube metering for high turndown or fouling concern
- Anti-migration bars



## Model 116 INTALOX® Deck Distributor (Model 117 Redistributor)

- ▶ Diameters 36 - 240 in. [150 - 6000 mm]
- ▶ Liquid rates between 4 - 80 gpm/ft<sup>2</sup> [10 - 200 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Orifices in deck

Orifices in the deck are arranged to provide optimum distribution quality. The deck-type construction provides good liquid cross-flow between gas risers that are positioned between drip points.

Because this deck style distributor is normally designed to be used to handle higher liquid flow rates, the orifices are usually large and do not tend to foul. For liquid rates below 8 gpm/ft<sup>2</sup> [20 m<sup>3</sup>/m<sup>2</sup> h], use of a channel or trough style distributor is generally recommended.

The standard turndown range is 2 : 1.

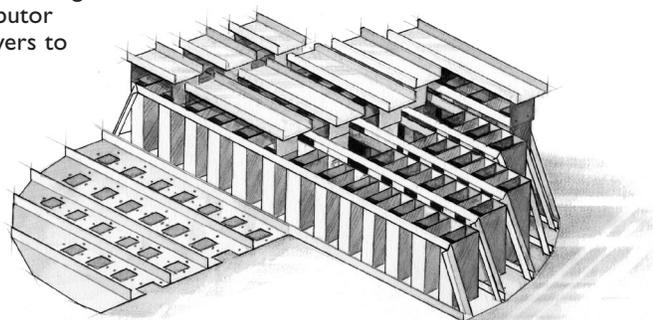
### Construction Details

The Model 116/117 distributor is clamped onto an annular ring that is seal-welded to the tower wall, with clamps provided. Hence, distributor levelness is determined by the ring levelness. Design of the Model 116/117 distributor takes into account support ring levelness tolerances within ASME code or as otherwise specified. All joints are gasketed.

For redistribution between beds, a separate liquid collector is not required. The standard design for a Model 117 redistributor includes gas riser covers to collect liquid.

### Design Options

- Orifice strainers
- Anti-migration bars in gas risers
- Raised tube metering for high turndown or fouling concern
- Construction for mounting between flanges



## Model 126 INTALOX® Channel Distributor with Bottom Orifices (Model 127 Redistributor)

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ Liquid rates between 2 - 16 gpm/ft<sup>2</sup> [5 - 40 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Orifices in channel base
- ▶ Limited fouling resistance
- ▶ Structural center channel provides flow equalization

Orifices in the base of the channels are positioned to optimize distribution quality. Vapor passage is provided by the space between the channels. Rates lower than 2 gpm/ft<sup>2</sup> [5 m<sup>3</sup>/m<sup>2</sup> h] can be accommodated but a Model 136 sidewall orifice distributor should be considered first. For systems with liquid rates in excess of 12 gpm/ft<sup>2</sup> [30 m<sup>3</sup>/m<sup>2</sup> h] a Model 116 deck style distributor should be considered.

The channel-type construction allows easy liquid sealing and distributor leveling, which is essential in large diameter towers. Because this distributor normally handles intermediate liquid flow rates, the orifices are usually large enough to allow low to moderate fouling resistance.

The standard turndown range is 2 : 1.

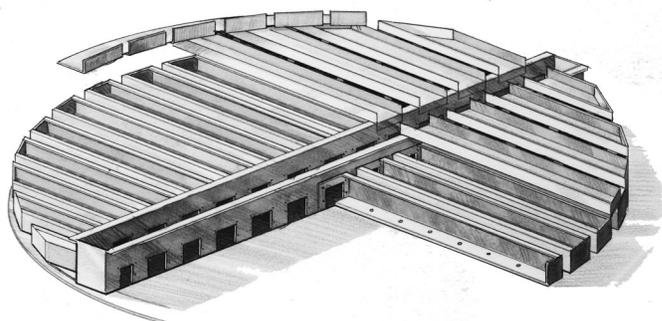
### Construction Details

The Model 126/127 distributor rests on an annular ring or is suspended from a ring or beams. All joints are gasketed.

The standard design for a Model 127 redistributor includes a weld-on wall wiper and bolted gas riser covers, used to collect and redistribute liquid. The redistributor design uses less column height than a separate collector/distributor layout and is valuable where space is limited and total cross mixing of liquid between beds is not critical.

### Design Options

- Model 127 cross-mixing capability (extent is dependent on diameter and rate)
- Orifice strainers
- Leveling screws
- Expandable and gasketed wall wiper (small diameter Model 127)



# Model 136 INTALOX® Channel Distributor with Drip Tubes (Model 137 Redistributor)

- ▶ Diameters greater than 10 in. [250 mm]
- ▶ Liquid rates between 0.3 - 12 gpm/ft<sup>2</sup> [0.75 - 30 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Structural center channel provides flow equalization
- ▶ Liquid overflow protection
- ▶ Side-wall orifices
- ▶ Fouling resistant

Orifices in the sidewalls of the channels are positioned to optimize distribution quality. Vapor passage is provided by the space between the troughs.

The fouling resistance of this distributor is higher than that of deck-type distributors because it features a debris collection zone below the sidewall orifices. The center channel of the distributor provides structural support as well as equalization of liquid between troughs.

The liquid from each drip point is conducted into the lower vapor velocity region below the distributor troughs. This results in low entrainment levels. In addition, overflow holes are provided at each conductor tube to ensure that if the maximum flow range of the distributor is exceeded, the liquid will be conducted to the packing in a controlled manner rather than to randomly spill over the troughs.

The standard turndown for a single sidewall orifice is 2 : 1. Using multiple orifices at two or more levels of the same discharge conductor can extend the turndown range. Turndown ratios up to 10 : 1 are achievable. The flow variation will be higher throughout all or part of the operating range with multi-level orifices.

## Construction Details

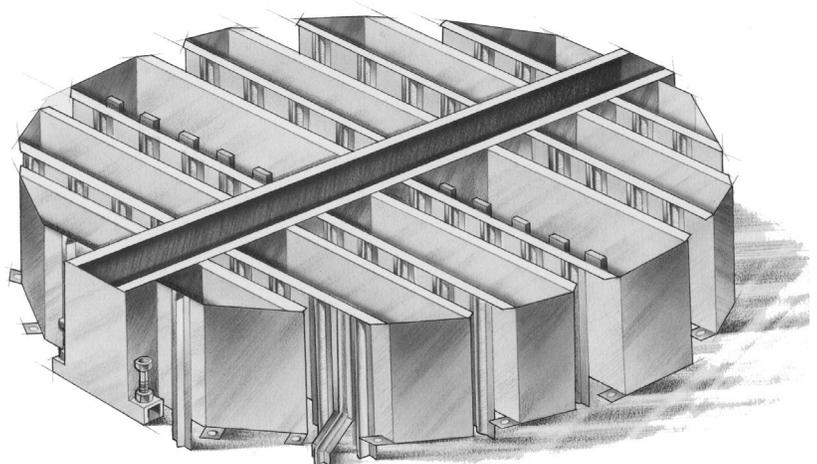
The Model 136/137 distributor are usually constructed as pans for diameters below 30 in. [750 mm] and as channels for diameters above 30 in. [750 mm].

The Model 136/137 distributor rests on an annular ring or is suspended from beams or clips. All joints are gasketed.

The standard design for the Model 137 redistributor includes a weld-on wall wiper and bolted gas riser covers to collect and redistribute liquid. The redistributor design uses less column height than a separate collector/distributor layout and is valuable where space is limited and total cross mixing of liquid between beds is not critical.

## Design Options

- Cross-mixing capability (extent is dependent on diameter and rate)
- Orifice strainers
- Leveling screws
- Multi-level orifices
- Expandable and gasketed wall wiper (small diameter Model 137)
- Removable drip tubes



# Model 141 INTALOX® Tubular Distributor

- ▶ Diameters 6 - 120 in. [150 - 3000 mm]
- ▶ Liquid rates between 0.3 - 8 gpm/ft<sup>2</sup> [0.75 - 20 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Enclosed tubular laterals
- ▶ High distribution point density
- ▶ Clean service only

The Model 141 distributor is most often used in conjunction with wire gauze packings. Orifices in the bottom of the tubular laterals are positioned to optimize distribution quality with a high drip point density. Vapor passage is provided by the space between the laterals. The Model 141 INTALOX distributor is suggested only for towers in extremely clean service free of fouling materials and debris.

The standard turndown is 2 : 1. However, the turndown range can be extended to approximately 5 : 1 if sufficient column height is available.

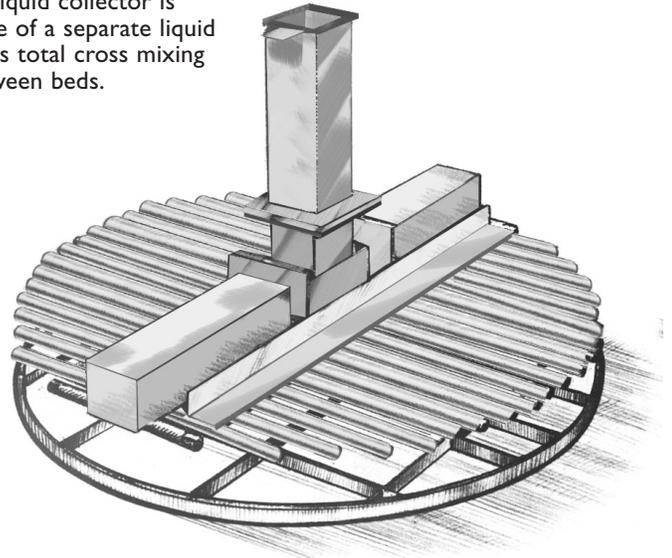
## Construction Details

As the standard, the Model 141 distributor is supported and leveled from an integral distributor support grid (Model 883).

For redistribution between packed beds, a separate liquid collector is required. The use of a separate liquid collector provides total cross mixing of the liquid between beds.

## Design Options

- Turndown ratio greater than 2 : 1
- Non-standard mounting arrangements
- Diameters exceeding standard range



# Model 156 INTALOX® Trough Distributor with Enhanced Baffle Plates

- ▶ Diameters greater than 30 in. [760 mm]
- ▶ Liquid rates between 0.3 - 8 gpm/ft<sup>2</sup> [0.75 - 20 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Sidewall orifice with enhanced baffle
- ▶ Fouling resistant
- ▶ For use with structured packing
- ▶ High vapor capacity
- ▶ Low entrainment

The Model 156 INTALOX distributor is designed for use only above structured packing. Orifices in the sidewalls of the troughs are positioned to issue liquid against an enhanced baffle that spreads the liquid in a direction perpendicular to the orientation of the top layer of the structured packing. The enhanced baffle increases the effective drip point density by uniformly wetting each and every sheet of structured packing. This increase in effective drip point density provides the ability to use a larger orifice diameter, contributing to increased fouling resistance.

The baffle plate distributor has excellent distribution performance characteristics particularly at low liquid rates. Total wetting of the packing surface is completed in only one layer of packing. Vapor passage is provided by the space between the troughs. The baffle also acts to shield the liquid from the vapor stream to avoid entrainment, thereby making this an excellent distributor choice when operating at high vapor rates.

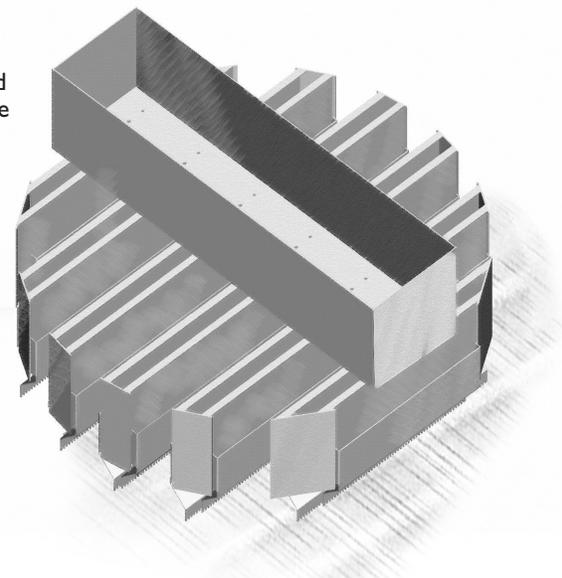
## Construction Details

The Model 156 is suspended from beams. The troughs are continuous across the column diameter and are fed with one or more parting boxes. Details of baffle arrangement are variable depending upon specific liquid rates and are determined at the time of design. There are no joints to seal, therefore, no gaskets are required for this distributor.

For redistribution between packed beds, a separate liquid collector is required. The use of a separate liquid collector provides total cross mixing of the liquid between beds.

## Design Options

- Mount on packing with the
- Model 883 bed limiter/support
- Metering boxes



# Model 186 INTALOX® Trough Distributor with Drip Tubes

- ▶ Diameters greater than 30 in. [760 mm]
- ▶ Liquid rates between 0.3 - 10 gpm/ft<sup>2</sup> [0.75 - 25 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Sidewall orifice
- ▶ Liquid overflow protection
- ▶ Fouling resistant
- ▶ Low entrainment

Orifices in the sidewalls of the troughs are positioned to optimize distribution quality. Vapor passage is provided by the space between the troughs. Special designs can handle liquid rates above or below the above stated range.

The liquid from each drip point is conducted into the lower vapor velocity region below the distributor troughs. This results in low entrainment levels. In addition, overflow holes are provided at each conductor tube to ensure that if the maximum flow range of the distributor is exceeded, the liquid will be conducted to the packing in a controlled manner rather than to randomly spill over the troughs.

The standard turndown for a single sidewall orifice is 2 : 1. Using multi-level orifices at each discharge conductor can extend the turndown range up to 10 : 1. The flow variation will be higher throughout all or part of the operating range with multi-level orifices.

## Construction Details

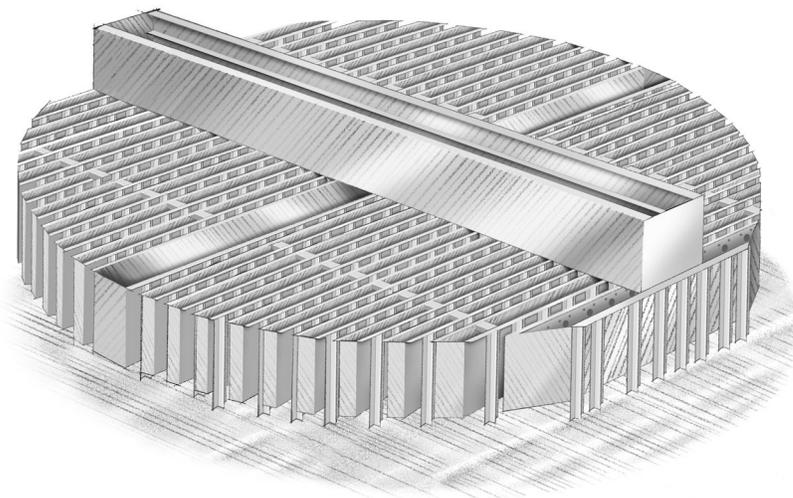
As the standard, the Model 186 distributor is suspended from beams. By special request, and within a limited range of diameters, provisions can be made for the distributor to rest on an existing support ring.

Model 186 troughs are continuous across the column diameter and are fed with one or more parting boxes. There are no joints to seal, therefore, no gaskets are required.

For redistribution between packed beds, a separate liquid collector is required. The use of a separate liquid collector provides total cross mixing of the liquid between beds.

## Design Options

- Orifice strainers
- Multi-level orifices
- Metering Boxes
- Mounted on support ring or supported by Model 883 bed limiter/support



## Model 905 Pan Distributor with V-Notch Risers

- ▶ Diameters 12 – 48 in. [300 - 1200 mm]
- ▶ Liquid rates between 1 - 8 gpm/ft<sup>2</sup> [2.5 - 20 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Weir in riser

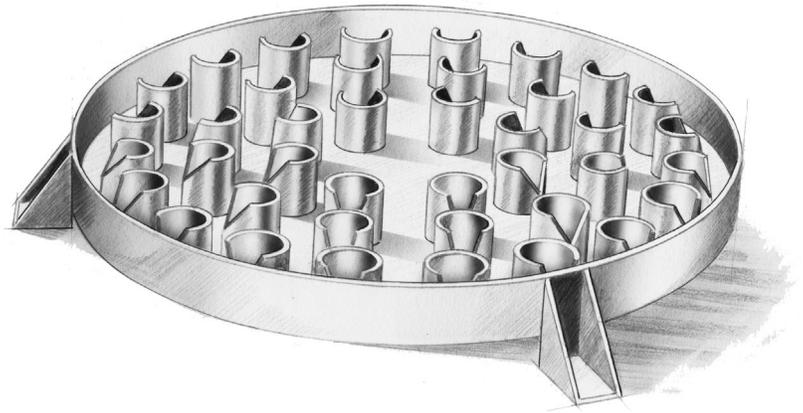
The Model 905 pan distributor is used for highly fouling services in towers with a diameter of less than 48 in. [1200 mm]. Cylindrical risers with "V" shaped weirs act as liquid downcomers as well as vapor risers. A high liquid turndown ratio is possible due to the weirs. However, the vapor velocity in the riser limits both liquid and vapor flow rates since both phases are flowing counter-currently in the same passages.

### Construction Details

This distributor is supported either by a full support ring or by lugs. Gasketed joints are standard for multi-piece pans when liquid rates are below 4 gpm/ft<sup>2</sup> [10 m<sup>3</sup>/m<sup>2</sup> h].

### Design Options

- One-piece construction for body flanged columns



## Model 906 Pan Distributor with Bottom Orifices

- ▶ Diameters up to 48 in. [1200 mm]
- ▶ Liquid rates between 1 - 30 gpm/ft<sup>2</sup> [2.5 - 75 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Orifices in pan bottom

The pan-type construction provides liquid level balance. Vapor passage is provided by circular gas risers as well as around the periphery of the pan. For small diameters, all vapor passage may be provided by the gap between the pan and the vessel wall, rather than gas risers.

For towers with diameters up to 20 in. [500 mm], the standard is to construct the pan in one piece for installation through a body flange. The standard turndown range is 2.5 : 1.

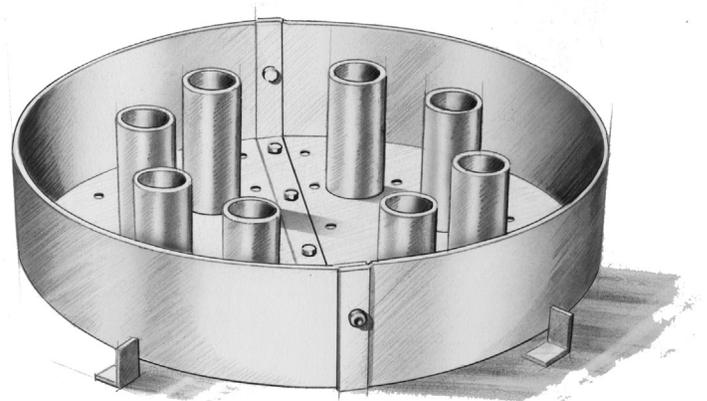
### Construction Details

This distributor is supported either by a full support ring or by lugs. Gasketed joints are standard for multi-piece pans when liquid rates are below 4 gpm/ft<sup>2</sup> [10 m<sup>3</sup>/m<sup>2</sup> h].

This device is not available in a design suitable for use as a redistributor.

### Design Options

- One-piece construction for body flanged columns
- Gasketing for liquid rates above 4 gpm/ft<sup>2</sup>
- Raised tube metering for high turndown or fouling concern
- Anti-migration bars



## Model 916 Deck Distributor with Bottom Orifices (Model 917 Redistributor)

- ▶ Diameters greater than 12 in. [300 mm]
- ▶ Liquid rates between 1 - 50 gpm/ft<sup>2</sup> [2.5 - 120 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Orifices in deck

The deck-type construction gives liquid level balance around the periphery of the distributor and additionally across the mid-span beam in large diameter columns. Vapor passage is provided through long, rectangular gas risers.

At lower liquid rates, as distribution orifice diameters get smaller, this distributor provides minimal fouling resistance. If fouling resistance is important a trough type distributor with sidewall orifices should be considered.

The maximum turndown range is determined by the size of the manway access. The standard turndown range is 2.5 : 1.

### Construction Details

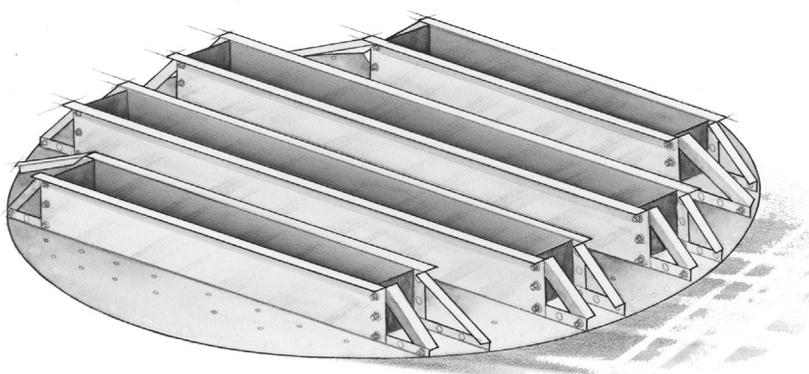
The distributor rests on an annular ring and is secured with tray clamps.

For redistribution between beds, a separate liquid collector is not needed. The standard design for a Model 917 redistributor includes gas riser covers to collect liquid.

Distributors in services with liquid rates below 4 gpm/ft<sup>2</sup> [10 m<sup>3</sup>/m<sup>2</sup> h] are gasketed as standard.

### Design Options

- Gasketing for liquid rates above 4 gpm/ft<sup>2</sup>
- Parting box



## Model 926 Channel Distributor with Bottom Orifices (Model 927 Redistributor)

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ Liquid rates between 1 - 20 gpm/ft<sup>2</sup> [2.5 - 50 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Orifices in base
- ▶ Limited fouling resistance
- ▶ Structural center channel provides flow equalization

The Model 926 distributor is a channel type distributor providing good cross flow and liquid handling capacity with low leakage compared to a deck style (Model 916) distributor. The structural center sump allows this distributor to be used in large diameter columns, up to 26 ft [8 m], without the need for additional support beams. The standard turndown range is 1.8 : 1.

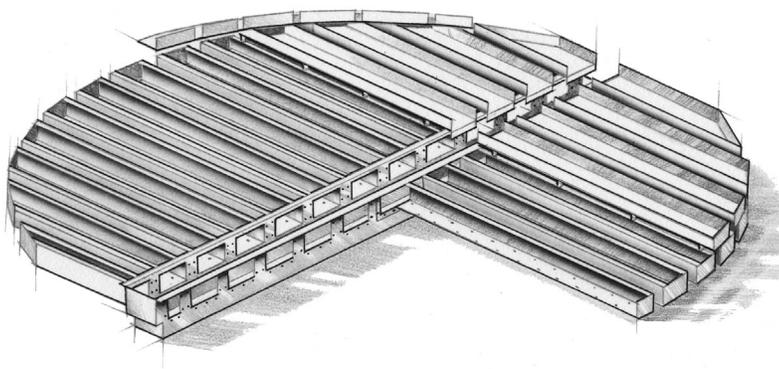
### Construction Details

The Model 926/927 distributor rests on an annular ring. Gasketed joints are standard for liquid rates below 4 gpm/ft<sup>2</sup> [10 m<sup>3</sup>/m<sup>2</sup> h].

The Model 927 redistributor includes gas riser area covers to collect liquid as well as a wall wiper to be welded to the column wall.

### Design Options

- Cross mixing (Model 927)
- Clamped to support ring for uplift resistances
- Leveling screws



# Model 976 Trough Distributor with Bottom Orifices

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ Liquid rates between 1 - 20 gpm/ft<sup>2</sup> [2.5 - 50 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Orifices in troughs

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 a parting box.

The standard turndown range is 2 : 1.

## Construction Details

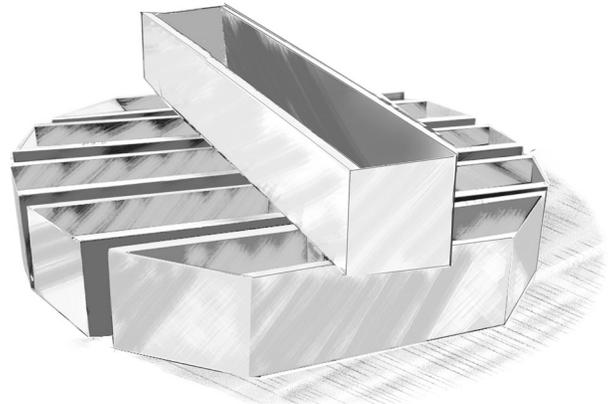
As the standard, the Model 976 distributor is suspended from beams. Within a limited range of diameters, provisions can be made for the distributor to rest on an existing support ring.

For redistribution between packed beds, a separate liquid collector is required. The use of a separate liquid collector provides cross mixing of liquid between beds.

There are no joints to seal for this distributor, therefore, no gaskets are required.

## Design Options

- Orifice strainers
- Mount on support ring



# Model 985 Trough Distributor with Weirs

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ Liquid rates between 2 - 40 gpm/ft<sup>2</sup> [5 - 100 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Weirs in troughs

The Model 985 is a weir-trough distributor for versatile liquid flow handling capability in towers with diameters larger than 36 in. [900 mm]. This distributor is particularly effective in handling high liquid flow rates in moderate and severely fouling services.

Model 985 distributors designed for the highest flow rates employ triangular weirs, also called "V" notches. If fouling is not severe, distributors designed for lower flow rates employ vertical rectangular notches, also called slotted weirs, for better flow control. Vapor passage is provided by the space between troughs.

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

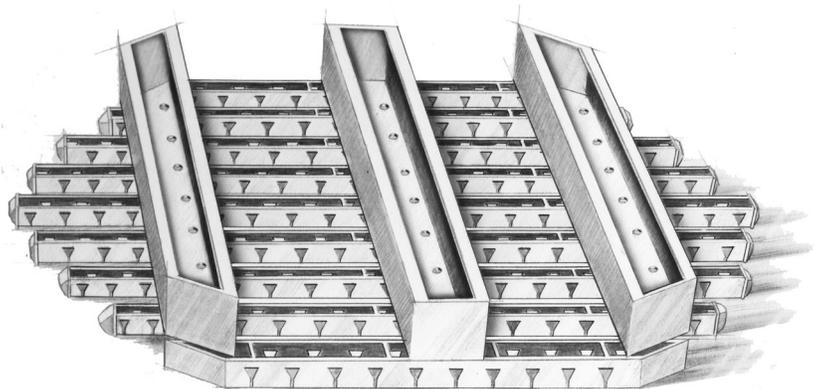
## Construction Details

The Model 985 distributor rests on a full annular ring.

For redistribution between packed beds, a separate liquid collector is required.

## Design Options

- Clamped to support ring
- Uplift resistant
- Distribution notch shape
- Guide channels



# Model 986 Trough Distributor with Drip Tubes

- ▶ Diameters greater than 30 in. [760 mm]
- ▶ Liquid rates between 0.3 - 20 gpm/ft<sup>2</sup> [0.75 - 50 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ Sidewall orifice
- ▶ Liquid overflow protection
- ▶ Fouling resistant
- ▶ Low entrainment

The construction and many features of this distributor are similar to the high performance Model 186 liquid distributor, except that many aspects of the construction are standardized, resulting in a distribution pattern and/or point-to-point flow variation that falls outside the INTALOX high performance criteria.

Orifices are located in the sidewalls of the troughs. Vapor passage is provided by the space between the troughs. The Model 986 distributor is a versatile distributor with a wide range of applicability. It is particularly desirable for use where liquid rates are low or in towers where fouling resistance and/or high turndown is required.

The liquid from each drip point is conducted into the lower vapor velocity region below the distributor troughs. This results in low entrainment levels. In addition, overflow holes are provided at each conductor tube to ensure that if the maximum flow range of the distributor is exceeded, the liquid will be conducted to the packing in a controlled manner rather than to randomly spill over the troughs.

The standard turndown for a single sidewall orifice is 2 : 1. Using multi-level orifices at each discharge conductor can extend the turndown range up to 10 : 1. The flow variation will be higher throughout all or part of the operating range with multi-level orifices.

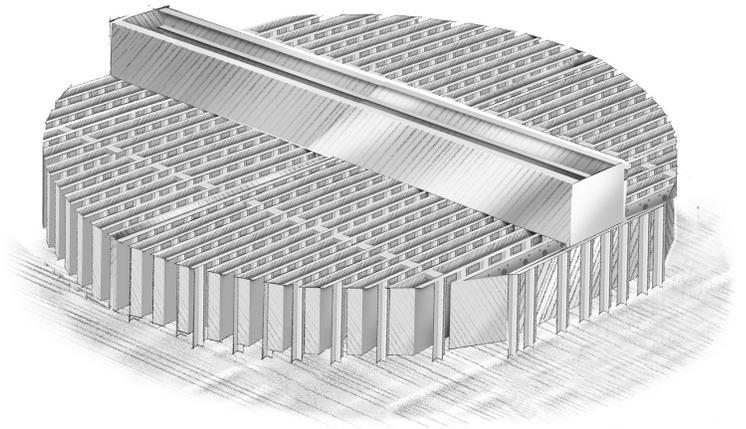
## Construction Details

As the standard, the Model 986 distributor is suspended from beams. Upon special request, and within a limited range of diameters, provisions can be made for the distributor to rest on an existing support ring.

For redistribution between packed beds, a separate liquid collector is required. The use of a separate liquid collector provides total cross mixing of the liquid between beds.

## Design Options

- Orifice strainers
- High turndown ratio
- Metering boxes
- Mount on support ring or supported by Model 883 bed limiter/support



## Model 941 Pipe-Arm Distributor with Orifices

- ▶ Diameters greater than 18 in. [430 mm]
- ▶ Liquid rates between 1.5 - 10  $\text{gpm/ft}^2$  [4 - 25  $\text{m}^3/\text{m}^2 \text{ h}$ ]

The Model 941 liquid distributor requires little column elevation to accomplish its distribution task, and it provides high open area for high vapor flow. The Model 941 distributor 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 distributor handles liquid rates up to 10  $\text{gpm/ft}^2$  [25  $\text{m}^3/\text{m}^2 \text{ h}$ ], but special designs can handle higher rates. The normal turndown ratio for the Model 941 distributor is 2.5 : 1.

### Construction Details

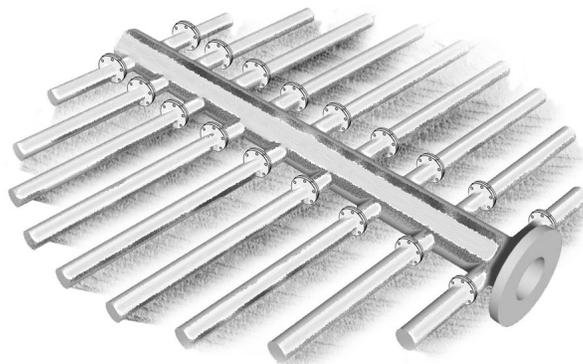
The header section is flanged for standard horizontal feed from the side of the tower.

Inlet flange mates to a 150 psi [PN 10] flange. The end of the header opposite the flange connection as well as the lateral ends are supported by clips as required. Laterals attach to the main header with flanged connections as standard.

When an external column feed is not present and for using this device as a redistributor, a total draw-off liquid collector with an external pump loop is required.

### Design Options

- Threaded header and laterals (4" [100 mm] and under)
- Vertical-feed header, on tower centerline
- Bayonet-style construction for small towers



## Model 943 Spray Nozzle Distributor

- ▶ Liquid rates between 0.2 - 50  $\text{gpm/ft}^2$  [0.5 - 120  $\text{m}^3/\text{m}^2 \text{ h}$ ]

Spray nozzle distributors are primarily used where good liquid coverage and complete wetting of the bed is necessary. They are commonly used in scrubbers and in the wash, pumparound and heat transfer sections of refining columns. For further detail regarding refining applications, please ask for Brochure KGSS-I.

The Model 943 spray nozzle distributor can be designed for very low liquid rates because each spray nozzle covers a large area of the tower. It can utilize relatively large nozzle opening sizes, so each nozzle provides a reasonable flow, even at low irrigation rates.

Full cone spray nozzles with an angle of 90° or 120° are the standard design for most applications. Spray nozzles providing maximum free passage and special distributor configurations to prevent liquid stagnation are typically recommended for refining column wash beds or other applications where complete wetting is critical to avoid fouling.

Turndown ratio is limited to 2 : 1 by the range of effective operation of the spray nozzles.

### Construction Details

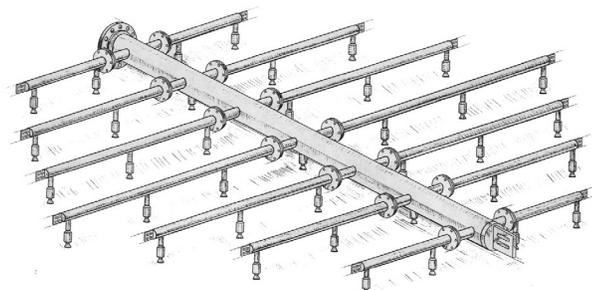
The header section is flanged for standard horizontal feed from the side of the tower.

The flange mates to a 150 psi [PN 10] flange. Laterals attached to the main header with flanged connections are standard.

For small diameter columns, the ends of the header and laterals are supported by clips as required. For larger diameter columns, laterals are attached to beams.

### Design Options

- Maximum free passage nozzles for fouling services
- Special piping design for fouling service



# Model 961 Enclosed Channel Distributor for Offshore Applications

- ▶ Diameters greater than 30 in. [760 mm]
- ▶ Liquid rates between 1 - 30 gpm/ft<sup>2</sup> [2.5 - 75 m<sup>3</sup>/m<sup>2</sup> h]
- ▶ For off-shore columns subject to motion

The Model 961 is a distributor designed specifically for off-shore column applications subjected to tilt and motion. Orifices are located in the base of the enclosed channels. Liquid is fed to each channel using a pre-distribution header. Vapor passage is provided by the space between the channels.

The enclosed channel construction allows the use of high liquid heads to minimize the flow variation due to the tilt and the effects of motion and acceleration of swaying columns.

Because of the unique nature and design of the Model 961 distributor, a Koch-Glitsch representative should be contacted for these applications.

## Construction Details

This distributor is hung from beams and is securely attached to withstand the rigors of column motion.

When located at the top of the column with a reflux stream, the reflux pump pressure is used to provide liquid head.

For use as a redistributor, a separate Model 613 liquid collector, (specifically designed for motion column service), is used in conjunction with the Model 961 distributor to provide the necessary liquid head.

The column height requirement is dependent upon turndown range and motion dynamics.

## Design Options

- Dependent on column configuration and requirement.



Testing of Model 961 enclosed channel distributor in the Koch-Glitsch test facility simulating wave motion.

# Feed Devices

Obtaining desirable tower performance requires the proper handling of liquid and vapor entering the column. The types of feeds or inlets into a column can generally be classified into four major categories:

- Liquid only (contains less than 1% vapor by volume)
- Mixed liquid and vapor, flashing or suppressed flash
- Vapor only
- Reboiler returns

The selection criteria for each category of feed device is unique.

## Liquid-Only Feeds

Among the factors Koch-Glitsch considers in designing a liquid feed device are; type of distributor, expected distributor performance, flow rate, operating range, degree of sub-cooled liquid and whether mixing with overhead liquid is required.

When the feed or reflux liquid is significantly sub-cooled, a specially designed feed arrangement may be required. A liquid with a wide temperature gradient, even if properly distributed to a packed bed, can induce mal-distribution due to uneven condensation.

The feed arrangement for these conditions depends on the distributor type. Please consult a Koch-Glitsch technical representative for recommendations.

## Liquid-Vapor and Flashing Feeds

For mixed liquid-vapor or flashing feed devices above a distributor, the selection depends on the distributor type, liquid and vapor flow rates, turndown, column height needed for disengagement and vapor distribution as well as the degree of mixing of the inlet liquid with the overhead liquid. In all cases, separating the vapor and the liquid phases is a primary concern. In some cases the requirements for additional pre-distribution may alter certain distributor designs.

## Vapor-Only Feeds

Two factors must be considered in choosing the proper device for a vapor only feed.

1. The kinetic energy of the inlet vapor must be considered in relation to the pressure drop in the packed bed, the feed nozzle arrangement and the tower separation requirements.
2. If there is a gross mismatch in the composition and/or temperature between the inlet vapor stream and bulk vapor flow, mixing of the two vapors optimizes the performance of the packing above.

Specific equipment for vapor distribution may not be required if sufficient column height is available for equalization or if the pressure drop in the packed bed is sufficient to provide proper vapor distribution.

## Reboiler Returns

To determine the need for and the type of device required for a reboiler return, the first step is to consider the condition of the stream and its kinetic energy.

For vapor-only returns, the kinetic energy of the inlet vapor must be considered in relation to the pressure drop in the packed bed, the feed nozzle size and arrangement, as well as the tower separation requirements.

For a mixed liquid-vapor or suppressed flash reboiler return stream, the selection of the device depends on flow rate, ratio of liquid and vapor flow, flow regime, nozzle size and arrangement, column height needed for vapor disengagement and the tower separation requirements.

## CFD Modeling

Good vapor distribution is essential to achieve superior separation efficiency. Particularly in refinery towers, poor vapor distribution can be a major source of coke formation resulting in frequent unit shutdowns. Koch-Glitsch uses modern Computational Fluid Dynamics (CFD) modeling technology to analyze the performance of existing equipment and to develop new improved designs. This involves computer modeling of the 3-dimensional configuration of the column internals to provide detailed predictions of fluid flow (velocity profiles, etc). A commercially available CFD software package is used in conjunction with expertise developed by Koch-Glitsch to analyze vapor and liquid distributors as well as packing performance.

Koch-Glitsch offers CFD services for the following tasks:

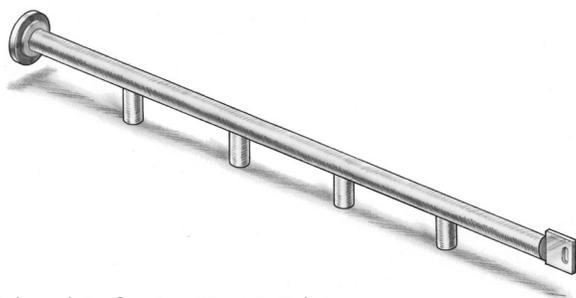
- Development and optimization of new mass transfer equipment
- Troubleshooting or analysis of existing equipment
- Confirmation of equipment designs prior to fabrication and installation

# Model 119 INTALOX® High Performance Liquid Only Feed Pipe

## ► Feed to INTALOX high performance distributors

The Model 119 liquid only feed pipe is used when liquid is fed from outside the column onto a Koch-Glitsch INTALOX high performance distributor or redistributor. The incoming flow must contain less than 1% vapor by volume.

The Model 119 feed pipe is a metered piping system consisting of one or more headers in conjunction with lateral branches, downpipes, and/or pre-distribution channels or parting boxes that feed directly to an INTALOX distributor. It is limited in turndown to a 2 : 1 ratio. The Model 119 feed pipe meters flow to one or more appropriate feed areas, matching the hydraulic requirements of the distributor. Excessive turbulence and horizontal flow velocity in the distributor are eliminated.



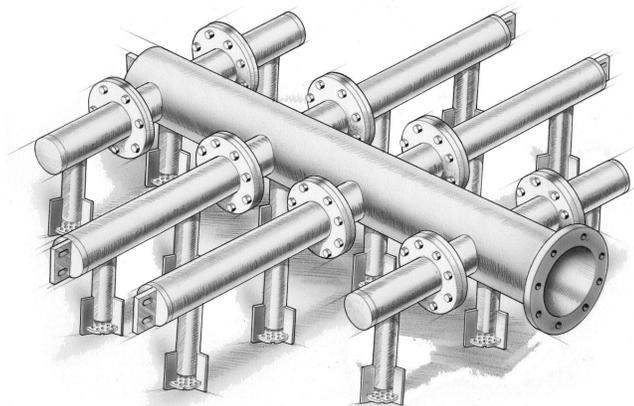
## Construction Details

The Model 119 feed pipe is attached to an internal column flange with further support by tower wall clips.

Branched piping is flanged as the standard, although, piping may have threaded connections for pipe diameters less than 4 in. [100 mm]. For large diameter headers, where manway access is limiting, field welding may be required.

## Design Options

- Bayonet-style construction for limited applications
- All-flanged construction
- Special design for subcooled feed



# Model 719 Liquid Only Feed Pipe

## ► Feed to traditional liquid distributors

The Model 719 liquid only feed pipe is used when liquid is fed from outside the column onto a traditional distributor or redistributor. The incoming flow must contain less than 1% vapor by volume.

The Model 719 feed pipe is a piping system consisting of one or more headers in conjunction with downpipes, pre-distribution channels or parting boxes that feeds directly to a traditional style distributor. The standard turndown ratio is 2.5 : 1

## Construction Details

The Model 719 feed pipe is attached to an internal column flange with further support by tower wall clips.

Piping may have threaded connections for pipe diameters less than 4 in. [100 mm]. For large diameter headers, where manway access is limiting, field welding may be required.

## Design Options

- Bayonet-style construction
- All-flanged construction

# Model 705 Flashing Feed Chamber

- ▶ Diameters up to 48 in. [1200 mm]
- ▶ Handles most two-phase feeds

The Model 705 is a two-phase feed device that is attached to a radial inlet. By using centrifugal force, the vapor exits the top of the chamber and the liquid is conducted out the bottom to a distributor or pre-distributor located below.

One or more Model 705 chambers may be used in larger diameter columns if the flow rates are suitable.

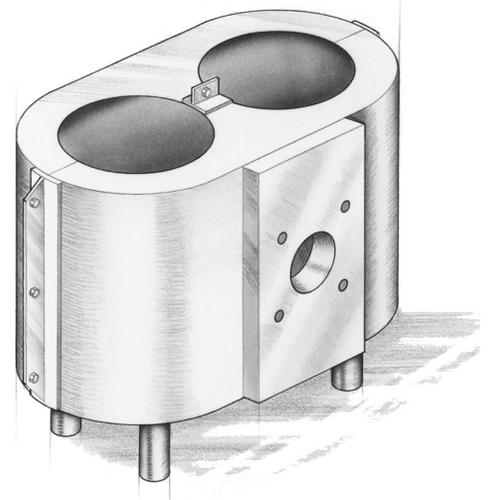
## Construction Details

For column diameters under 22 in. [530 mm], the Model 705 feed chamber is constructed in one piece. For larger diameters the chamber is constructed in multiple pieces.

For inlet pipe sizes less than 4 in. [100 mm], the Model 705 feed chamber attaches to a threaded, bayonet style pipe (supplied by others). Inlet sizes 4 in. [100 mm] and larger are attached with a flange as standard.

## Design Options

- Supply of bayonet inlet



# Model 745 Flashing Feed Pipe

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ Feed device separates liquid and vapor of flashing inlet streams

The Model 745 feed pipe is used to handle flashing inlet streams by separating the phases. The liquid impinges on an angled baffle trough, promoting disengagement of the liquid and vapor phases. The vapor exits above and the liquid is directed downward. The liquid may be sent directly to a distributor, a pre-distributor or to a collector located between packed beds. An optional vapor hood is available to improve the mixing of the incoming vapor with the bulk vapor flow.

This model uses less column height than the Model 755 feed gallery but is limited to feeds that are flashing at the column inlet.

All pieces are designed to pass through vessel manways.

## Construction Details

The Model 745 feed pipe is connected to an internal column flange and further supported by a wall clip. The flash trough bolts to clips, seats or beams depending upon location and size.

The inlet pipe flange is gasketed, while the need for gasketing of the flash trough depends on the type device below it.

## Design Options

- Bayonet type feed pipe
- Vapor hood



## Model 755 Flashing or Mixed Phase Feed Gallery

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ For liquid/vapor mixed or flashing feeds
- ▶ Applicable for all liquid to vapor ratios

The Model 755 flashing feed gallery is a feed device to accommodate mixed liquid/vapor or flashing feeds. Incoming flow is directed tangentially against the tower wall. A gallery below the inlet deflector collects liquid into a pool, allowing the vapor phase to disengage. The liquid then flows directly to a distributor or into a parting box in a controlled manner.

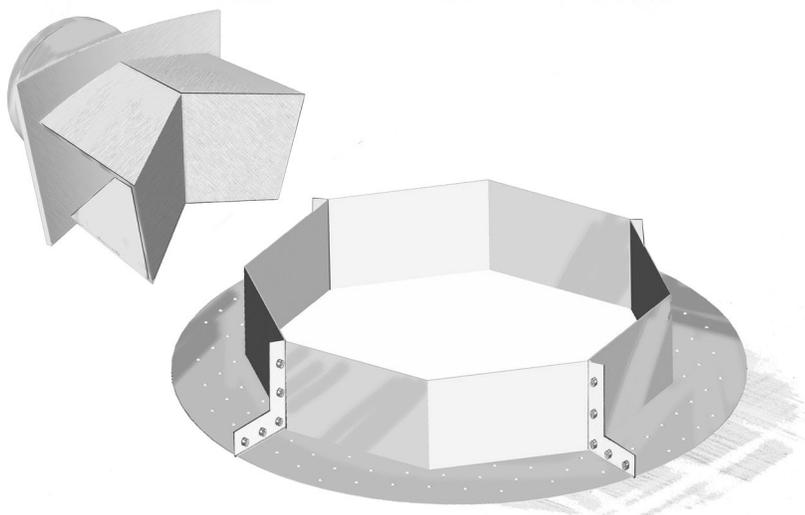
In many cases the gallery can be fitted with covers to collect liquid from a packed bed above, providing a combination flash device with liquid collector.

### Construction Details

The inside of the gallery is normally polygonal, built in sections as necessary for column access. The gallery is clamped to a support ring as the standard attachment.

### Design Options

- Joint gasketing
- Liquid collection from above



## Model 788 Enhanced V-Baffle Inlet Diffuser

- ▶ Diameters greater than 30 in. [760 mm]
- ▶ Non-fouling
- ▶ Suitable for vapor-only, mixed liquid-vapor or flashing feeds

The Model 788 V-Baffle is used for vapor-only, mixed liquid/vapor feeds or flashing feeds where the flow energy is excessive. This device reduces the inlet stream energy and can often be designed to provide a level of vapor distribution that eliminates the need for a more complex vapor distributor. It is a very effective phase separator for two phase feeds.

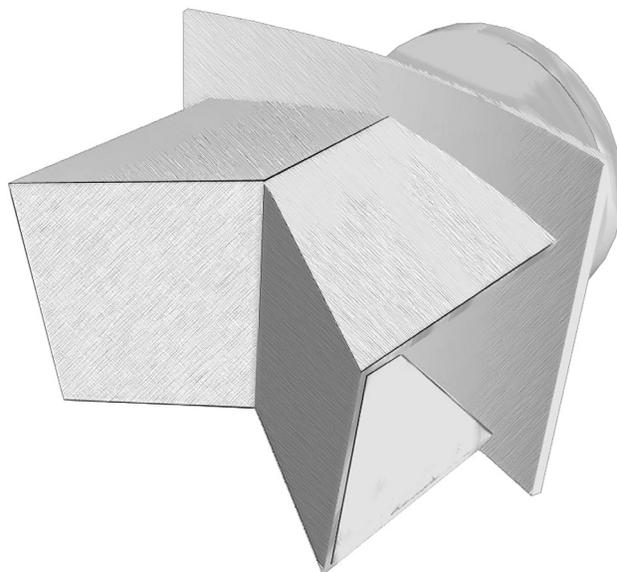
The vapor diffuser divides the inlet stream and then directs the streams tangentially to each side. A patented Enhanced V-Baffle design often provides additional control of the incoming stream. The pressure drop across this device is relatively low compared to deck or pipe type vapor distributors.

### Construction Details

This device is field welded to the vessel wall.

### Design Options

- Erosion allowance
- Anti-swirl baffle



# Model 758 Enhanced Vapor Horn

- ▶ **Diameters greater than 6 ft [1.8 m]**
- ▶ **Suitable for vapor-only, mixed liquid-vapor or flashing feeds**

Vapor horns have been utilized primarily for two phase inlets of refinery fractionators. These devices are designed to provide both bulk phase separation of the vapor and liquid as well as initial distribution of the feed vapor. Performance of these feed inlet devices is critical to ensure adequate gas oil quality and yield, maximum column capacity and proper wash bed performance. Koch-Glitsch's proprietary enhanced vapor horn, an extension of conventional vapor horn technology, provides improved vapor distribution and de-entrainment of the feed.

For vapor/liquid phase separation, the open bottom construction and the centrifugal action induced to the feed stream will direct entrained liquid particles to the column wall, where they will flow down into the column sump or collector tray below.

The patented enhanced vapor horn employs baffles, in a proprietary arrangement, to avoid excessive impingement and feed splashing which can result in the formation of small liquid particles that are more likely to be re-entrained. The baffles help break the high feed inlet velocity for both improved vapor distribution and de-entrainment. Uniform velocity (in both the vertical and horizontal direction) is desired to minimize re-entrainment of liquid.

Once the bulk phase separation is complete and the swirling motion is no longer desirable, patented anti-swirl baffles eliminate the cyclonic motion of the vapor.

Koch-Glitsch has applied both large scale laboratory testing and CFD analysis to evaluate, optimize and validate the de-entrainment and vapor distribution performance. Koch-Glitsch has hundreds of commercial installations of this technology in columns with diameters up to 50 ft [15 m].

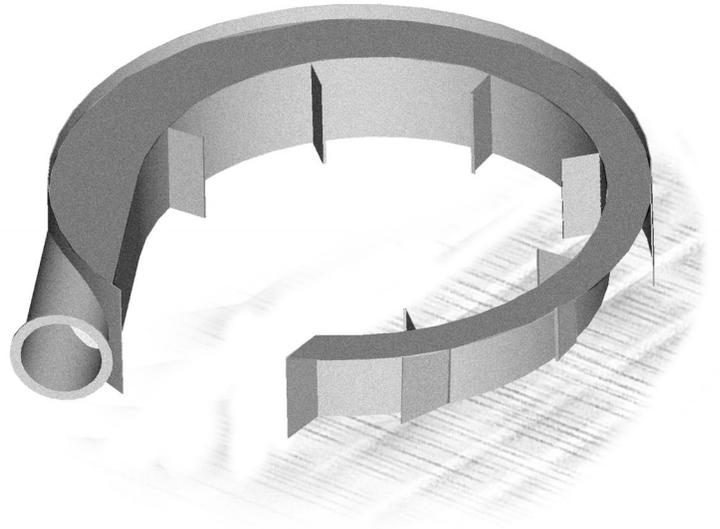
## Construction Details

The enhanced vapor horn is available in any weldable metal and is designed for field welded assembly to provide maximum strength and reliability.

This technology can be successfully adapted to a wide variety of feed inlet configurations including both radial and tangential feed nozzles as well as the use of multiple feed inlets.

## Design Options

- Radial or tangential inlets
- Multiple feed inlets
- Heavy-duty design for increased uplift protection
- CFD analysis
- Wear plates



# Model 716 Deck Type Vapor Distributor

## ▶ Diameters greater than 30 in. [760 mm]

The Model 716 vapor distributor is a deck type used to correct poor vapor distribution below a packed bed. This device can be used between packed beds where a vapor feed is introduced or above reboiler return streams.

The vapor is metered through vapor risers as liquid is collected from a packed bed above. The liquid leaves the vapor distributor through a downcomer. To perform the task of vapor distribution, the Model 716 will consume some pressure drop.

The turndown ratio is generally about 4 : 1, provided pressure drop is not excessive for the process.

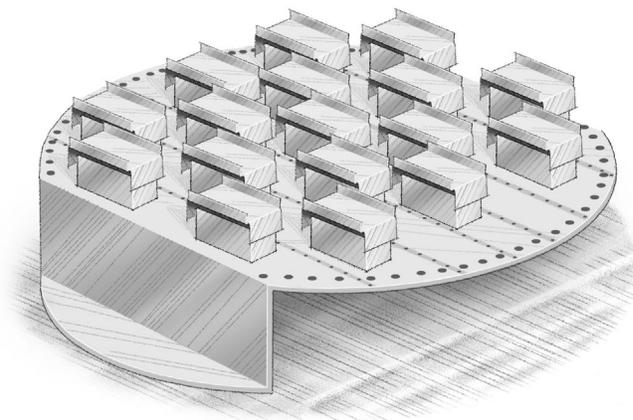
## Construction Details

The Model 716 vapor distributor is clamped to a support ring and typically requires bolting bars and segmental supports for its downcomer and seal pan. Midspan beams may be used for larger diameter towers.

Standard construction will withstand 50 lbs/ft<sup>2</sup> [0.024 bar] upward force. However, special designs are available which can withstand greater uplift requirements.

## Design Options

- Liquid draw sump
- Pipe downcomers, if applicable
- Uplift specifications



# Model 746 Lateral Arm Vapor Distributor

## ▶ Diameters greater than 18 in. [450 mm] ▶ Vapor-only inlet streams

The Model 746 lateral arm vapor distributor is used when a vapor feed requires uniform distribution across the tower area. Typical applications include vapor feed at the bottom of the tower or between beds.

When used at the bottom of a tower it can save tower elevation compared to a deck type (model 716) vapor distributor. When used between beds, it will ensure that the vapor feed is well distributed and well mixed with the vapor from the bed below.

To achieve good distribution the required pressure drop across the vapor distributor is determined by the flow rate and size of the inlet. Turndown is generally 4 : 1, but can be higher or lower depending upon the allowable pressure drop for the process.

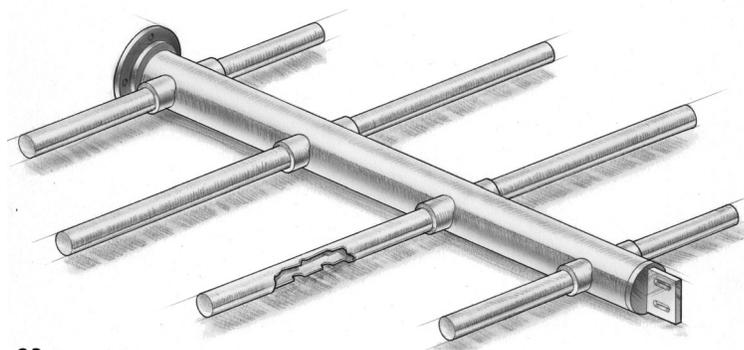
## Construction Details

The main header attaches to an inlet flange (supplied by others) and is further supported supplied by a wall clip. The laterals are supported by wall clips, as needed. Access diameter must be sufficient to accommodate the header assembly. For large diameter headers, where manway access is limiting, field welding may be required.

Laterals are flanged as the standard, but may have threaded connections for pipes 4 in. [100 mm] and less.

## Design Options

- All flanged construction
- Bayonet-type for small columns



# Model 748 Vapor Diffuser

- ▶ Diameters greater than 48 in. [1200 mm]
- ▶ Vapor-only inlet streams

The Model 748 vapor diffuser is used for vapor-only feeds where the flow energy is excessive. This device is not a vapor distributor. It reduces the vapor energy such that a more complex vapor distributor may not be necessary.

The vapor diffuser uniformly meters the vapor stream out the upper area of the pipe and the shroud and then directs the flow downward to each side. The pressure drop across this device is relatively low compared to the Model 746 vapor distributor.

Turndown is generally 4 : 1.

## Construction Details

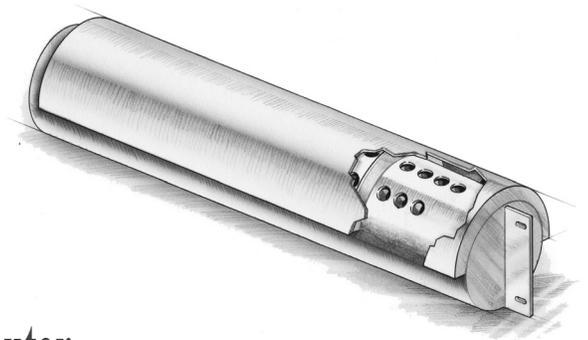
This device is attached to an internal tower inlet flange (supplied by others) and is further supported by a vessel wall clip as the standard construction.

Optionally, the inside pipe can be designed to bayonet into the vapor inlet nozzle, in lieu of an internal flange.

One-piece construction is standard provided column access diameter is sufficient. Otherwise, multi-piece construction is provided. In some cases, field welding of multi-piece construction may be required.

## Design Options

- Bayonet inlet construction



# Model 768 EVENFLOW™ Vane Type Vapor Distributor

- ▶ Diameters greater than 72 in. [1800 mm]
- ▶ Preferred for vapor-only feed

The Model 768 EVENFLOW™ vane type vapor distributor is used for high energy vapor inlet streams entering through a radial inlet. Although the device has been utilized in applications with high velocity mixed phase feeds, the performance of the device is best when limited to vapor-only feeds.

Baffles used in conjunction with a tapered configuration provide vapor distribution with minimal pressure drop. The curved baffle plates partition the inlet vapor stream into multiple small segments, reducing the velocity and directing the segmented streams horizontally across the column area.

Performance of the EVENFLOW vapor distributor has been validated using CFD analysis as well as numerous successful commercial installations.

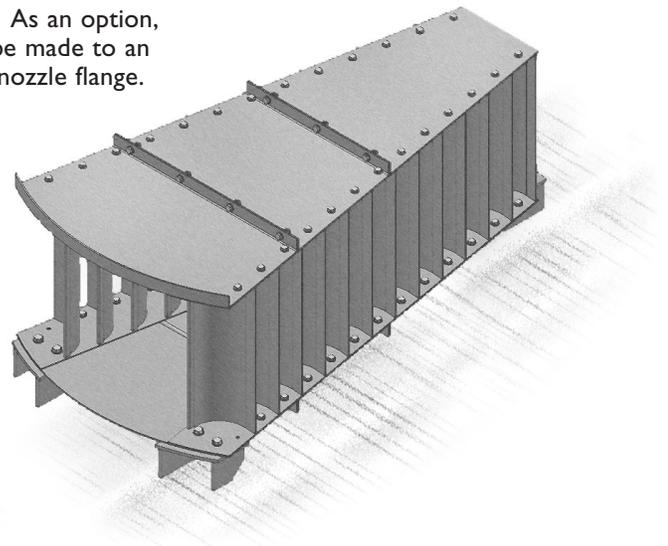
## Construction Details

Multi-piece construction is supplied for installation through a vessel manway. Flanged and bolted construction is supplied as the standard. Field welded construction is an available option.

The inlet attachment requires welding to the vessel wall. Additional support clips welded to the vessel may be required. As an option, attachment can be made to an existing internal nozzle flange.

## Design Options

- Field welded construction
- Attachment to existing flange
- CFD analysis



## Model 611 Deck Style Liquid Collector

- ▶ All diameters
- ▶ For total or partial liquid draw-off
- ▶ Suitable to feed a liquid distributor or trayed section below

The Model 611 deck collector is versatile in design and construction depending on the application requirements. With tall vapor risers, large holdup volumes can be retained on the deck. One or more sumps, downcomers or downpipes can be provided.

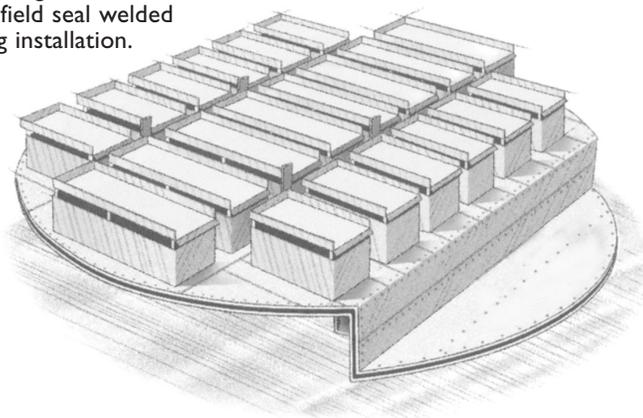
### Construction Details

Joint construction details are variable depending upon the degree of leakage allowable. Both gasketed and seal welded construction are available for deck sections as well as for attachment inside the column.

If the deck sections exceed the height permitting manway access, due to tall vapor riser height, the vapor risers are supplied as separate pieces. These can be supplied as flanged, bolted and gasketed construction or to be field seal welded to the decks during installation.

### Design Options

- Vapor riser height
- Seal welded or gasketed construction
- Sump configurations
- Downcomer variations
- Body flange mounting



## Model 621 Trough Style Liquid Collector

- ▶ Diameters greater than 40 in. [1000 mm]
- ▶ Permits thermal expansion
- ▶ Minimizes field welding
- ▶ Total or partial liquid draw
- ▶ 25 - 40% open area

The Model 621 trough collector is a good choice where thermal expansion is a concern. The trough arrangement rests on a support ring permitting free expansion while minimizing the amount of welding to the vessel wall. A wall wiper above the troughs collects and directs liquid to the troughs. Liquid flows from the troughs into a center sump. The troughs and sump sizes are variable and are designed to meet the application needs.

This collector can be used for total or partial draw-off and/or to feed a liquid distributor below.

### Construction Details

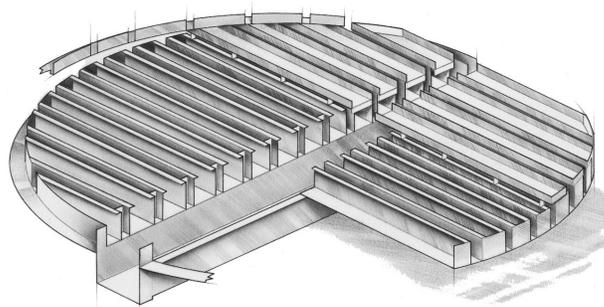
All trough joints are bolted and gasketed. The troughs rest on a 360° support ring.

The center sump must be partially welded to a seat. The wall wiper is welded to the vessel as the standard. Vapor riser covers are bolted above the riser area and drain into the center sump.

If the sump size required for process conditions exceeds the size of manway access, these pieces are supplied in sections, to be field welded.

### Design Options

- Sloped construction for drainage
- Gasketed and clamped wall wiper
- Manway access through collector



# Model 633 Chevron Vane Liquid Collector

- ▶ Diameters greater than 30 in. [760 mm]
- ▶ High vapor capacity
- ▶ Low pressure drop
- ▶ Can be used for draw-off or collection of liquid between packed beds

The Model 633 chevron-type vane collector can be used as a collector for liquid draw-off or as part of a liquid collector/redistribution system between packed beds.

When used as a collector between packed beds, it is chosen because it has low vapor phase pressure drop.

In addition to collection and mixing between beds, a liquid-only feed entering the column can be introduced with a simple inlet into the collector annulus. This enables the feed to be totally mixed with the bulk column liquid while eliminating the need for a separate feed pipe for the inlet stream.

Due to the wide range of applications for this type collector, the construction details are quite variable.

All equipment is designed to pass through vessel manways for installation.

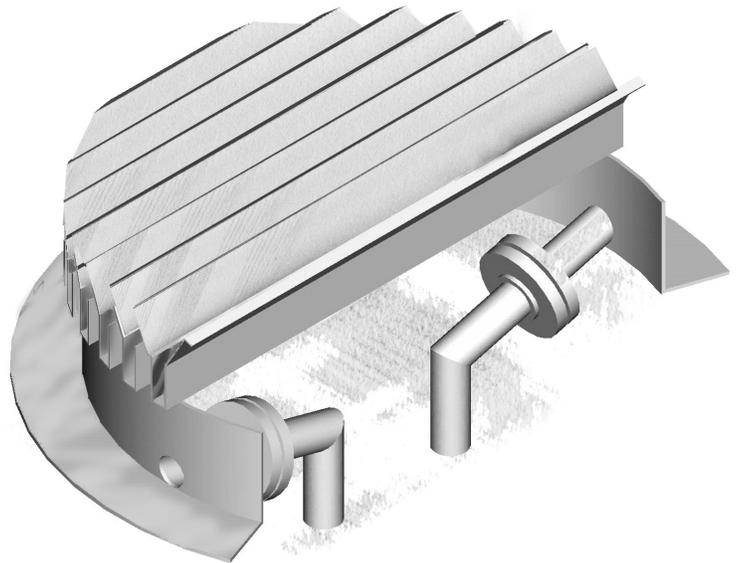
## Construction Details

The collector vanes are supported by channels bolted to an annular sump. The annular sump is seal welded to the vessel and is supplied by others. For small diameter columns with body flanges, the ring of the annular sump may be supplied as sandwiched between body flanges.

As there are no joints to seal, no gaskets are needed for the collector itself. Gaskets may be required for flanged connections of downpipes as required.

## Design Options

- Vane shape and size
- Supply of annular sump
- Mount between vessel body flanges



# Bed Limiters

## Structured Packing

Bed limiters for structured packing are recommended when there is the potential for packing displacement during upset conditions. Many columns operate at a low pressure drop and a low percentage of flood and are not prone to sudden vapor surges. In these cases, bed limiters are not required.

In some cases, where upset conditions are not a concern, the Model 883 bed limiter/liquid distributor support for structured packing may act as a support for a trough type liquid distributor. Except in the case of the Model 883, the bed limiter is not included as part of any other support device.

Only a non-interfering bed limiter design should be used with INTALOX high performance distributors.

## Random Packing

A packing retention device is recommended whenever there is the potential for sufficient vapor load to fluidize the top of a packed bed.

As packing approaches and enters an upset or flooding condition, the pressure drop rises quickly and often uncontrollably. If a packed column goes into flood, this rate will nearly always result in the top of the bed being fluidized. Because conditions that result in the fluidization of some or all of the packing at the top of a bed are difficult to predict, a packing retention device is always recommended for random packings.

The two basic ways to prevent the upward movement of random packing are to use bed limiters or anti-migration devices.

Bed limiters confine the packing movement and either attach to the vessel wall or rest on top of the packing. Sometimes, locator bars are used to limit movement.

Bed limiters attached to the vessel either by clips or clamped to a support ring generally require integral structural members that can interfere with the liquid distribution pattern. These types are not recommended for use with high performance liquid distributors. Only a non-interfering bed limiter design should be used with INTALOX high performance distributors.

Another method of retaining packing is to use anti-migration bars at the base of the vapor risers of a liquid distributor. For most distributor designs using round or rectangular vapor risers, this option is available provided the distributor is not continuously subjected to high vapor load.

The anti-migration devices will not prevent the packing from becoming fluidized and unlevelled at the top of the bed, but will keep the packing from being blown up through the vapor risers.

## Model 803 Structured Packing Bed Limiter, Non-Interfering

- ▶ For all column diameters
- ▶ Minimizes interference of high performance liquid distributors

The Model 803 bed limiter is designed for use with sheet metal or gauze type structured packing. The bed limiter is bolted to vertical wall clips attached to the vessel wall.

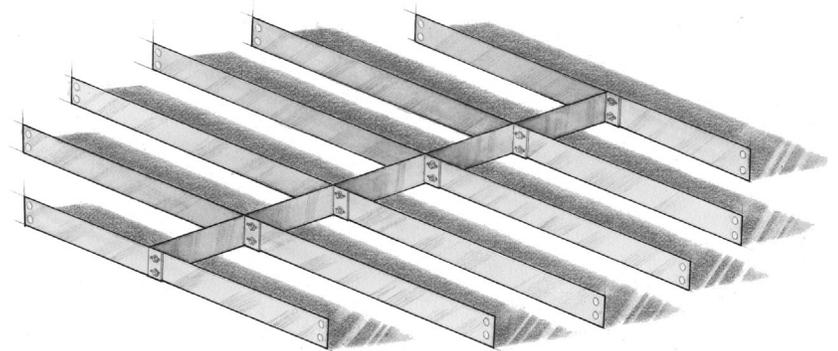
When used to restrict small diameter, one-piece packing layers, the bed limiter is normally integrated with the liquid distributor (see Model 883 bed limiter). In this case, the uplift protection provided is limited by the allowable method of attachment to the vessel.

### Construction Details

Standard construction will withstand 50 lbs/ft<sup>2</sup> [0.024 bar] upward force.

### Design Options

- Greater uplift resistance
- Jack screws for diameters under 36 in. [900 mm]



# Model 805 Random Packing Bed Limiter, Non-Interfering

- ▶ For all column diameters
- ▶ Requires no vessel attachments
- ▶ Minimizes interference of drip point from high performance liquid distributors

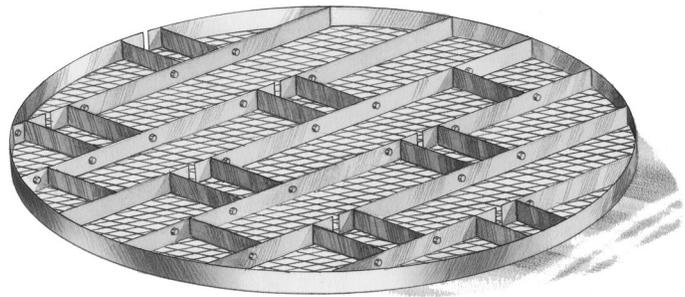
The Model 805 bed limiter is used to retain random packing when used in conjunction with an INTALOX high performance liquid distributor. The structural components of this bed limiter are designed to minimize the interference of the liquid flow from the distributor.

## Construction Details

Standard construction will withstand 50 lbs/ft<sup>2</sup> [0.024 bar] upward force.

## Design Options

- Increased uplift resistance



# Model 825 Random Packing Bed Limiter

- ▶ For all column diameters
- ▶ Fastens to vessel wall
- ▶ For use with traditional distributors

The Model 825 bed limiter is used with most random packing when traditional liquid distributors are used. To provide uplift resistance, this bed limiter is attached to the column.

## Construction Details

The bed limiter is designed to withstand 50 lbs/ft<sup>2</sup> [0.024 bar] uniform uplift.

The standard method of attachment to the vessel is to clamp to an annular ring welded in the column. As an option, the attachment method may be with clips welded to the vessel wall.

## Design Options

- Increased uplift resistance
- Jack screws or clamps for diameters up to 36 in. [900 mm]
- Clip mounted to vessel



# Model 883 Structured Packing Bed Limiter/Liquid Distributor Support

- ▶ For all column diameters with structured packing
- ▶ Supports tubular, channel or trough type liquid distributors
- ▶ Used for large diameter columns to reduce structural components
- ▶ Provides limited uplift resistance
- ▶ Eliminates interference of high performance liquid distributors

The Model 883 bed limiter is primarily used for large diameter columns where the tower is not subject to process upsets or flooding. The bed limiter acts as a structural support and leveling device for the liquid distributor. The weight of the distributor retains the packing while simplifying the mechanical structure needed to support the distributor.

The Model 883 bed limiter is also applied in small diameter columns with one-piece packing layers, where no vessel support rings, clips or other internal protrusions from the wall are permitted.

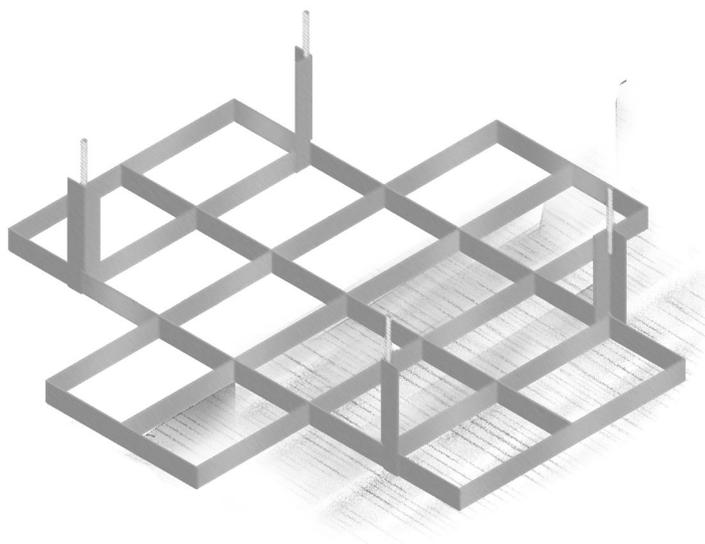
## Construction Details

Standard construction is to have the Model 883 bed limiter rest directly on the structured packing with the weight of the distributor limiting the bed movement.

As an alternative, the Model 883 bed limiter can be attached to the vessel with wall clips. When attached with clips, standard construction will withstand 50 lbs/ft<sup>2</sup> [0.024 bar] upward force.

## Design Options

- Jack screws for diameters under 36 in. [900 mm]
- Attach to vessel wall clips for uplift resistance



# Support Plates

Every packed bed will need a support. Two critical factors to be considered in the design of a packing support are:

- It must physically retain and support the packed bed under operating conditions in the column including but not limited to packing type and size, design temperature, bed depth, operating liquid holdup, material of construction, corrosion allowance, material buildup in the bed and surge conditions.
- It must have a high percentage of free area to allow unrestricted counter-current flow of downcoming liquid and upward flowing vapor.

Pressure drop calculations for all Koch-Glitsch packings include the pressure drop of the properly designed support. All supports are designed to handle the flow rates specified at the time of order placement and will not limit the capacity of the packing they retain.

Random packing uses a gas-injection type support that provides separate passages for liquid and vapor flow so that the two phases do not compete for the same opening. Packing elements are retained with specific slot openings while the contour of the support provides a high percentage of open area.

The inherent construction of structured packing allows it to be supported by a simple open grid structure.

FLEXIGRID structured packing may utilize a beam and/or an open grid structure.

## Model 802 Structured Packing Support Grid

- ▶ **All column diameters**
- ▶ **Supports all sheet metal or wire gauze packings**

The open grid type structure of the Model 802 support grid allows free and uniform passage of the liquid and vapor so the packing capacity is not limited.

The supports for smaller columns having body flange access are generally supplied as one-piece units. All others are supplied for installation through vessel manways.

### Construction Details

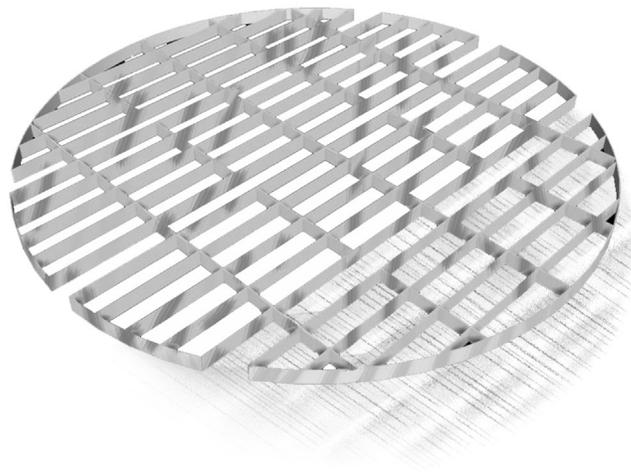
For very small diameter columns, the support rests on lugs. For all others, the Model 802 support grid rests on a 360° support ring. Support ring load calculations are the responsibility of others.

Midspan beams may be required, depending upon column diameter and load requirements.

Grid sections are bolted together but are not clamped to the support ring as the standard.

### Design Options

- Support ring clamps
- Uplift resistance



# Model 804 Random Packing Gas Injection Support Plate

- ▶ Diameters greater than 36 in. [900 mm]
- ▶ Gas injection design

The Model 804 gas injection support is designed to support the desired packing under the specified operating conditions while not limiting the capacity of the packing. Therefore, beam height, material thickness and slot size will vary depending on packing size, bed weight and process conditions.

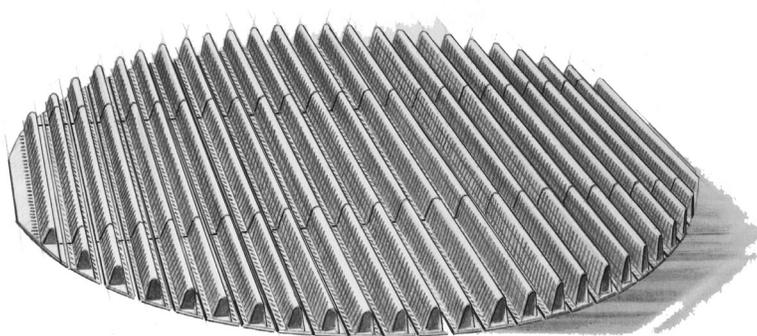
Sections are clipped together and the assembly is clamped to the vessel support ring as the standard.

## Construction Details

The support rests on a 360° support ring. Support ring load calculations are the responsibility of others.

Columns with diameters larger than 14 ft [4.2 m] generally require the use of midspan beams. Smaller diameter columns may require midspan beams depending upon material of construction, design load and temperature.

## Design Options



# Model 814 Random Packing Gas Injection Support Plate

- ▶ Diameters 12 - 48 in. [300 - 1200 mm]
- ▶ Gas injection design

The Model 814 support combines a high percentage free area with excellent mechanical strength. Two to four piece construction is supplied as the standard, depending on diameter.

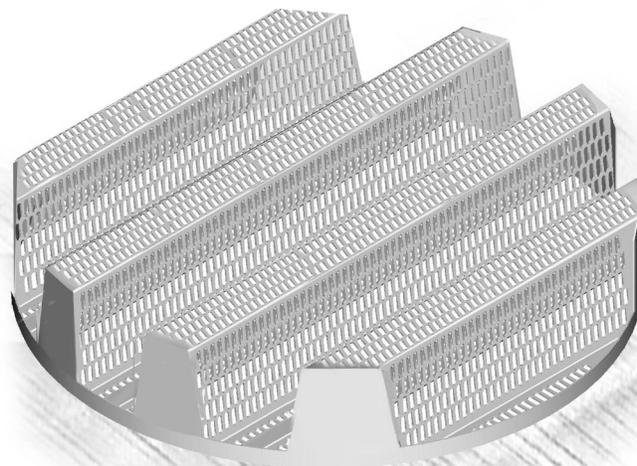
## Construction Details

This support rests on a 360° support ring. Support ring load calculations are the responsibility of others.

Optional one-piece construction (for body flanged columns only) may rest on tower clips.

## Design Options

- One piece construction
- Support ring clamping



# Model 824 Light Duty Random Packing Support Plate

- ▶ **Diameters 4 - 36 in. [100 - 900 mm]**
- ▶ **Low hydraulic loading**
- ▶ **Low support strength requirements**

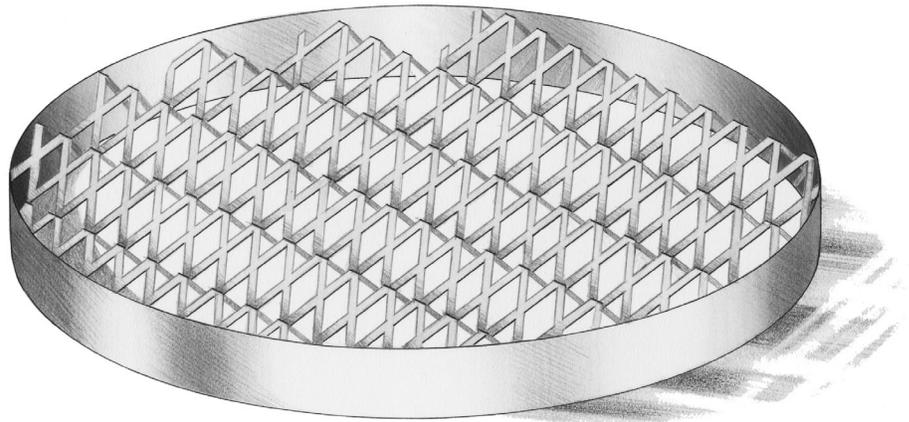
The Model 824 light duty support should only be used for columns with low operating bed weights and low to moderate hydraulic loads. Typically, it is used with plastic packings or short beds of metal random packings.

## Construction Details

Expanded metal is utilized in the construction of the Model 824 support plate and its availability may limit the materials of construction offered for this support.

## Design Options

- Support ring clamps for towers greater than 12 in. [300 mm]
- One-piece construction



# Construction Details

## Metal

Tower internals are available in any formable, weldable sheet metal material. Where pipe is involved in the design, the choice must be any weldable metal for which pipe and flanges are readily available. The following materials are most often used for tower internals:

- Carbon steel (not recommended for liquid distributors)
- Stainless steel (low carbon content is preferred); Ferritic, Austenitic, Duplex, Martensitic
- Nickel alloys
- Copper alloys
- Titanium, Zirconium

Internals are not stress relieved or annealed and do not typically conform to pressure vessel standards.

Internals fabricated from sheet metal materials will be supplied in "as-sheared" condition.

Designs including corrosion allowances are available for many tower internals. Designs with corrosion allowances are not recommended for liquid distributors since corrosion of the metering device will affect performance. Designs for INTALOX high performance liquid distributors are not available with corrosion allowances.

## Bolting

With the exception of specific sizes for pipe flanges, all fasteners will be  $\frac{3}{8}$  in. [10 mm] unless otherwise specified. Bolting will conform to AISI standards. Bolting conforming to ASME specifications is available by special request.

## Certification

Material certification is available for all fabricated internals. Positive Material Identification (PMI) testing is available by special request.

## Gasketing

For multi-piece tower internals requiring gasketed joints, many choices of gasket material are available. Where gasketing is required, braided fiberglass tape is supplied as the standard for linear joints. Depending on the service, FLEXITALLIC® SF2400, expanded PTFE or spiral wound stainless steel with flexible graphite filler gaskets are supplied as the standard for flanged connections. Other gasket materials are available by special request.

## Flanges

For tower internals using pipe sections or branches and where the connections are inside the column pressure boundary, the standard connections use flanges. These flanges may be standard machined pipe flanges with 150 psi [PN 10] rating or flanges fabricated by Koch-Glitsch from plate, depending on material of construction, size and availability.

In some cases for pipe connections with diameters under 4 in. [100 mm], threaded connections may be used. Please include specific requirements concerning flange type, rating or pipe schedule specifications at the time of inquiry.

## Manway Access

All tower internals are designed in sections to pass through vessel manways. Tower internals are designed to pass through a vessel manway of 18 in [450 mm] minimum inside diameter, unless otherwise specified. Larger manways often provide the ability to increase turndown ratio on distributors and/or to optimize the design of components for faster, easier installation. Please provide manway locations and sizes at the time of inquiry.

## Scope of Supply

For the fabricated internals in this brochure, Koch-Glitsch supplies all removable parts. The internals do not include vessel attachments, unless specifically stated in the item description, for connection or support, although these may be quoted/supplied separately. Examples of such attachments that may be required are:

- Support rings
- Sump frames
- Internal flanges at feed inlet nozzles
- Wall clips for support
- Ring channel (Model 633)

## Minimum Support Ring Widths

all dimensions are expressed in inches [millimeters]		
Tower I.D.	Internals Resting on or Clamped to Support Ring	Internals Through-Bolted or Using Leveling Screws
Up to 18 [up to 457]	0.75 [20]	1.5 [40]
18.1 - 24.24 [458 - 615]	1.0 [25]	1.5 [40]
24.25 - 48.24 [616 - 1225]	1.5 [40]	2.0 [50]
48.25 - 72.24 [1226 - 1835]	2.0 [50]	2.0 [50]
72.25 - 96.5 [1836 - 2450]	2.5 [65]	2.5 [65]
96.6 - 144.5 [2451 - 3670]	3.0 [75]	3.0 [75]
144.6 - 168.7 [3671 - 4285]	3.5 [90]	3.5 [90]
168.8 - 216.3 [4286 - 5495]	4.0 [100]	4.0 [100]
216.4 - 240.5 [5496 - 6110]	4.5 [115]	4.5 [115]

If the support ring size is other than these listed above, special consideration must be given to the plate diameter and vessel tolerances.

# Special Tower Internals

The following is a partial list of other tower internals not specifically covered in detail in this brochure. For further information concerning these models, please contact a Koch-Glitsch representative.

Device	Model	Description
Liquid Distributors	996	Trough type distributor with drip point multipliers for very low liquid load
Feed Devices	765	Suppressed flash vapor feed distributor for flashing feed or suppressed vaporization reboiler return
	798	Vapor inlet designed for FCC Main Fractionators for extreme fouling application
Liquid Collectors	613	Deck style liquid collector for off-shore columns subject to tilt and motion
	622	Trough style liquid collector for fouling services
Bed Limiters	815	Anti-migration screen used to separate two different random packing sizes in a single bed
	845	Bed limiter designed for random packed beds using spray nozzle distributors to minimize disruption of spray pattern at the top of the bed
Liquid / Liquid Extraction Internals	534	Packing support/disperser plate for use when light phase is dispersed
	535	Packing support/disperser plate for use when heavy phase is dispersed
	544	Feed pipe for dispersed phase to be used in conjunction with Models 534 or 535 above
	545	Feed distributor for the continuous phase
Supports and Tower Attachments	800	Annular support ring or support ring segment
	801	Free Flow support ring
	810	Support beam – fabricated channel or I-beam
	811	Free Flow support beam
	820	Support truss – fabricated truss or lattice beam
	828	Drip ring
	830	Beam seats and clips
	858	Rosette style wall wiper

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