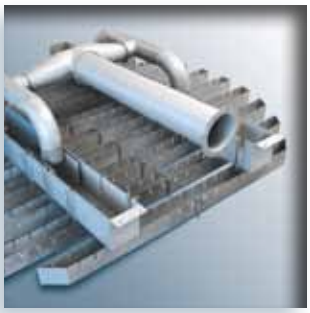
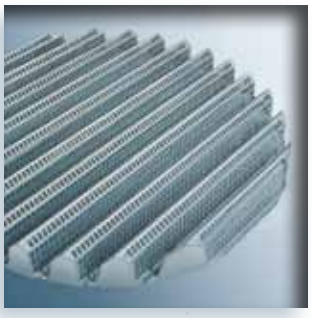




Column internals
Our complete program for optimal performance

RVT – Member of Kober Group

Column internals
Know-how and experience from RVT Process Equipment GmbH

RVT Process Equipment has been certified according to ISO 9001 since 1996, and according to ISO 14001 since 2010.

Mass transfer performance as well as the hydraulic characteristics of a packed column are highly dependant on the quality of the column internals used. The optimal configuration of the internals to the selected tower packings as well as to the individual operating conditions and material requirements demand comprehensive process engineering know-how and experience.

RVT Process Equipment is your competent and reliable partner for all requirements in terms of column internals and packings. Our complete program includes the following items:

- Liquid distributors
- Collecting trays
- Liquid feed systems
- Bed supports
- Bed limiters
- Mist eliminators
- Gas distributors
- Custom made internals for special applications

In combination with our comprehensive tower packing and mass transfer tray program, we offer complete solutions from one source to customers worldwide.

RVT Process Equipments' column internals are manufactured in our fabrication facilities, where we process a wide range of metal and plastic materials including fluoropolymers (e.g. PTFE, TFM). We handle specific solutions and designs in cooperation with our customers as required for any special application. To complete the available material options, ceramic and graphite internals are also offered.

Designs and technical drawings for our column internals are generated by state of the art software programs including AutoCAD and SolidWorks. RVT Process Equipment can provide field crews to install column internals or provide an onsite supervisor.

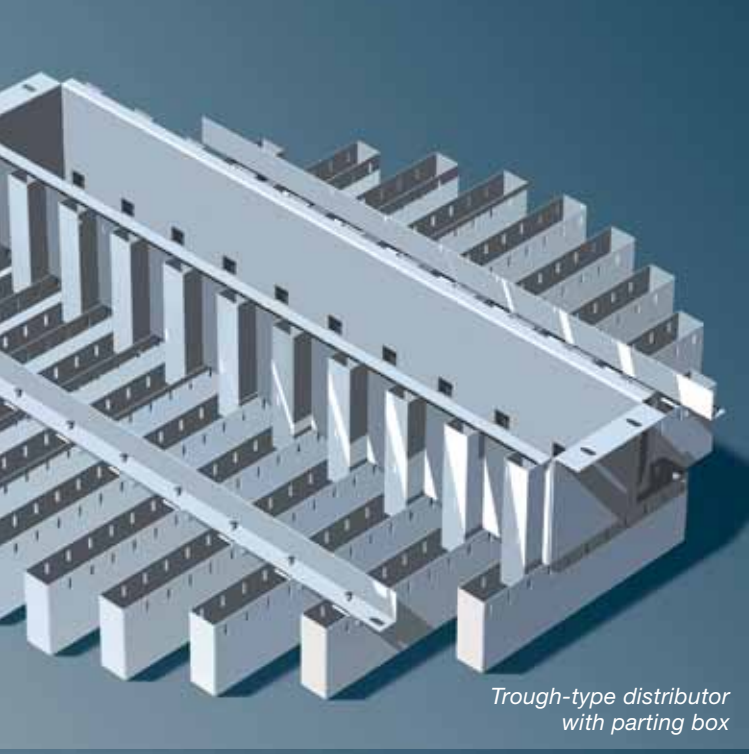
RVT Process Equipments' research and development facility, which includes a liquid distributor test facility, ensures that the quality control measures are executed and the results achieved meet the performance required.

RVT Process Equipment is DIN ISO 9001 certified. The qualification of our fabrication facility employees complies with strict workmanship and quality control standards thus assuring high quality. We are a specialized industrial fabricator per § 19 WHG (German Law for Water Protection).

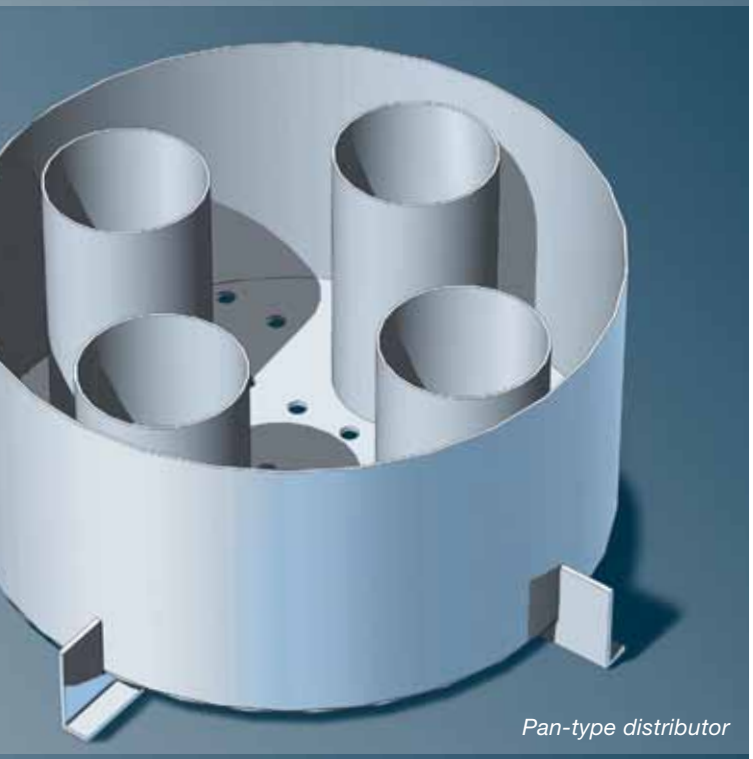
Our locations in Steinwiesen (headquarter) and Marktrodach (factory)

Fabrication of a thermoplastic tray

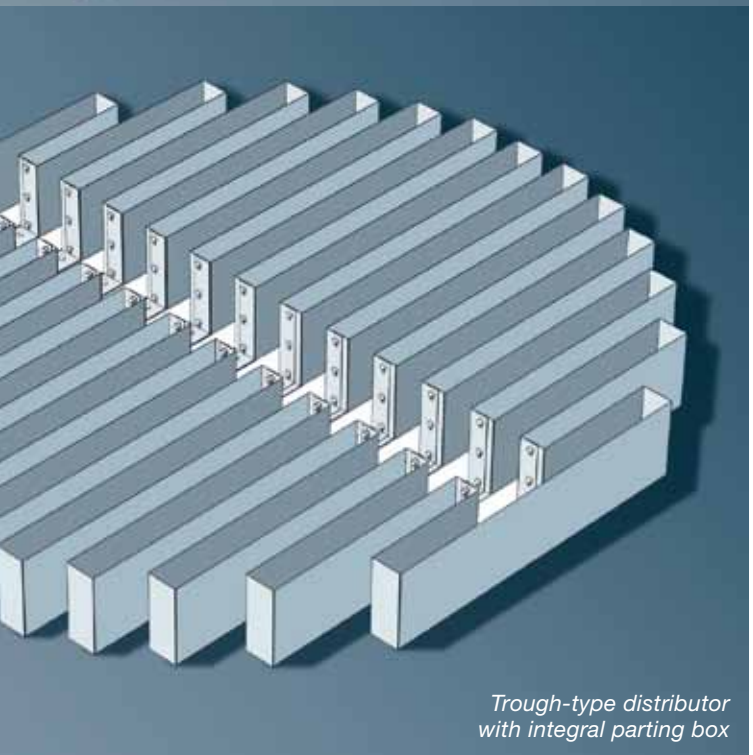
Testing of a through-type distributor



Trough-type distributor with parting box



Pan-type distributor



Trough-type distributor with integral parting box

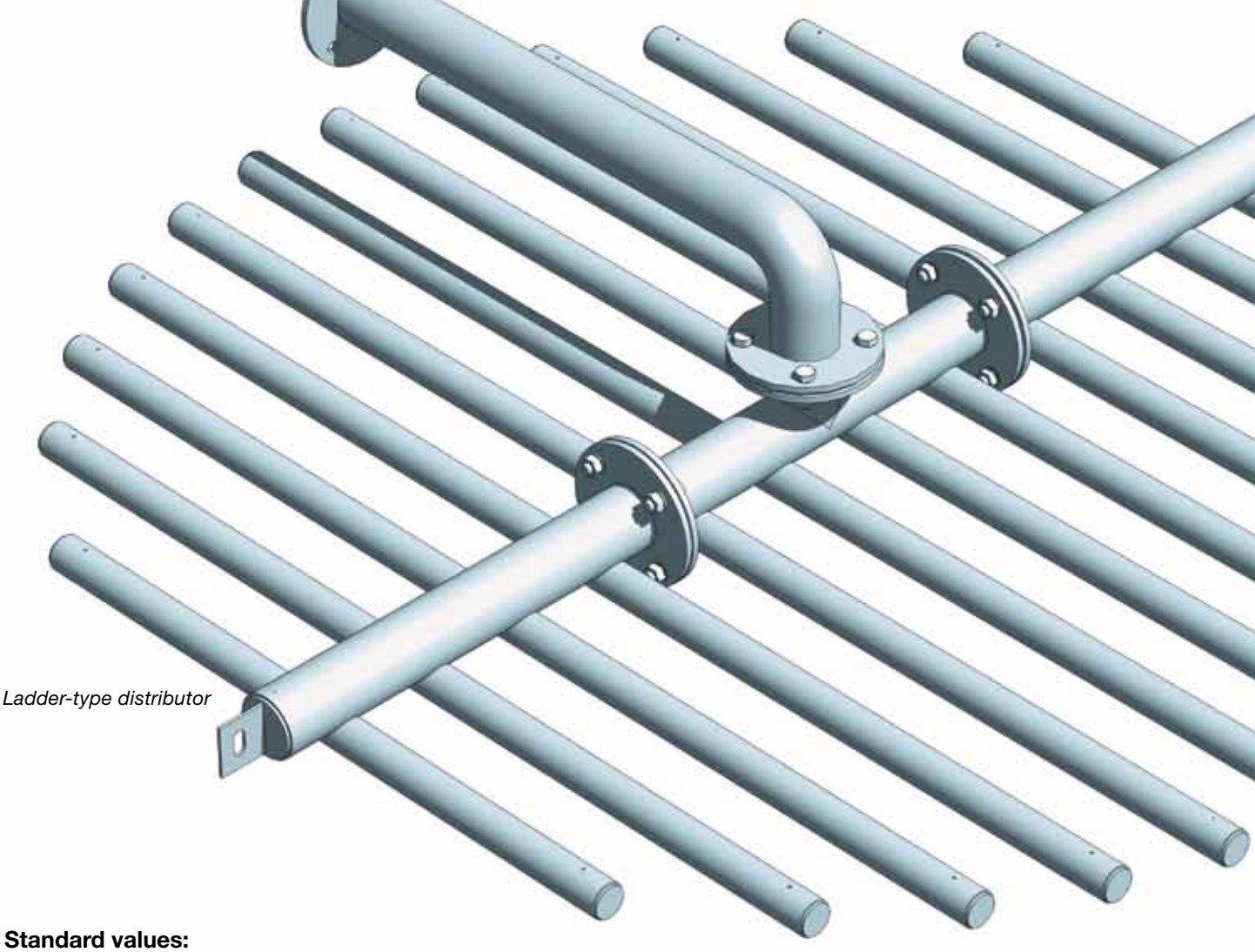
Liquid distributors
Design types and functional principles

Packed columns require properly designed liquid distribution systems to irrigate the entire packed bed effectively. The mass transfer performance of a packed column is highly dependent upon the quality of liquid distribution through the packed bed. To achieve optimum mass transfer for the entire operating range of a packed column, equal distribution of liquid over the entire bed cross-section must occur. Other important characteristics of liquid distributors include low gas-side pressure drop, low sensitivity to fouling, low overall height as well as the ability to handle multiple incoming feed streams, if necessary. Liquid distributors must be designed to allow horizontal leveling to ensure equal distribution of liquid over the entire distributor cross-section.

RVT Process Equipments' comprehensive experience over the past several decades ensures the selection of the optimal solution for each application.

For the wide range of various applications, we provide the following basic designs of liquid distributors:

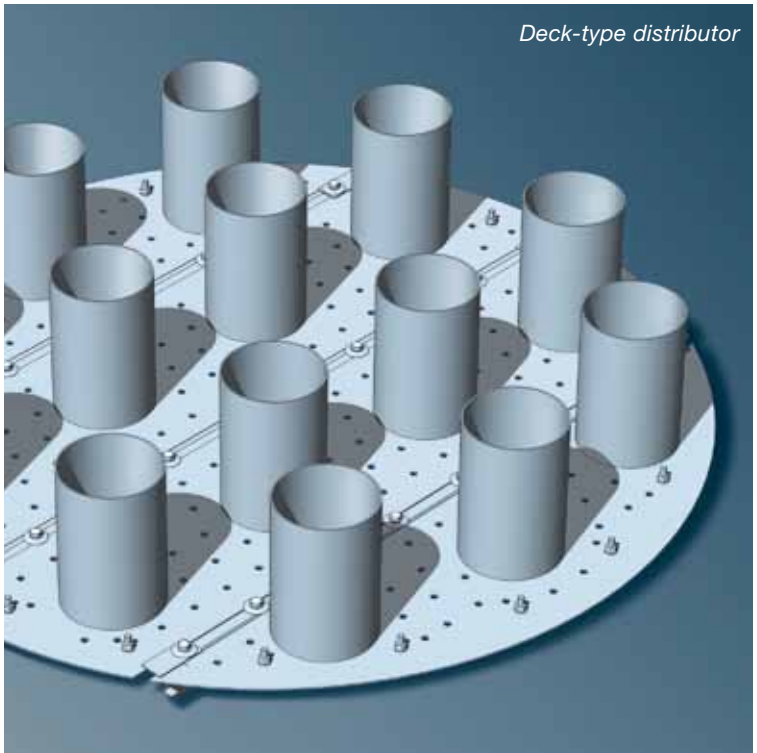
- Pan-type distributor
- Deck-type distributor
- Trough-type distributor
- Ladder-type distributor
- Spray-nozzle-type distributor



Ladder-type distributor

Standard values:

Design type	Liquid load in m^3/m^2h	Recomended column diameter in mm
Pan-type distributor	0.3 – 200	100 – 1,600
Deck-type distributor	5 – 200	> 200
Trough-type distributor	0.3 – 50	> 600
Ladder-type distributor	4 – 100	all sizes
Spray-nozzle-type distributor	3 – 200	all sizes



Deck-type distributor

Liquid distributors
Principles of distribution

Several key principles must be considered when assessing liquid distribution design.

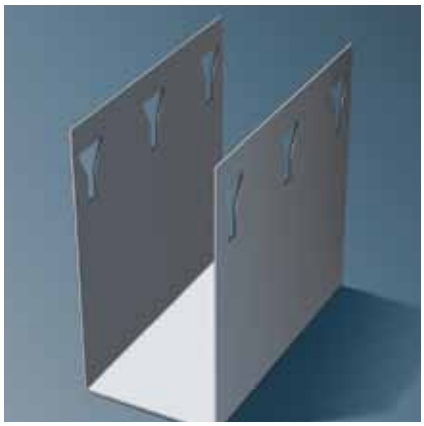
Applicable principles are dependent upon the following:

- Liquid load to be distributed
- Working range
- Liquid properties
- Potential for fouling
- Allowable entrainment

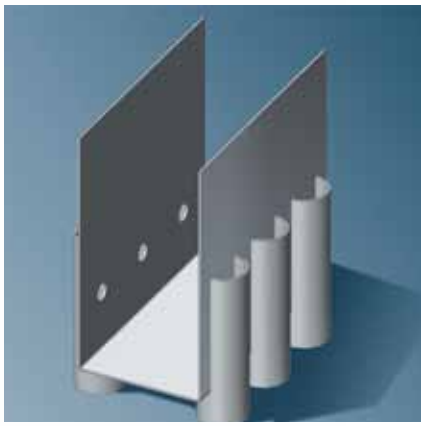
The number of drip points generally ranges between 60-150/m^2, depending on the particular application. The following principles of liquid distribution are applied:

- Orifices at the bottom of the distribution troughs are used for clean systems with standard turn-down.
- Orifices, weirs or attached distribution pipes on the sides of individual troughs are suitable for low liquid loads and wide operating ranges.
- Overflow distribution (e.g.-via weirs on trough sides) is recommended for systems where the risk for fouling exists.
- Overflow drip pipes where the risk for fouling exists.
- Spray nozzles, particularly for pipe (ladder) type distributors or designed in an array, for solid-free systems
- Combinations of the above-mentioned systems

Troughs with orifices at the bottom



Troughs with overflow distribution via engineered weirs



Troughs with side orifices and distribution pipes

Drip tube with side orifices

Drip tube with overflow weirs

Drip tube with slotted weirs

Liquid distributors
Predistributors

Uniform liquid feed to the liquid distributor selected for a particular application is critical to the optimum performance of this distributor. The feed system must distribute liquid as evenly as possible to the entire liquid distributor while taking into consideration liquid discharge velocity and liquid pressure fluctuations.

The liquid feed system is especially critical in systems of high liquid loads and large diameter columns.

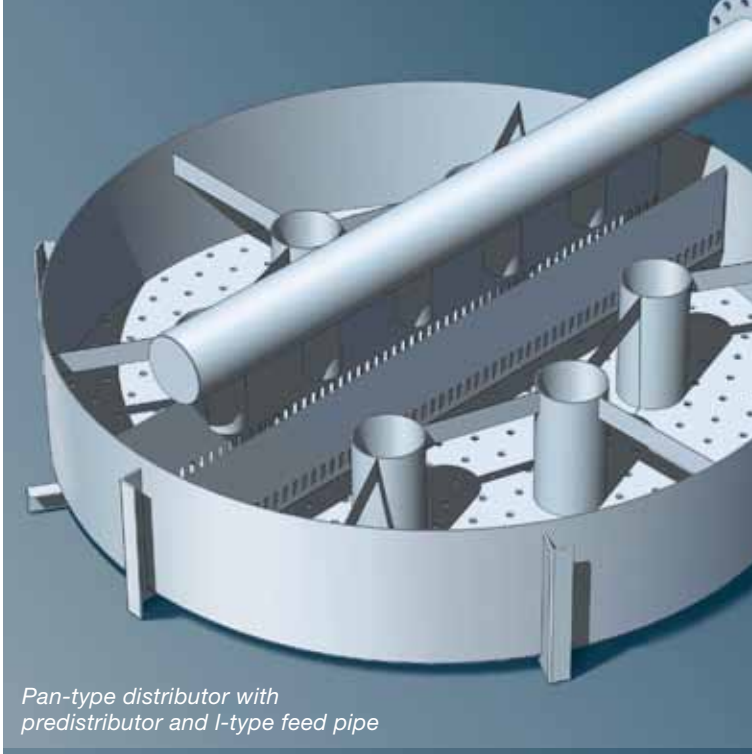
Fundamental design options are as follows:

- Ladder type feed system for low and medium liquid loads (< 80 m^3/m^2h, turndown ratio of 1:3) and
- Parting box with downcomers for higher liquid loads and wider turndown ranges (1:10 or more)

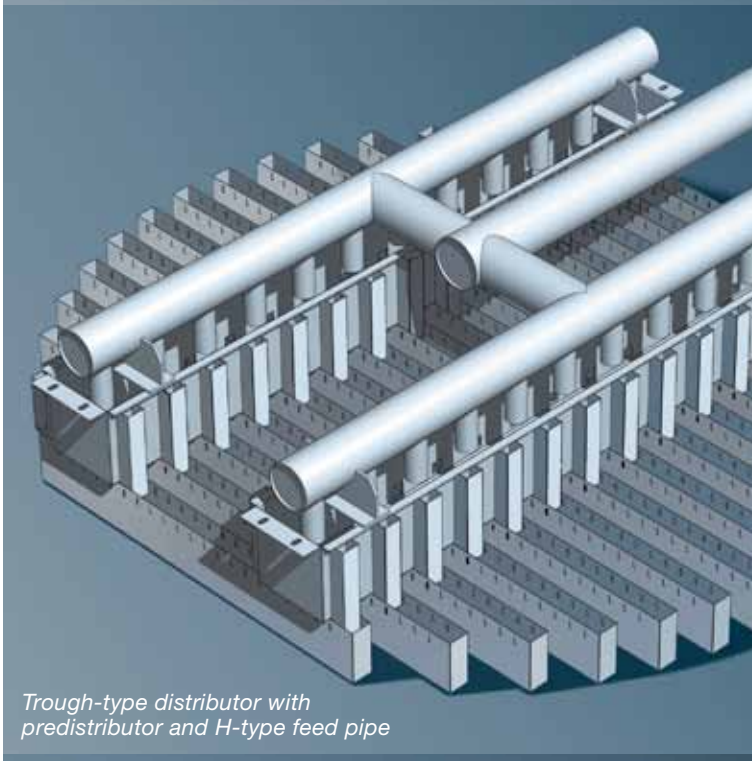
Special parting box designs are available to handle two phase mixtures at high temperatures.

A system that distributes liquid feed prior to the distributor is not required by lower liquid loads (up to 5 m^3/m^2h) and smaller diameter columns.

Each of the above-mentioned liquid feed designs has specific advantages. Not every design is able to be used with various types of liquid distributors. Our know how and experience allow us to support you in the optimal configuration of liquid feed system and distributor for your particular application.

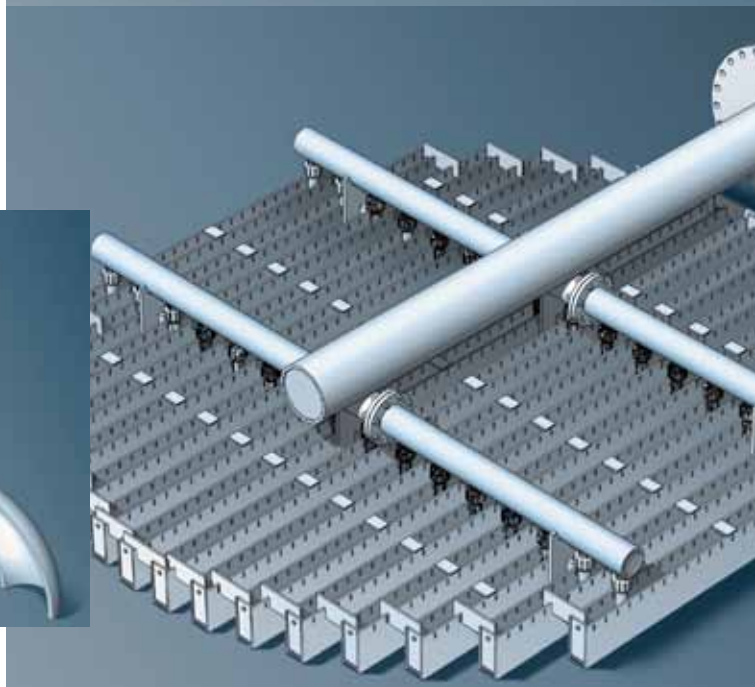


Pan-type distributor with predistributor and I-type feed pipe



Trough-type distributor with predistributor and H-type feed pipe

Detail orifice



Trough-type distributor with predistributor by orifice and I-type feeding pipe

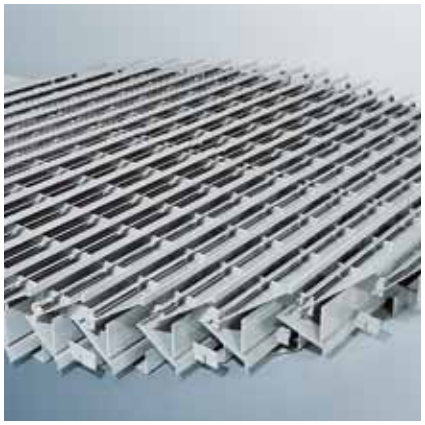
Collecting trays and distributors
Design principles and types

Collecting trays are used to collect downcoming liquid at the bottom of a packed bed and to allow for either removal of this liquid from the column or to feed it into a liquid distributor below the collecting tray. This liquid redistributor distributes the liquid load over the entire cross-sectional area of a second, lower packed bed.

Collecting trays and redistributors are typically applied in the following cases:

- An additional liquid feed stream needs to be introduced or removed
- A high number of transfer stages must be achieved
- Maldistribution of the downcoming liquid caused by high bed heights must be prevented
- The weight or mechanical stability of the packed bed is limited

For less critical applications, total height of the required collecting tray and subsequent liquid redistributor can be reduced by the use of a chimney tray/chevron collector construction as shown below.



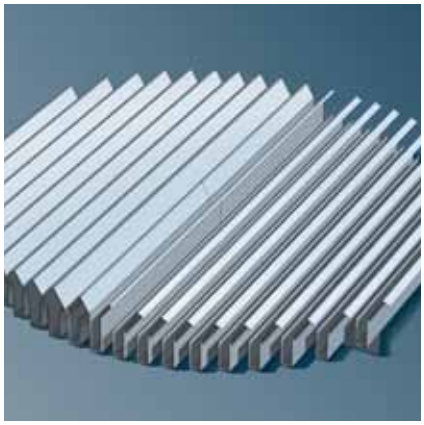
Combi element

Collecting tray

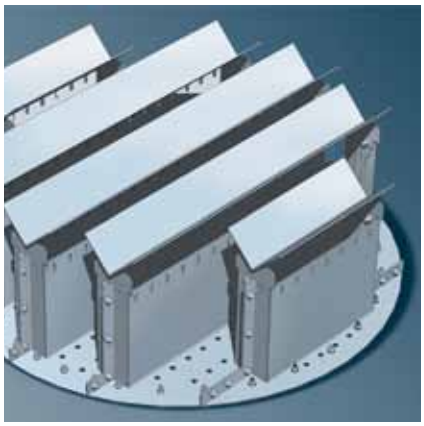
Typically, liquid in the collecting tray is removed either via a circulating collecting trough or a draw off nozzle. The collecting tray can be used as a sump. During equipment downtime, liquid is retained in this sump. The height of the chimneys determines the volume of liquid that can be retained. In order to prevent leakage, the collecting tray is often welded or laminated in the vessel by the vessel manufacturer.

Combi Element

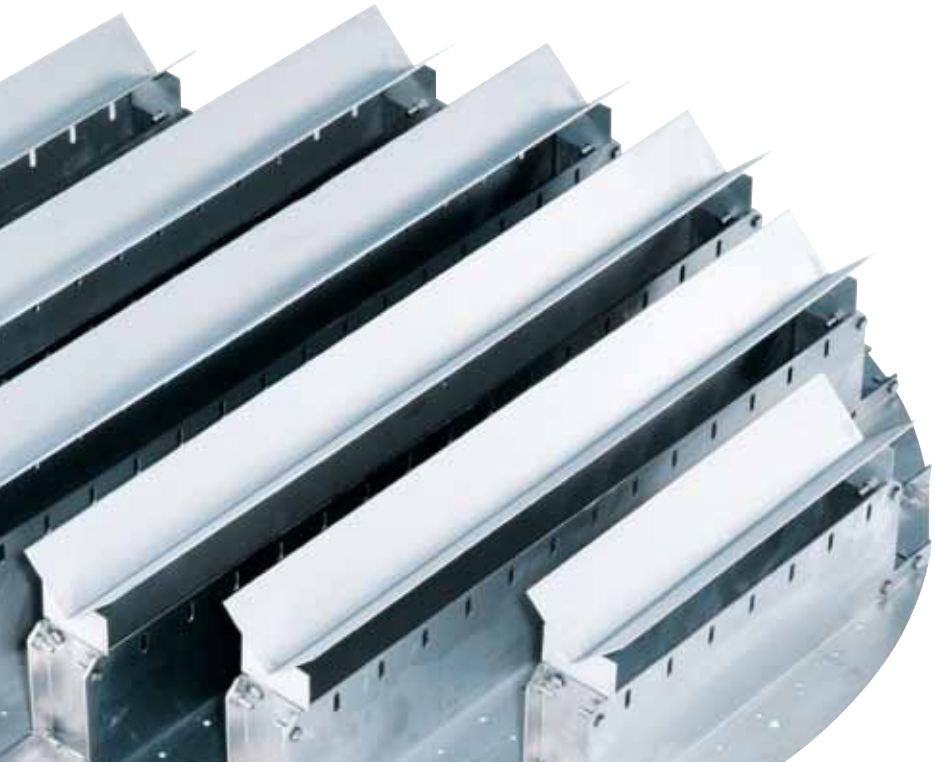
In order to reduce the overall height of a packed column and to reduce the number of internals used, various internals can be strategically combined into a single unit. Between two packed bed sections, a device for collecting and removing or redistributing the downcoming liquid is necessary. The patented RVT Combi Element accomplishes these multiple tasks in a single internal. In addition to reducing overall vessel height, further advantages are a relatively low pressure loss and very low weeping rates.



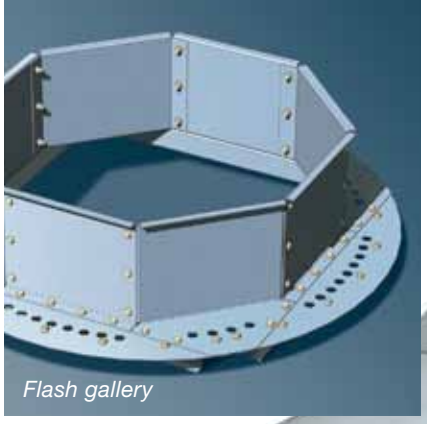
Vane-type collecting tray



Deck-type distributor with covered gas chimneys



Feed systems
For multiple phase feeds

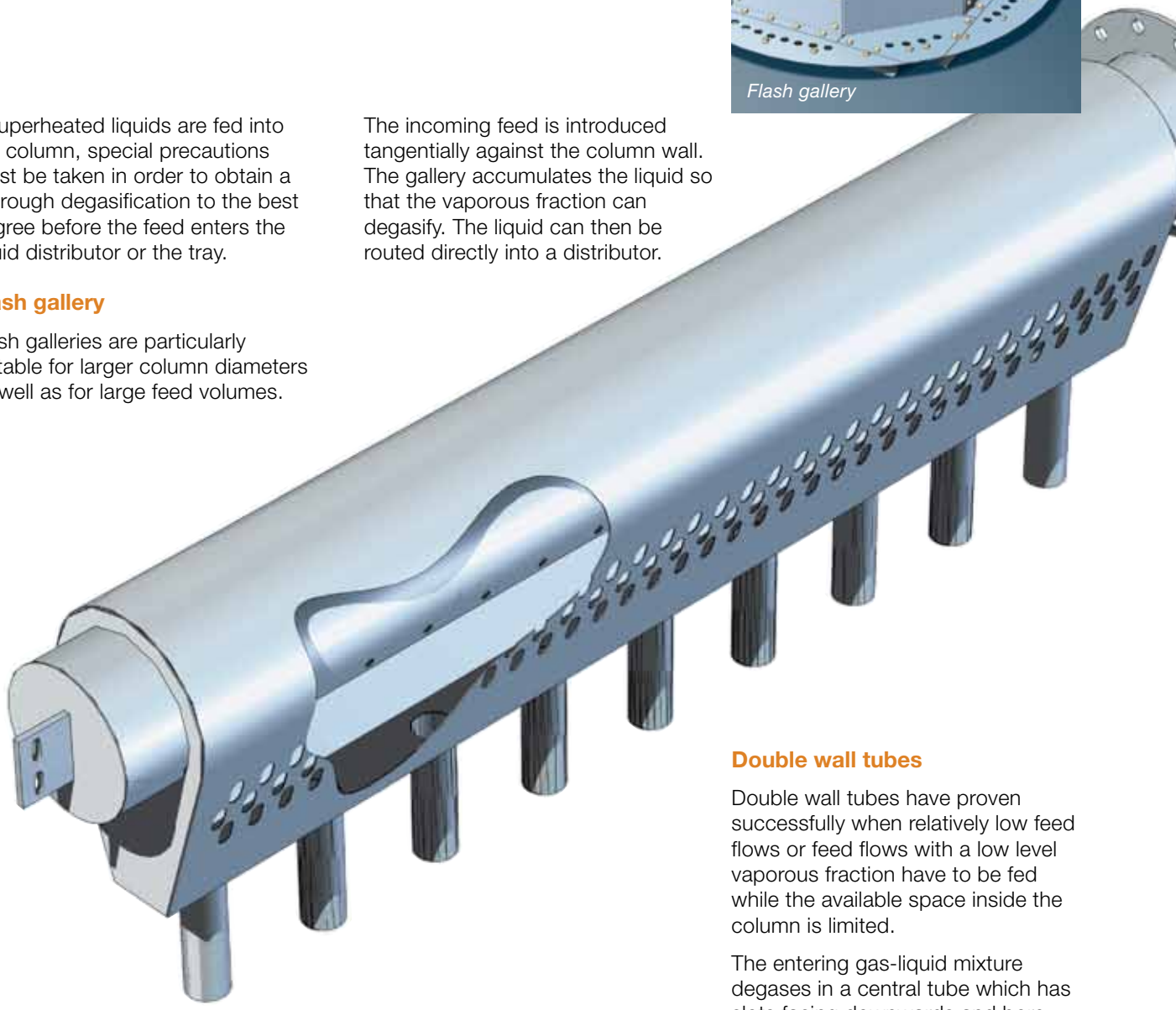

Flash gallery

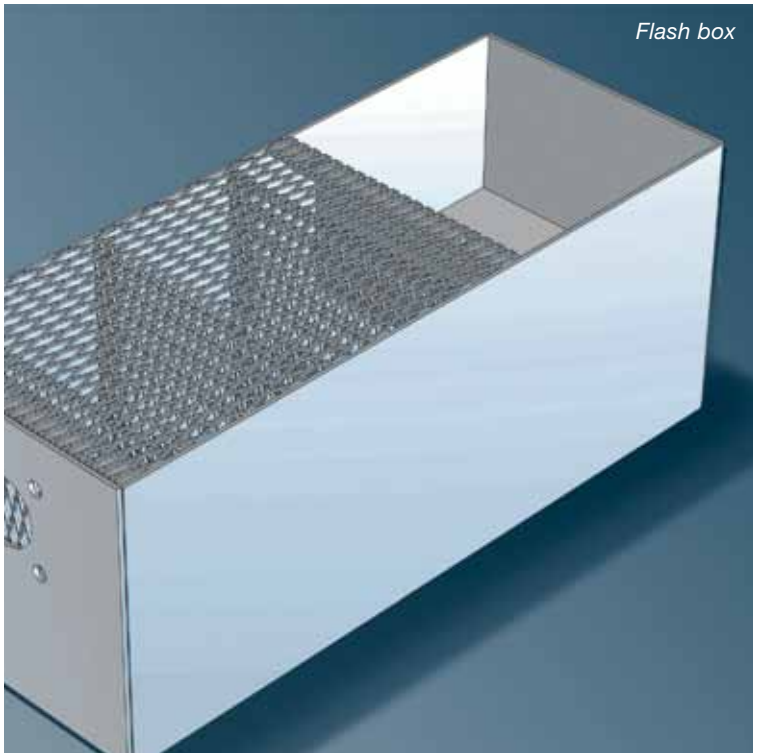
If superheated liquids are fed into the column, special precautions must be taken in order to obtain a thorough degasification to the best degree before the feed enters the liquid distributor or the tray.

The incoming feed is introduced tangentially against the column wall. The gallery accumulates the liquid so that the vaporous fraction can degasify. The liquid can then be routed directly into a distributor.

Flash gallery

Flash galleries are particularly suitable for larger column diameters as well as for large feed volumes.




Flash box

Double wall tubes

Double wall tubes have proven successfully when relatively low feed flows or feed flows with a low level vaporous fraction have to be fed while the available space inside the column is limited.

The entering gas-liquid mixture degases in a central tube which has slots facing downwards and bore-holes in the upward direction. Overflow spouts are arranged in the encasing tube while the gas phase escapes upwards by way of bore-holes arranged on the sides.

Flash box

Flash boxes are suitable for low flows. These boxes are arranged in the column near the distributor. The incoming feed degases in the flash box where the stabilized liquid is directed downwards and the vapour escapes upwards.

Gas distributors
Design principles and types

Gas distributors have the task of uniformly distributing the incoming gas stream over the entire cross-section of a tray or packed column.

Through proper design, the resulting pressure loss is kept as low as possible. Depending on the gas volume, gas velocity, temperature and gas stream constituents being handled, the design and the material of construction of the gas distributor is selected. If required by the customer, CFD simulations of the incoming gas stream for a specific gas distributor can be provided.

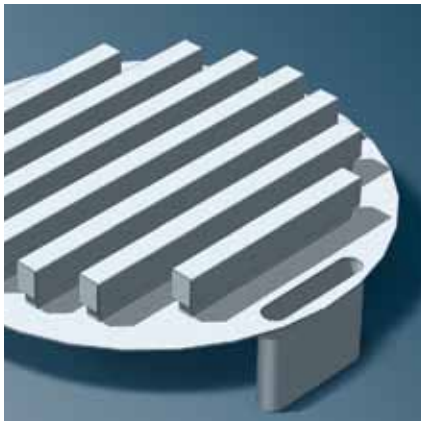
Gas distributors with guide vanes

This distributor type uses an engineered arrangement of curved guide vanes to evenly distribute the incoming gas flow which then exits the distributor in a horizontal direction. This design is used particularly in large diameter columns with low gas velocities.

Gas distributor with guide vanes

Chimney tray distributor

With the chimney tray distributor, the gas flow is distributed evenly by means of covered chimneys while downcoming liquid is collected and drawn off through a shaft or pipe. The pressure loss through this type of distributor can be relatively high.



Chimney tray distributor

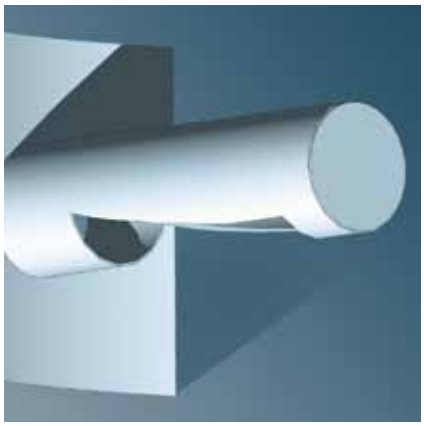
Ladder-type distributor

Ladder-type distributor

The total required installation height of the ladder-type distributor is less than that of the chimney tray distributor. The operating range of this gas distributor depends, to a major degree, on the allowable pressure loss.

Inlet feed pipe

Inlet Feed Pipes are used in cases where the gas velocity is high. The kinetic energy of the incoming gas is reduced by this distributor and therefore improving the gas distribution to the column internals.



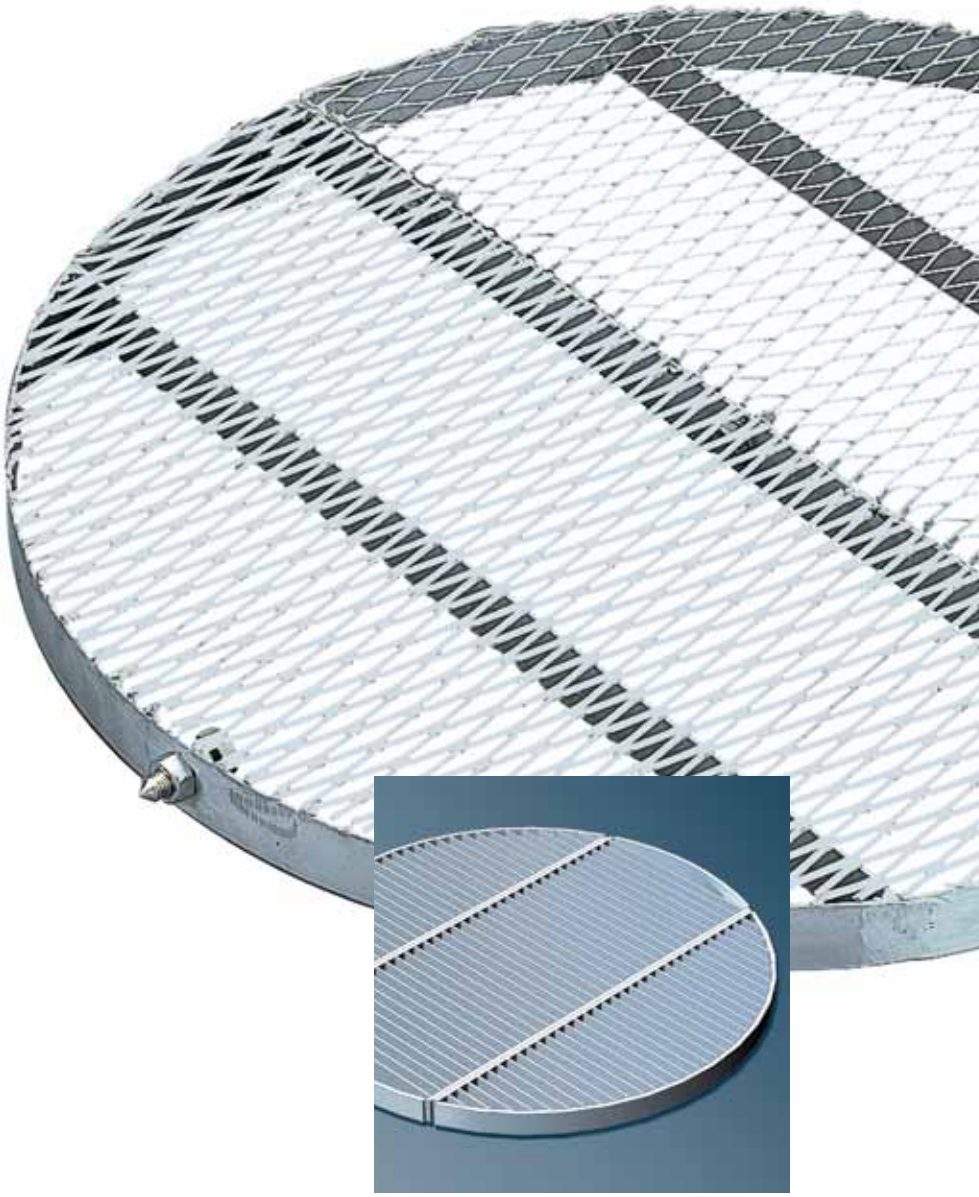
Inlet feed pipe

Bed limiters
Designs

Bed Limiters are installed directly above a packed bed to prevent the movement of the packing. They are particularly necessary in such cases where packing can experience uplift due to high gas loading or sporadic pressure surges. In addition, they can be used to separate packing of different sizes to avoid mixing of different packings inside the column.

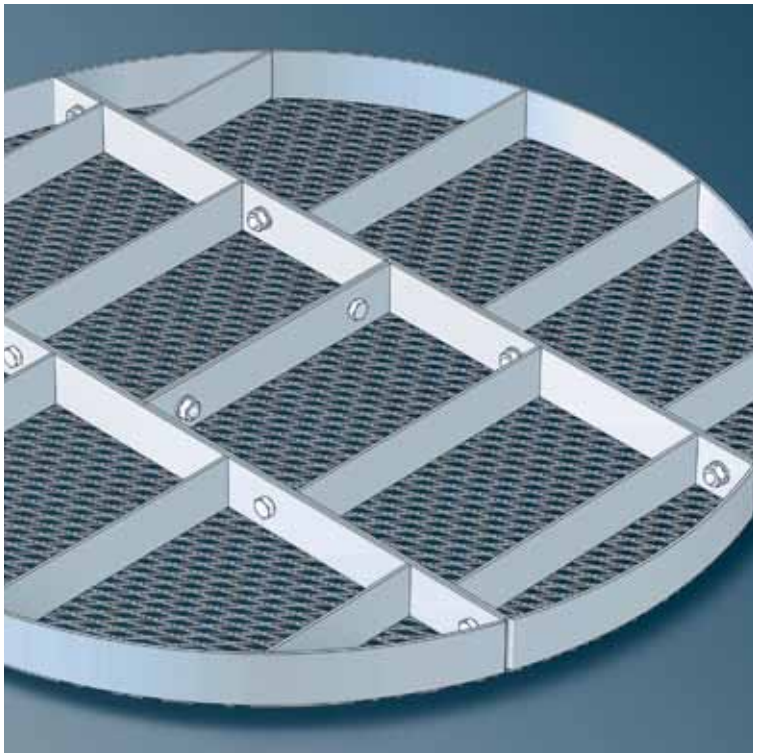
Bed limiters are designed in such a way that they do not disturb the steady state of the liquid distribution.

Depending on the model, bed limiters either sit directly on top of the packed bed or are mechanically attached to the vessel wall. It is also possible to hang them directly from the liquid distributor and/or redistributor. Additionally, bed limiters can be integrated into the design of the liquid distributor or redistributor.



Bed limiter made of plastic material

Bed limiter made of metal material



Support grids
Adapted to random and structured packings

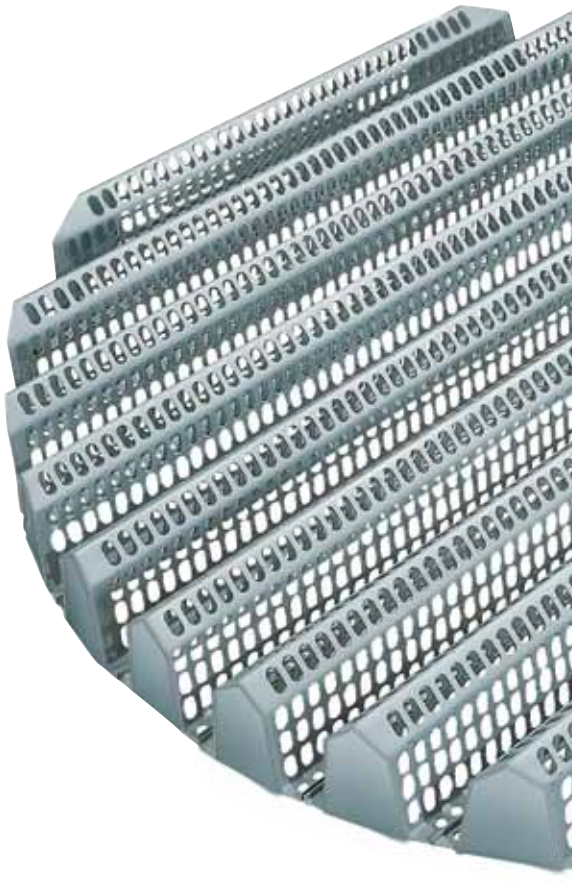
A variety of support grids are available to support the column packed bed, depending on the specific application and the column diameter. The support grid must be constructed in such a way that it minimally hinders gas and liquid flows. Between the packed bed and the support grid, the risk of reduced hydraulic capacity can exist. Support grids must be adapted to the type of packing, bed height, liquid holdup, possibly additional weight caused by fouling and the design temperature for specific applications.

Support grids require a support ring and, depending on the diameter and/or the supporting loads, one or more internal support beams. If high gas velocities, pressure surges or flooding may occur, the bed support can be mechanically fastened to the support ring.

Flat support grid (type M65)

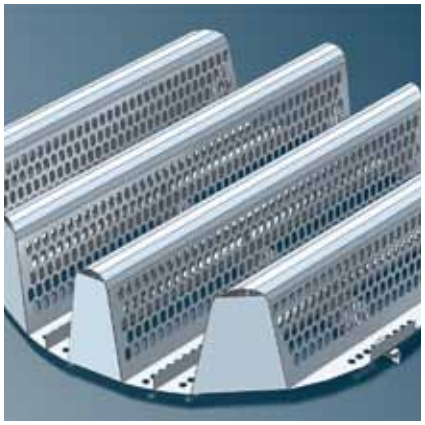
Flat Support Grid

The most straightforward design is the flat support grid which is used for small column diameters. The hydraulic conditions need to be taken into consideration as this type of support grid has a relatively low free cross-section. Flat support grids are available in ceramic and graphite materials in addition to metals and thermoplastics.

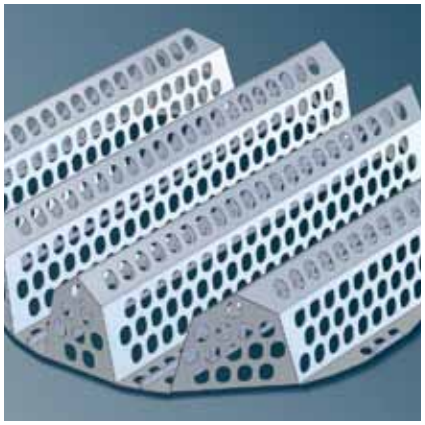


Profile support grid

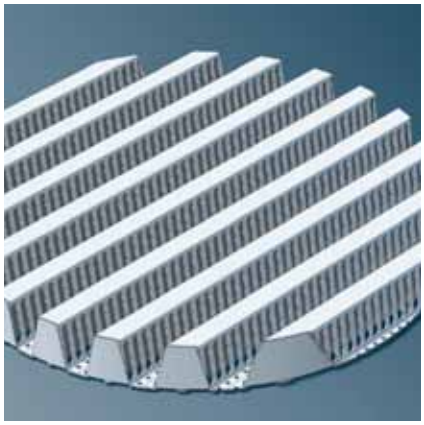
Profile support grids, using profile beams, offer a free cross section of 100% in relation to the entire column cross-section. Downcoming liquid flows separately from the upflowing gas stream, thus preventing the risk of flooding, even at high hydraulic loading. The height of the profile beams as well as the slot width are a function of the parameters for a specific application.



Profile support grid (Type M350)



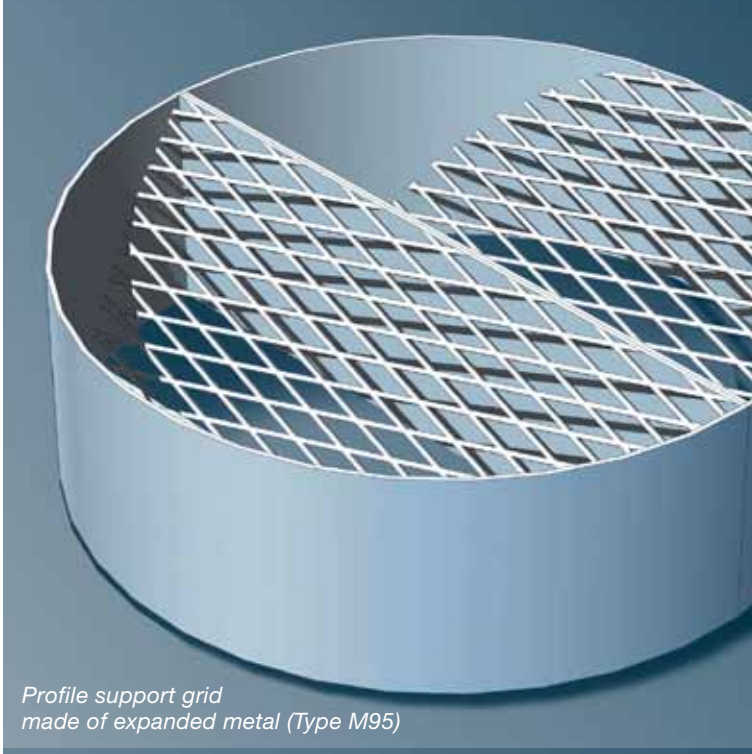
Profile support grid (Type M165)



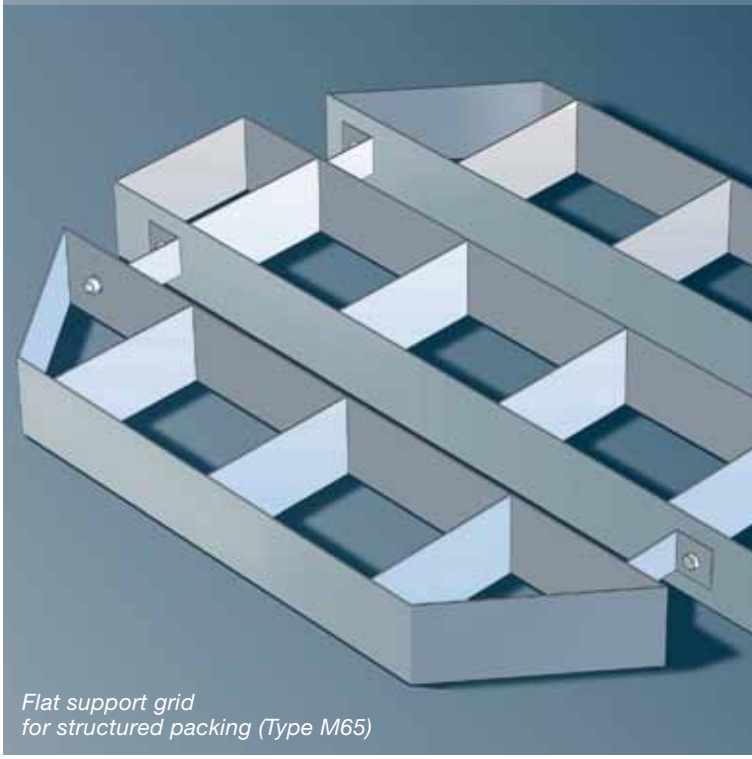
Profile support grid (Type M250)

A profile support grid made of expanded metal is an inexpensive alternative which is only available in metal. This support grid is suitable for low loads as well as columns with small diameters.

Profile support grid made of metal



Profile support grid made of expanded metal (Type M95)



Flat support grid for structured packing (Type M65)

The open structure of the flat support grid for use with structured packing allows unhindered flow of liquid in relation to the gas stream, thus preventing limitation of hydraulic capacity in the column.

Demisters
Ensure minimal droplet entrainment

Demisters are employed at the top of a packed column or in conjunction with a collecting tray between two packed beds. They separate liquid droplets from the gas stream. This way, droplet discharge from the column and/or the liquid entrainment from one stage to the next is minimized.

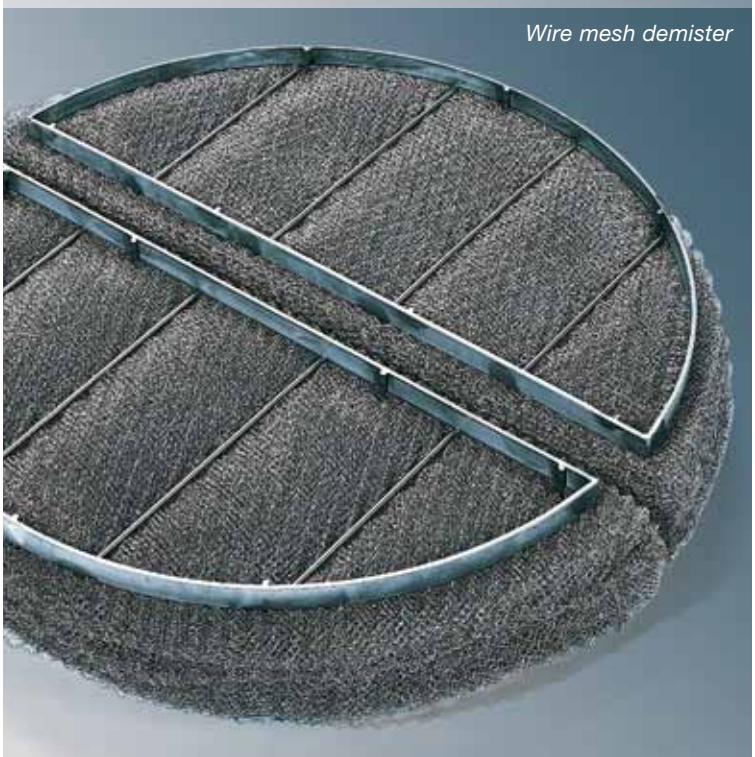
Droplet separation in demisters is achieved utilizing mass inertia of the liquids. For this reason, droplet removal efficiency declines with larger droplet diameter.

A difference is made between wire mesh demisters and surface impact demisters (primarily vane type construction). Where wire mesh demisters are concerned, droplet coalescing leads to increased droplet size allowing the discharge of these droplets from the demister. These demisters are recommended in particular for systems where no solids buildup can occur.

In vane-type demisters, the gas flow is deflected several times so that the liquid droplets impinge on impact surfaces where they then flow from these in a downward direction.

Scaling of solids can be avoided or reduced with the use of spray nozzles situated above the demister.

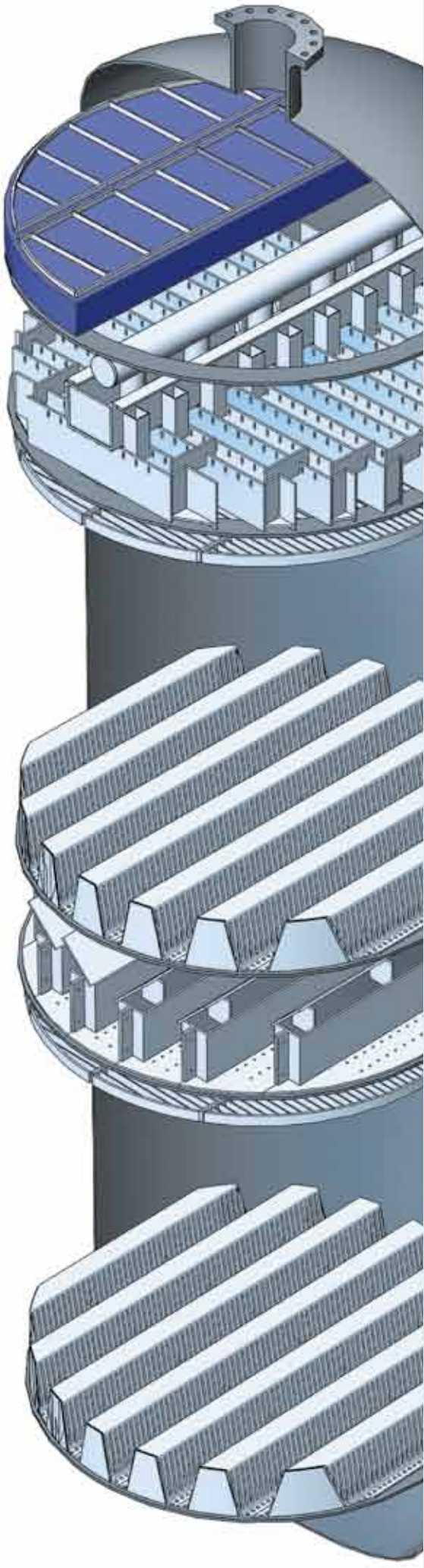
Vane-type demister



Wire mesh demister

Our range of products
An overview

Description	Materials of Construction: Metal	Plastic	Ceramics / Graphite
Liquid distributors			
Pan-type distributor	M 150 T	P 150 T	K 150 T
Trough-type distributor	M 150 KK	P 150 KK	K 150 KK
Trough-type distributor with integral parting box	M 150 KQ	P 150 KQ	-
Deck-type distributor	M 150 B	P 150 B	-
Ladder-type distributor	M 150 RR	P 150 RR	-
Spray nozzle-type distributor	M 150 SR	P 150 SR	K 150 SR
Düsenverteiler	M 150 SR	P 150 SR	K 150 SR
Feed pipes			
L Type	M 155 L	P 155 L	-
H Type	M 155 H	P 155 H	-
T Type	M 155 T	P 155 T	-
I Type	M 155 I	P 155 I	-
Collecting trays – redistributors			
Chimney-type collecting tray	M 900 K	P 900 K	-
Vane-type collecting tray	M 900 L	P 900 L	-
Pan-type redistributor	M 200 T	P 200 T	K 200 T
Trough-type rredistributor	M 200 KK	P 200 KK	-
Trough redistributor with integral parting box	M 200 KQ	P 200 KQ	-
Deck-type redistributor	M 200 B	P 200 B	-
Rückverteilerboden	M 200 B	P 200 B	-
Feed Systems for two-phase mixtures			
Flash gallery	M 800 B	-	-
Flash box	M 800 K	-	-
Double wall tube	M 800 R	-	-
Gas distributors			
Guide vane	M 850 L	P 850 L	-
Chimney tray	M 850 B	P 850 B	-
Ladder-type	M 850 R	P 850 R	-
Support grids			
Flat support grid	M 65	P 65	K 65
Profile support grid (low beam)	M 95	P 95	-
Profile support grid (medium beam)	M 165	P 175	K 180
Profile support grid (high beam)	M 350	P 250	K 300
Bed limiters			
Expanded metal	M 100 S	-	-
Flat profile	M 100	P 100	K 100
Demisters			
Wire mesh	M 950	P 950	-
Vane	M 960	P 960	-



Two stage packed column with (from below): profile support grid, bed limiter, redistributor, profile support grid, bed limiter, trough distributor with parting box and feed pipe, demister

Column internals
For application in processes with highly corrosive substances and high temperatures

Highly corrosive and high temperature operations require high-grade materials. If chemical resistant plastic materials cannot be used due to their decreasing stability at high temperatures, high grade special materials like Zirkonium or Tantalum can be used.

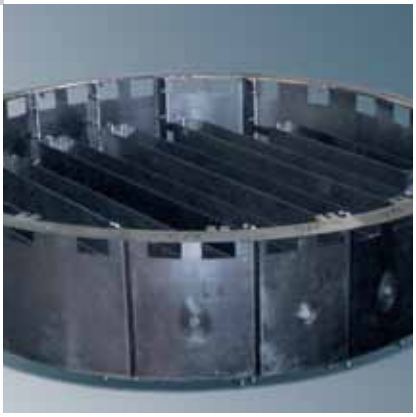
In some cases, we can offer chemical resistant and competitive constructions which combine several materials in one part, as shown below:

Liquid distributors of Zirconium

Task: Saving cost of liquid distributor for low liquid loads

Materials approved by customer:

- Tantalum => expensive
- Graphite => high wall thicknesses
- PTFE => low mechanical stability



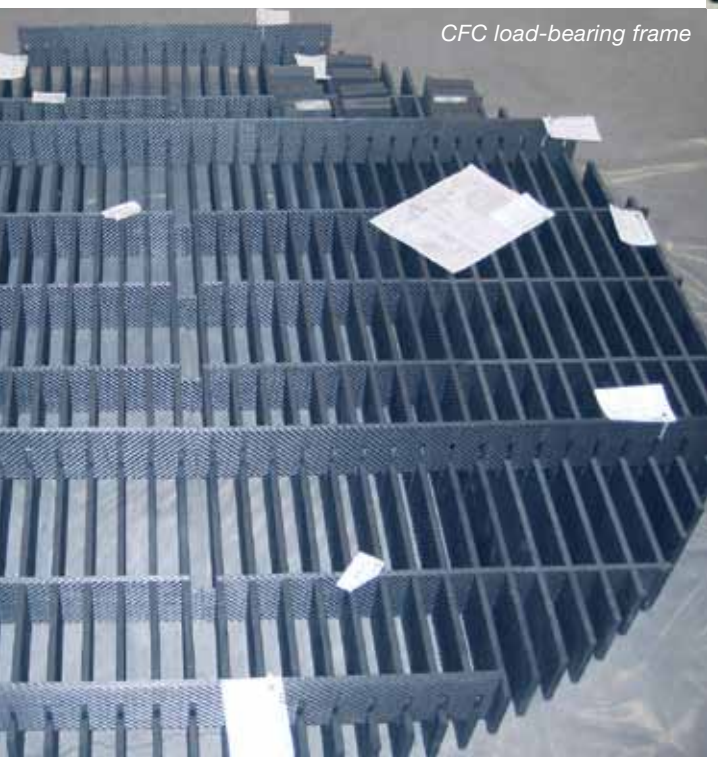
Distributor of Tantalum

Distribution devices /
Tantalum drip tubes

Solution for cost reduction:

- CFC load-bearing frame
- Distribution devices / Tantalum drip tubes
- All other components were made of TFM/PTFE

Base plate of PTFE



CFC load-bearing frame

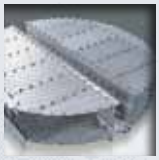
RVT Process Equipment GmbH
Range of products

The way to RVT Process Equipment

Tower packings for mass and heat transfer

Structured packings for mass and heat transfer

Column internals



Mass transfer trays

Biological carrier media

Turn-key units for waste gas scrubbing

Ammonia recovery processes

Combustion plants for the disposal of exhaust air, waste gases and liquid media

Our addresses

RVT Process Equipment GmbH
Paul-Rauschert-Straße 6
96349 Steinwiesen, Germany

Phone +49 (0) 9262 77-0
Fax +49 (0) 9262 77-771
E-Mail info@rvtpe.de

RVT Process Equipment, Inc.
9047 Executive Park Drive
Suite 222
Knoxville, TN 37923, USA

Phone +1 (865) 694-2089
Fax +1 (865) 560-3115
E-Mail info@rvtpe.net

Kunshan
RVT Process Equipment Co., Ltd
No. 66 - 68, Shaojing Road
Development Zone Kunshan
215300 Kunshan
Jiangsu province
P.R. China

Phone +86 (512) 55 18 82 52
Fax +86 (512) 55 18 81 87
E-Mail info.cn@rvtpe.com

www.rvtpe.com

Column internals
12/2012