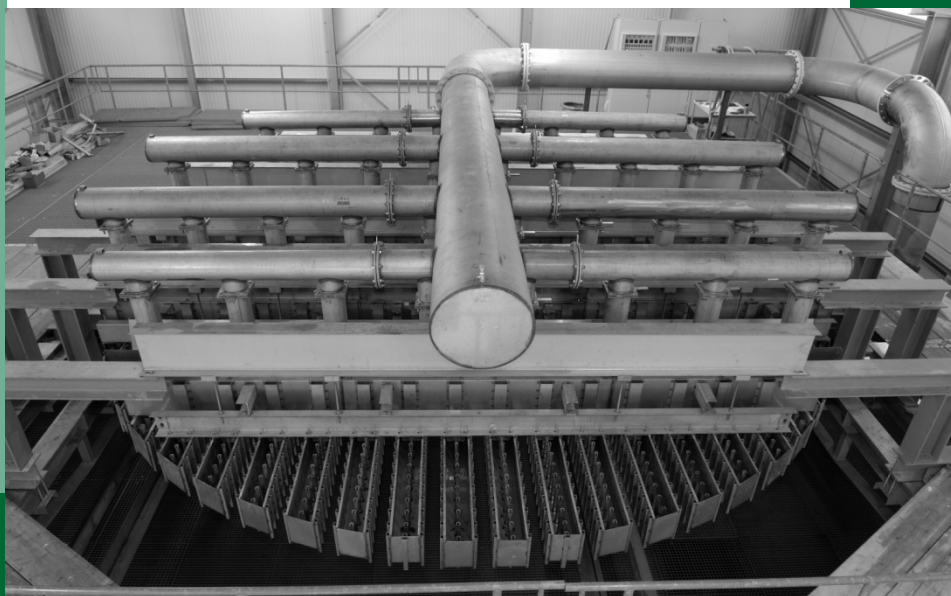# COLUMN INTERNALS
Product Bulletin 1101

Superior performance by design™
RASCHIG USA, INC.

Index Column Internals

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®

Index Column Internals

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The Importance of Internals in Packed Columns

Nowadays, the ever-increasing efforts to achieve a process with optimal performance characteristics demand modern mass-transfer equipment, i.e. high mass-transfer efficiency but a minimal energy requirement. These improved processes can only be met by modern packed beds if the internals in those packed columns - liquid and gas distributors, hold-down and support structures, liquid collectors and redistributors - are designed according to modern principles.

The gas and liquid distributors, which must be carefully designed and mounted with the greatest accuracy, are of prime importance in this respect. Detailed investigations into the uneven distribution of liquid in packed columns (maldistribution) have highlighted the influence of uniform distribution over the column cross-section on mass transfer efficiency.

Properly designed support and hold-down plates are also important if a reduction in throughput is to be avoided. Increased pressure drops may sometimes result from the use of an inadequate support plate.

Furthermore, there have been cases in which the tower packings have been damaged or even swept away due to the absence of a hold-down plate. These packing elements, carried out to downstream equipment, can lead to damage more costly than the price of the hold-down plate.

Our range of internals includes many types and sizes, manufactured in metal or plastic, and designed according to the state of the art of chemical engineering and mechanical design. A modern column design demands a basic understanding of the fluid-dynamic flow relationships in mass transfer columns. Experiments in the pilot plants at Raschig have in the past produced important criteria for designing internals, criteria which are taken into account in every new design project today. We would be happy to advise you and are able to offer tailor-made solutions to your individual problems.

The Influence of Internals on Mass Transfer Efficiency

1. Liquid Distribution

Many research contributions have pointed out the influence of the uneven distribution of liquid over the column cross-section on the efficiency of a mass transfer column. The dependency relationships observed in these studies confirm the interrelationships observed under practical conditions and explain many past failures.

If we observe, for instance, the flow path from a liquid feed point onto a packed bed we will see the profile shown in the attached figure 1. When a jet of liquid hits a bed the jet spreads out to the contact points of the packings and trickles down. After a defined distance of flow, the circular cross-section through which the liquid passes achieves an almost constant diameter. For this reason, when designing liquid distributors one must take care that the flow zones of neighboring liquid feed points overlap sufficiently to prevent unwetted zones and to achieve a largely homogeneous irrigation density. The diameter of the circular cross-sections that form depends on the type of packing used, the material they are made of and on the liquid load. With most mass transfer conditions, an even liquid distribution is achieved after a short inlet height with as little as 100 feed points per m² of cross-sectional area. RASCHIG USA standard liquid distributors are therefore designed for 100 drip points per m² of cross-sectional column area for most services and applications.

Fig. 1: Profile of liquid flow in packed columns
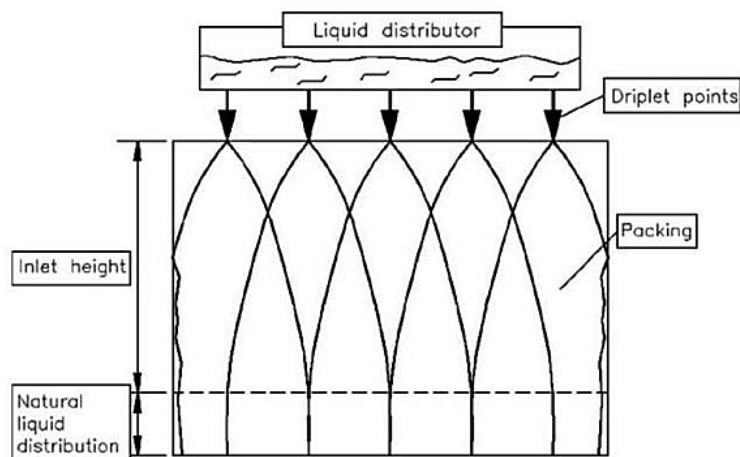
The Influence of Internals on Mass Transfer Efficiency

Measurements of the mass transfer efficiency of dumped packings or packed beds along a mass transfer column have confirmed this relationship between internals and mass transfer efficiency. They have shown that a constant mass transfer efficiency is achieved only after a certain inlet height, see the attached figure 2. The "natural liquid distribution", as it is known, comes about after liquid has flowed through this inlet height. It is characterized by the packing itself. The length of this inlet height is influenced by the number of feed points per m² of cross-sectional column area. The studies show that for every packing there is a number of distributor points at which that optimal mass transfer efficiency is achieved throughout the packed bed which corresponds to the natural liquid distribution within the bed.

The natural liquid distribution in the packed bed is generally better than that of a standard distributor. For instance, a 25-mm PALL-RING made of metal requires about 400 feed points per m² to be provided by a high quality liquid distributor. In most cases, however, it is more economical to make use of the option of liquid distribution via the packing itself by increasing the packed bed height than to use a complexly structured and therefore expensive high quality liquid distributor.

Fig. 2: Efficiency of a packed bed along the bed height
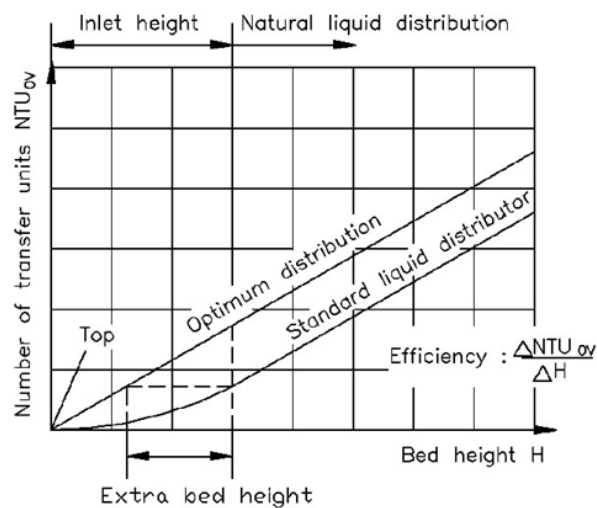
The Influence of Internals on Mass Transfer Efficiency

2. Liquid Redistribution

After a packed bed reaches a certain height, the liquid phase should be redistributed in order to counteract the danger of maldistribution. The height after which redistribution should be provided depends on many influencing factors. This can be best illustrated by using the rectification of a binary system as an example (see figure 3).

The McCabe-Thiele diagram shows the equilibrium curve of a binary system which is to be rectified and the operating lines, entered by way of example, for the enrichment and stripping part of a rectification column. The illustration generally assumes that the phases are equally distributed, i.e. a homogeneous L/V flow ratio over the cross-section of the column.

Various studies on the even distribution of the liquid flow over the cross-section of the column, however, show that under real conditions the liquid flows through the bed in falling films of differing thickness and, particularly in packed beds, rivulets and drops are formed. As a result, depending on the location, there are differing liquid loads and differing L/V phase ratios over the cross-section of the column. Figure 4 shows the effects of differing phase ratios on the necessary number of theoretical plates. The nearer a mass transfer column is operated to the minimum reflux ratio, the greater is the necessary number of theoretical plates. This is already shown clearly in figure 3, in which the real difference in the L/V flow ratio is shaded in.

Fig. 3: McCabe-Thiele diagram for rectification systems with locally different L/V-phase ratios
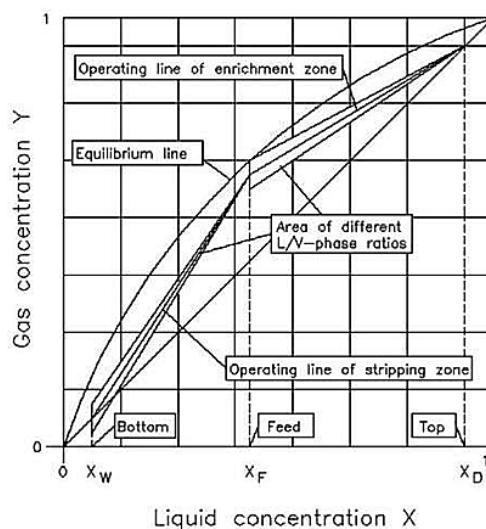
The Influence of Internals on Mass Transfer Efficiency

A mass transfer column therefore consists of zones which, in comparison with the theoretical design, separate particularly well due to a high L/V flow ratio while other areas present a reduced mass transfer efficiency due to a low L/V flow ratio. If the column is operated near the minimum reflux ratio, the areas that separate particularly well can no longer compensate for the zones with moderate mass transfer efficiency, thus causing large differences in the necessary number of theoretical plates, see figure 4. This means that a drop in mass transfer efficiency must be expected in particular when the mass transfer process is operated near the minimum reflux ratio. An especially critical operating point is when the areas with the low L/V flow ratio fall short of the minimum L/V phase ratio and an disproportionately large drop in mass transfer efficiency occurs. The figure 3 illustrates how the redistribution of the liquid phase at the feed cross-section causes the stripping part of a rectification to react largely independently of the enrichment part.

If despite these conditions a transfer task is carried out in the vicinity of the minimum reflux ratio, a liquid collector, followed by redistribution, should be used after a certain bed height. In this case a redistribution must be installed, as shown in the figures 3 and 4, even before the shaded area along the operating line reaches the equilibrium curve or large differences come to bear in the mass transfer efficiency owing to the differing L/V flow ratio. The redistribution must ensure such thorough mixing of the liquid phase that the real operating point returns to the theoretical operating line (see figure 5).

Fig. 4: Dependence of the number of transfer units on the L/V-phase ratios
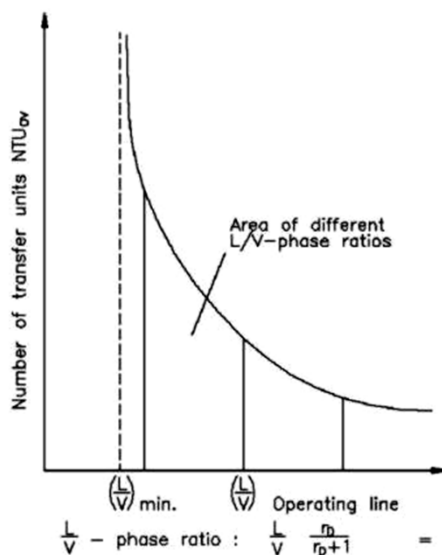
The Influence of Internals on Mass Transfer Efficiency

The height of a packed bed after which redistribution of the liquid phase becomes necessary is therefore dependent on the position of the phase equilibrium, i.e. on the substance system to be separated and the process conditions. It is also determined by the L/V flow ratio in the column, i.e. the reflux ratio chosen. In addition, traditional packings such as the PALL-RING cause a considerably worse liquid distribution than modern packing geometries such as the RASCHIG SUPER-RING. The latter's distribution quality of the liquid phase is equivalent to that of a structured packing.

The following additional factors influence the maldistribution of the liquid phase in a mass transfer column. From the point of view of installation, the correct horizontal orientation of a liquid distributor is only possible to a certain extent. The flow velocities in the distributor troughs always cause differing loading heights in the troughs owing to the drag, and differing volume rates flow from the downcomer points. Furthermore, if columns are operated for prolonged periods, individual downcomer points may be blocked by particles of dirt or rust. For manufacturing reasons, the orientation of the support rings on which liquid distributors are placed must be level to within defined limits. The same applies to the vertical installation of the column shell, since a tower out of vertical alignment will impact the levelness of the support rings installed within it.

Fig. 5: McCabe-Thiele diagram for rectification systems with locally different L/V-phase ratios
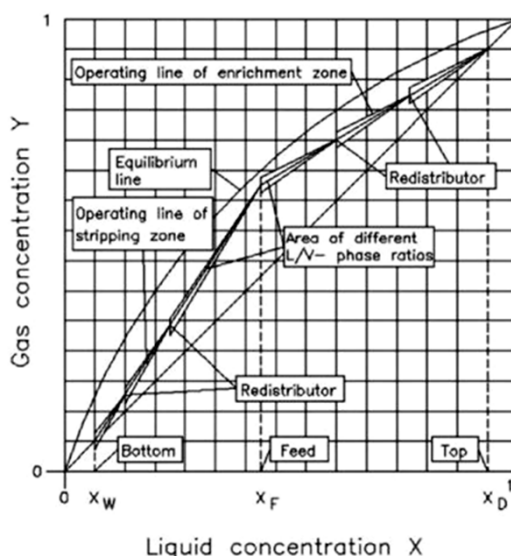
The Influence of Internals on Mass Transfer Efficiency

In the case of mass transfer columns, therefore, it is not possible to make a general prediction of the bed height after which the liquid phase should be redistributed. For rectification there is a critical system-related condition when large numbers of theoretical plates (more than 10 theoretical plates) are needed. If a higher degree of mass transfer efficiency is required, the dependency relationships which have been explained should be examined.

In the case of desorption or stripping of liquids the mass transfer column is similarly sensitive in its reaction as rectification is to differing L/V flow ratios. This is the case when very low liquid exit concentrations are required, e.g. in the case of feed points for wastewater treatment. As the attached figures 4 and 6 shows, the mass transfer efficiency of a packing in the case of locally differing L/V ratios often no longer suffices to fulfill the transfer task with a given column height. This loss of mass transfer efficiency caused by the areas with low phase ratios can no longer be compensated for by those with high L/V flow ratios and therefore prompt redistribution of the liquid phase is indispensable.

The relationships in the absorption of gases are less problematical (see attached figure 7). In many cases the distance to the minimum solvent ratio is large enough to permit dumping heights of over 10 m without redistribution.

Fig. 6: Diagram for Desorption or stripping columns with locally different L/V-phase ratios
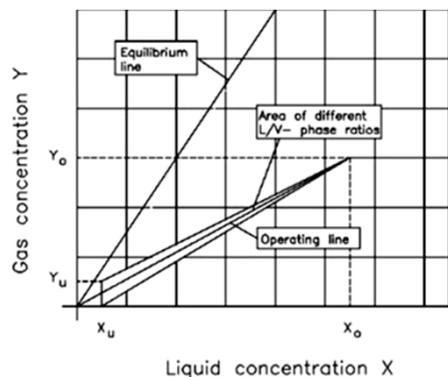
Fig. 7: Diagram for absorption columns with locally different L/V-phase ratios

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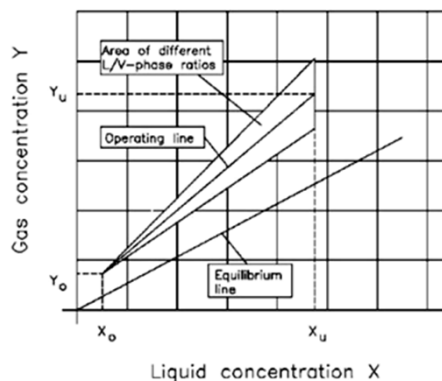
The Influence of Internals on Mass Transfer Efficiency

3. Gas Distribution

Modern packing geometries are usually characterized by a very low pressure drop for the gas or vapor flow. However, the pressure drop ensures an even distribution of the gas over the cross-section of the column.

Studies have shown that a pressure drop of at least 1 mbar should be present in order to achieve predominantly homogeneous gas distribution. In no rare cases, this pressure drop is only achieved after several meters of height of the gas flow. In order to avoid a drop in mass transfer efficiency, a gas distribution system should then be used at the bottom of the column.

A gas maldistribution can also occur in large diameter columns where especially large gas loads are feed without a gas distribution system. Both these factors may lead to a vapor channeling in the lowest section of the bed. If this results in the occurrence of flooding phenomena in the heavily loaded areas, the drop in mass transfer efficiency will be greater.

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The Influence of Internals on Mass Transfer Efficiency

4. Hold-down Plate

The purpose of hold-down plates is to form the upper limit of the packed bed. They can either be fastened in place with a support ring or lie loosely on the bed. The latter option is applied in the case of dumped packings where it is expected that the settling of the bed will cause a reduction in the bulk volume over time.

The constant optimization of the packing geometries have led in the past to lighter and lighter structures. The lighter the bed is, however, the more easily it can be fluidized by the gas or vapor current. This is particularly true in the case of light materials such as plastic. For this reason, we recommend the installation of a hold-down plate when using packings made of plastic.

The loosening point of a bed is decisively defined by the state of the two-phase flow. The banking up of the liquid phase in the loading area above the loading point causes a back mixing of the liquid phase in the dumped packings or in the packed bed. This is often accompanied by pulsing movements of larger volumes of liquids in particular in the case of medium-sized and large liquid loads. These may be so strong that parts of a packed bed or a packing also move and are carried up and out. Locally, large empty spaces appear in the bed, causing a maldistribution of the phases. A drop in mass transfer efficiency is inevitable. We therefore recommend that a hold-down plate be used in case of high column loads. If surges of gas or vapor are to be expected, e.g. when starting up a plant, a hold-down plate should also be installed.

5. Support Plate

A modern support plate structure for packed beds has a large free cross-section. This is to prevent a backing up of liquid into the bed as a result of increased gas velocities. Furthermore, an as large a free cross-section as possible reduces the pressure drop for the gas current.

In addition, the support plates should be so designed as to prevent a blocking of their orifices, either by the packings themselves or by possible solid particles in the liquid.

Support Plates
in Metal and Plastic

The main function of a support plate is to bear the packed bed. In addition to this, it must also meet other requirements.

- ⇒ High degree of permeability for both gas and liquids.
- ⇒ High degree of stability with low own weight.
- ⇒ Availability in various types of material to suit different corrosion levels.
- ⇒ Easy installation in the column (segment construction).

The flat bar plates and perforated plates used in the past possessed distinct disadvantages. The free cross-sectional area of the plates was too small and was further reduced by the tower packings on top. In order to achieve the necessary stability, the plates often had an extremely high own weight.

The development of modern types of support plate for different kinds of materials has ensured that the requirements listed above can be fulfilled.

The Multibeam support plate is available for use with metal and plastic tower packings; this plate works on the gas injection principle and has proven its worth in operation. One of the types used for tower packings made of plastics is the patented RASCHIG SUPER GRID®.

For structured packings, a flat bar support plate, designed to fit the packing segments, is used.

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Multibeam Support Plate Type SP1

The SP 1 Multibeam support plate is designed for use in columns with diameters exceeding 1200 mm. The undulatory design ensures a high degree of permeability for gas and liquids. In the standard version, permeability is more than 90 %. The perforation of the plate elements is suitable for both ring-shaped and saddle packings. The minimum dimensions for the tower packings are dN > = 15 mm for rings and dN > 1" for saddles.

If you wish to use smaller packings, we can also advise you as to suitable solutions.

The support plate can be disassembled into segments. The overall height and the wall thickness of the standard support plates depends on the material used.

H = 250 mm for carbon steel, stainless steel and special alloys

H = 300 mm for thermoplastic materials

The standard wall thicknesses are:
- $\Rightarrow$ 3 mm for carbon steel
- $\Rightarrow$ 2 mm for stainless steels and special alloys
- $\Rightarrow$ 6 mm for thermoplastic materials

In cases of extreme operation conditions, there may be deviations from the standard material thicknesses. The standard version plates can carry packed beds greater than those that can normally be achieved due to the drop in efficiency with increased bed height in the columns. With column diameters above 3000 mm, additional support should be provided by means of central or lateral beams; this also facilitates installation of the segments.

As a rule, all support plates lie on a closed support ring which is normally welded in by the column manufacturer. In order to prevent the support plates from being lifted when there are pressure surges in the column, the former is fixed to the support ring by means of special locking devices and to any reinforcing beams present.

In addition, the individual segments are bolted to one another.

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Multibeam Support Plate Type SP1

The required fixing materials, such as nuts, bolts and washers, are normally included in our quotation.

When placing orders or submitting inquiries, please state the type, size, material and bed height of the desired tower packing. When ordering support plates made of thermoplastic materials, such as polypropylene (PP), polyvinyl chloride (PVC), polyvinylidene fluoride (PVDF), etc., we also require the temperature at the support plate for design purposes.

All weights we give are based on standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table in the last chapter. We would like to stress that these are mere approximations.
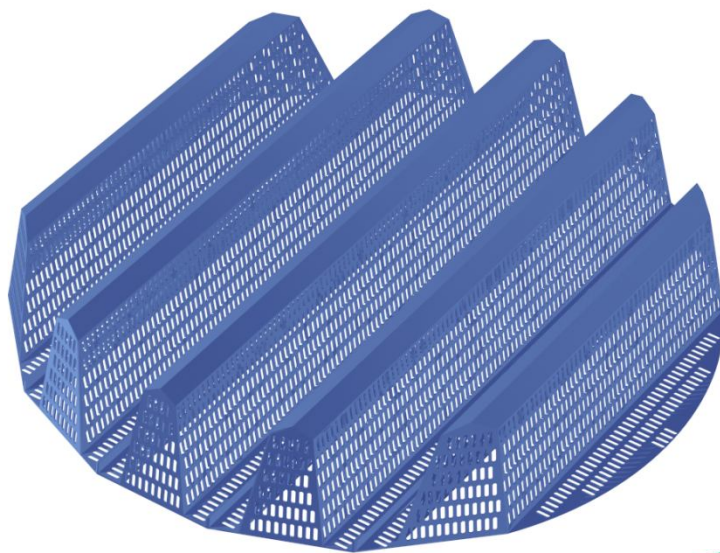
Multibeam Support Plate Type SP1

Typical dimensions of the SP 1

Inside diameter* of column-D mm	Outside diameter of plate-D_R mm	Minimum width of support ring mm	Number of standard profiles	Approx. weight kg
1,200	1,160	50	3	45
1,500	1,450	65	4	72
1,800	1,750	65	5	105
2,100	2,050	65	6	140
2,400	2,350	65	7	180
2,700	2,650	65	8	230
3,000	2,940	75	9	285

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Multibeam Support Plate Type SP 2 and SP 3

This type of support plate is intended for use in columns with diameters from 300 mm to 1200 mm. The plate is in segmental design which facilitates installation; for diameters up to 800 mm, the plate is in two parts, for diameters above 800 mm in three parts. Under normal circumstances, the individual segments in the column are not bolted together. This can be provided for, however, on special request. The necessary manhole for installation should have a nominal width of at least 450 mm.

The SP 2 and SP 3 needs a closed support ring or support lugs.

The perforation of the plate is such that ring-shaped packings with a nominal diameter of more than 15 mm and saddles with a diameter of more than 1" cannot fall through.
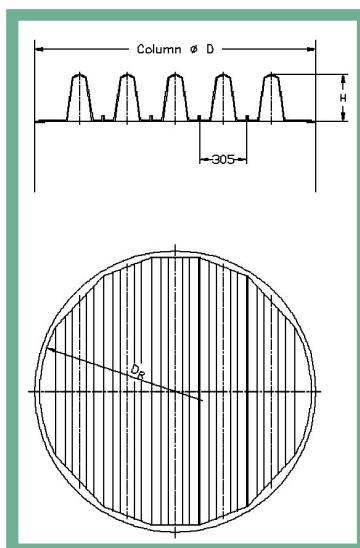
All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

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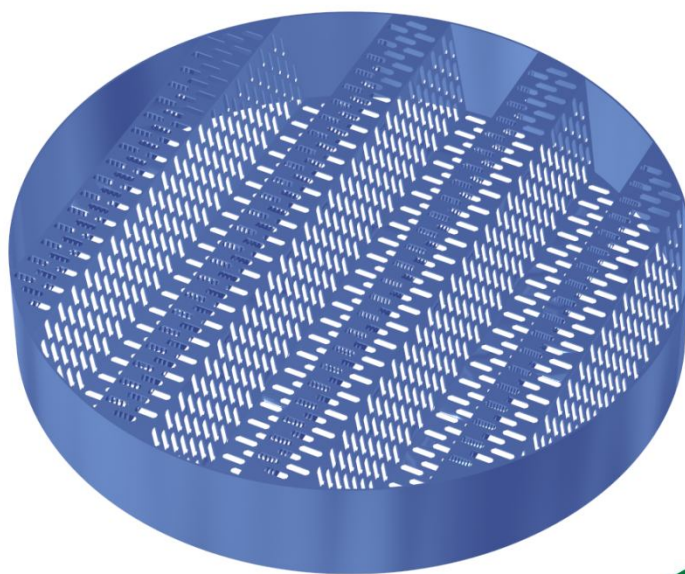
Multibeam Support Plate Type SP 2 and SP 3

Typical dimensions of the SP 2

Inside diameter* of column- D mm	Outside diameter of plate – D_R mm	Minimum width of support ring mm	Number of standard profiles	Approx. weight kg
300	285	20	2	4
400	385	20	2	7
500	480	25	2	12
600	580	25	2	16
800	770	40	2	26
1,000	970	40	3	31
1,200	1,170	40	3	45

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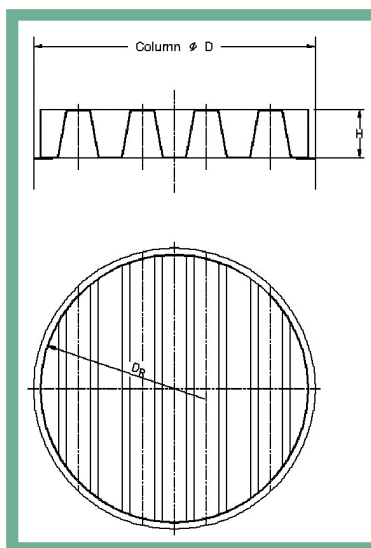
Multibeam Support Plate Type SP 2 and SP 3

Typical dimensions of the SP 3

Inside diameter* of column - D mm	Outside diameter of plate – D_R mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
100	90	15	50	1
200	185	20	50	2
300	280	20	60	5

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Hexa-Grid Support Plate
Type SP-HG

The Hexa-Grid is a modern flat bar support plate recommended for use in mass transfer processes which are highly prone to fouling. This applies, for instance, to substance systems tending towards polymerization which coat the surface of the support plate. The Hexa-Grid support plate is designed to ensure high degrees of solidity with a minimum material input. The vertical support rods are shaped so as to make it impossible for the dumped packings to block the orifices.

All weights we give are based on standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

Hexa-Grid Support Plate
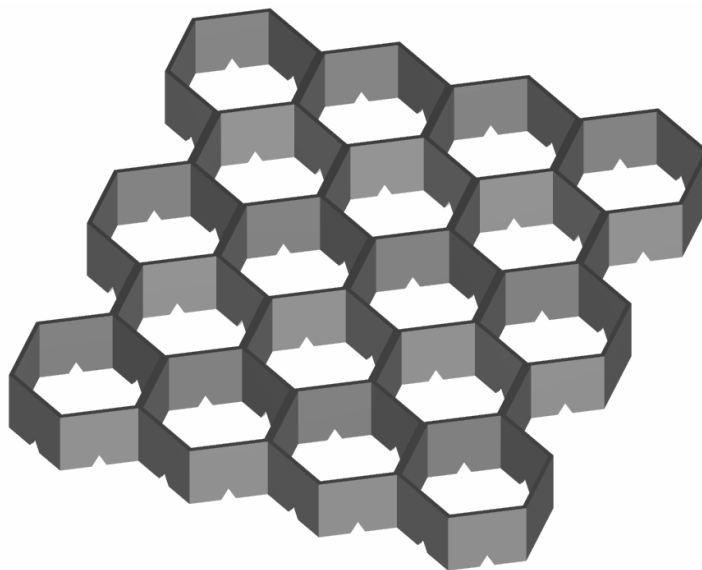# Type SP-HG

Typical dimensions of the SP-HG

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
400	385	20	50	6
800	770	40	50	17
1,000	970	40	80	55
1,500	1,460	50	80	90
1,800	1,760	50	100	145
2,100	2,050	65	100	200
2,400	2,450	65	100	270
2,700	2,750	65	100	340
3,000	2,940	65	100	400

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Support Plate Cross-Flow-Grid
Type SP-CF

The Cross-Flow-Grid is a modern support plate consisting of criss-crossed guide elements. The criss-crossed elements create a turbulence of the gas flow and thus ensure an even distribution of the gas phase over the column cross-section without causing a significant pressure drop. Owing to the arrangement of the elements, the liquid flows through the plate on the side facing away from the gas current, thus preventing banking-up effects to a large extent, even with large gas loads. The Cross-Flow-Grid support plate is designed so that it ensures a high degree of solidity with a minimum material input.
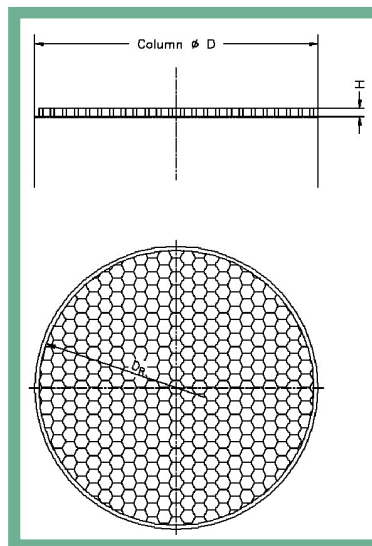
All weights we give are based on standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

Support Plate Cross-Flow-Grid Type SP-CF
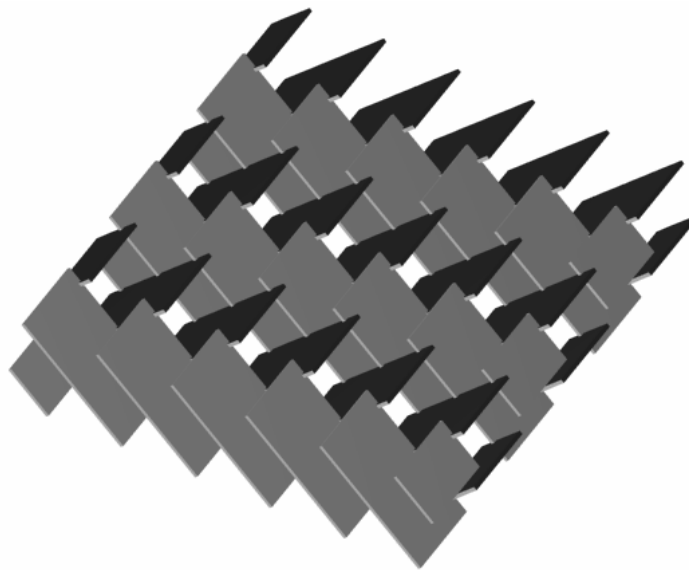
Typical dimensions of the SP-CF

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
400	385	20	50	8
800	770	40	50	21
1,000	970	40	80	66
1,500	1,460	50	80	108
1,800	1,760	50	100	174
2,100	2,050	65	100	240
2,400	2,450	65	100	324
2,700	2,750	65	100	408
3,000	2,940	65	100	480

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Flat Bar Plate Type SP-P

The SP-P flat bar plate is a support structure designed especially for packings. It ensures a maximum open cross-sectional area and is thus also ideally suitable for large column loads.

The SP-P flat bar plate consists of a frame which lies on a support ring. The mesh width of the flat bars is 100 x 500 mm, and the plate can be subdivided in case of large column diameters. This enables problem-free installation through manholes. Carbon steels and stainless steels are the materials used, but the SP-P is also available in special metals.
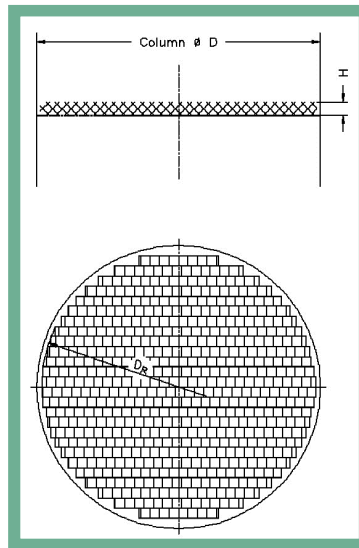
All weights we give are based on standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

Flat Bar Plate Type SP-P

Typical dimensions of the SP-P

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
400	385	20	50	4
800	770	40	50	12
1,000	970	40	80	42
1,500	1,460	50	80	65
1,800	1,760	50	100	120
2,100	2,050	65	100	160
2,400	2,450	65	100	210
2,700	2,750	65	100	265
3,000	2,940	65	100	330

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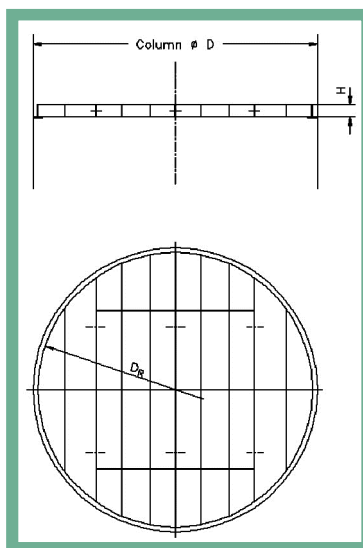
RASCHIG-SUPER GRID Support Plate Type RSG

The RASCHIG-SUPER GRID is a flat bar support plate with evenly distributed orifices. The spacer plates at the upper side of the plate ensure that the dumped packings do not block any orifices. Owing to the spacer cams they are mainly inclined, just as they are in the packed bed itself. Consequently, the support plate displays almost the same permeability as the packed bed it supports.

Its pressure drop is extremely low. If the dumping heights above and below the RASCHIG-SUPER GRID are not large, a liquid redistributor can be dispensed with. The liquid of the upper packed bed is distributed evenly on the packed bed below because of the equal distributed orifices over the surface of the plate.

The overall heights of the plastic RASCHIG-SUPER GRID are not bound to a standard dimension. They are determined only by structural conditions. The overall heights are in each case determined on the basis of the respective weight load and operating temperature. The continuous length of the elements may be up to 3 m. A segmented version is also available.

The RASCHIG-SUPER GRID is manufactured from various thermoplastic materials, such as polypropylene (PP), polyvinyl chloride (PVC), polyvinylidene fluoride (PVDF), etc.
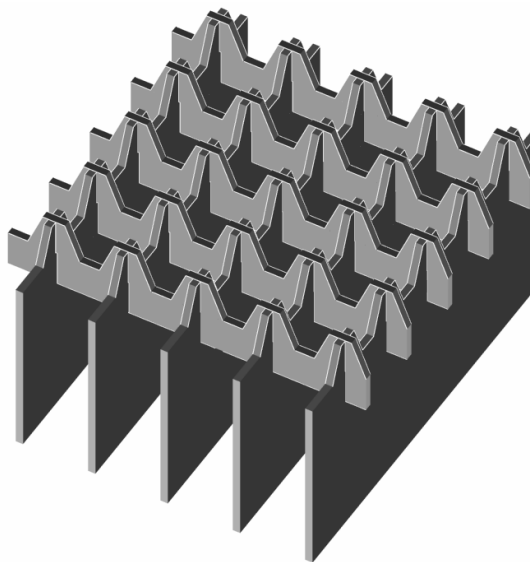
RASCHIG-SUPER GRID Support Plate Type RSG

Typical dimensions of the RSG

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Number of segments	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
500	470	2	40	170	4
800	770	2	40	170	10
1,200	1,170	3	50	220	27
1,500	1,460	4	50	220	42
1,800	1,760	4	50	220	60
2,100	2,060	5	65	220	85
2,400	2,360	6	65	220	110
2,700	2,660	6	65	220	140
3,000	2,960	7	65	220	170

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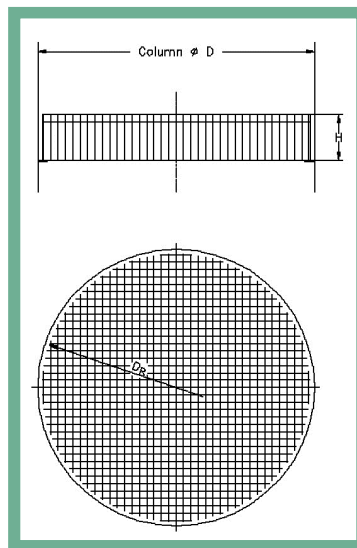
Hold-down Plates in Metal and Plastic

Plastic and metal packings are extremely strong and, generally, not prone to breakage if brought into motion due to pressure surges in the column or by accidental flooding. Experience shows, however, that it is necessary to take precautions aimed at preventing packings from being swept away by the flow of vapor, in order to avoid damage in downstream plant installations.

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Hold-down Plate Type HP 1

To prevent packings from being swept away by the flow of gas or vapor we supply hold-down plates of the type HP 1 which are designed for this very purpose and which are attached either to a support ring or rest on ledges. Special clamps are supplied along with the plate for this purpose. The hold-down plate is designed so as not to interfere with the distribution of liquid.

The HP 1 hold-down plates consist of a frame backed with a screen of expanded metal. The mesh width of this screen depends upon the size of packing used. The plates, which are divided into segments, are installed into the column through the manholes and then bolted together. The materials used are carbon steel, stainless steels and thermoplastic materials. Please note that plates made of carbon steel are normally backed with screens made of stainless steel. Versions made of special metals are also available.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.
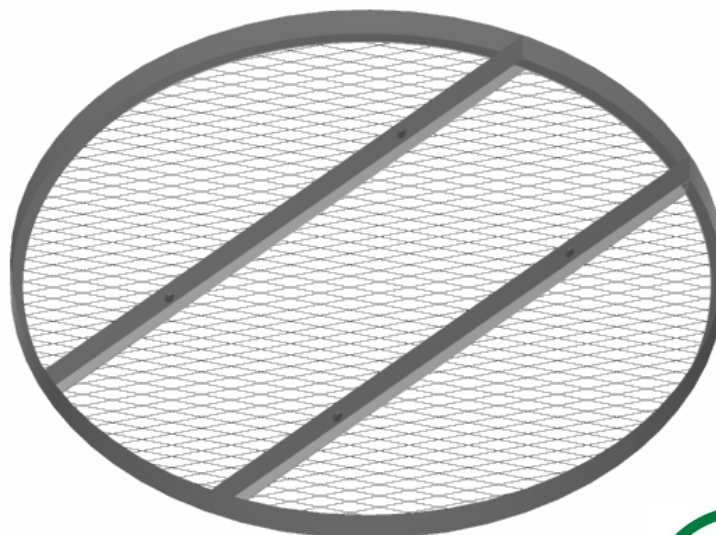
Hold-down Plate Type HP 1

Typical dimensions of the HP 1

Inside diameter* of column - D mm	Outside diameter of plate - D$_R$ mm	Number of segments	Minimum width of support ring mm	Overall height – H mm	Approx. weight kg
500	485	1	20	50	2
800	770	2	40	60	6
1,200	1,170	3	50	60	13
1,500	1,470	4	50	80	27
1,800	1,770	5	50	80	38
2,100	2,060	5	65	80	52
2,400	2,360	6	65	80	68
2,700	2,660	7	65	80	86
3,000	2,960	7	65	80	106

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Hold-down Plate Type HP 2

These hold-down plates are used in combination with packings made of materials prone to breakage; e.g. ceramics or carbon. The plates are intended to prevent movement in the packed bed. This reduces the risk of packing breakage and wear. Broken pieces of the packing could settle in the packing bed, thus reducing permeability. The result would be a reduction in column efficiency or even an approach to the flooding point.

Hold-down plates of the type HP 2 rest directly on top of the packed bed without being connected to the column shell and prevent movement of the packings at the upper end of the packed bed by virtue of their own weight. Since the packed beds often settle to a certain degree during operation, the hold-down plate lying loosely on top of the bed is able to follow it down.

In the standard version, the hold-down plate is backed with expanded metal. The mesh width of the screen is such that ring-shaped packings of the size dN > 15 mm and saddles of the dimension dN > 1" cannot pass. In order to facilitate installation, the plates are divided into segments which are bolted together in the columns.
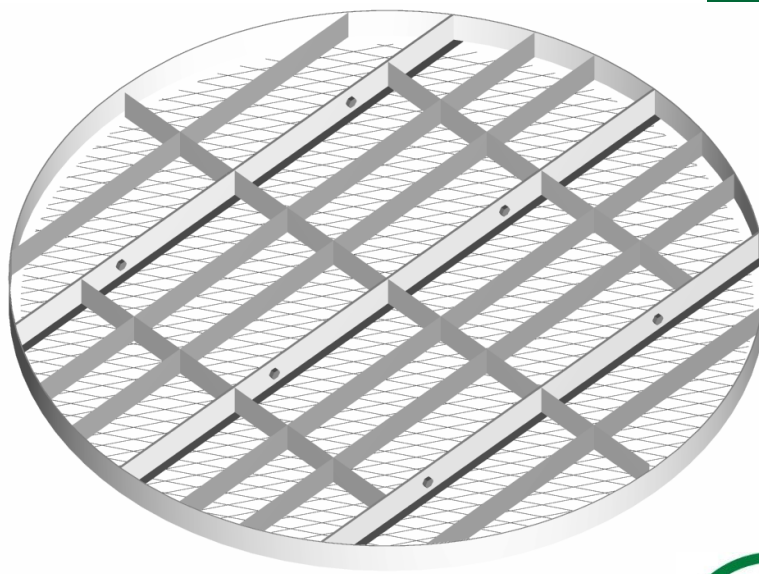
Hold-down Plate Type HP 2

HP 2 hold-down plates are available in carbon steel and stainless steel; it should be noted that carbon steel plates are also fitted with a mesh screen made of stainless steel. Standard material thickness of the frame sections is 5 mm.
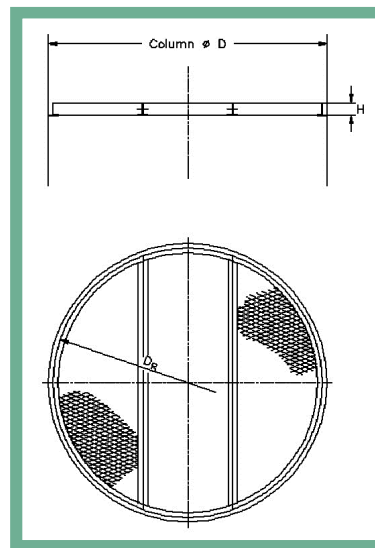
All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

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Hold-down Plate Type HP 2

Typical dimensions of the HP 2

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Number of segments	Overall height - H mm	Approx. weight kg
500	485	2	80	19
800	785	2	80	48
1,200	1,180	3	120	108
1,500	1,470	4	120	169
1,800	1,770	4	120	243
2,100	2,070	5	120	330
2,400	2,370	6	120	432
2,700	2,670	6	120	545
3,000	2,960	7	120	675

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Hold-down Plate Type HP-P

These hold-down plates are used in combination with structured packings, lie on top of them and are stayed at the column wall. The plates are intended to prevent movement in the packed bed. The liquid distributors used together with packings are supported on the metal HP-P hold-down plate by adjustable bolts, thus making a support ring structure unnecessary.

To allow easier installation in large columns, the plates are divided into segments which are bolted together in the column.

HP-P hold-down plates are available in carbon steel and in stainless steel versions. The standard material thickness of the frame parts is 5 mm.
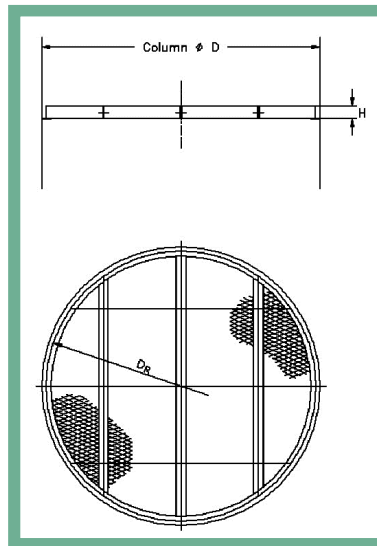
All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.
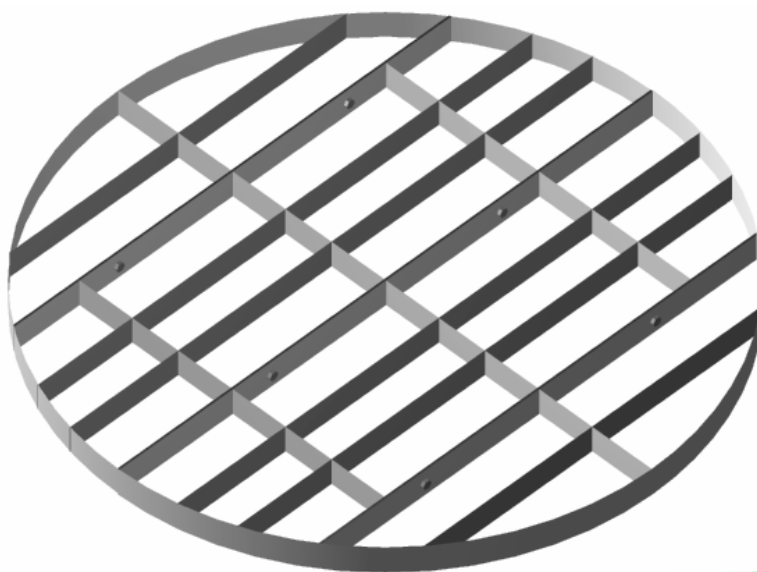
Hold-down Plate Type HP-P

Typical dimensions of the HP-P

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Number of segments	Overall height - H mm	Approx. weight kg
500	470	2	50	3
800	770	2	50	7
1,200	1,170	3	50	17
1,500	1,460	4	50	27
1,800	1,760	4	60	46
2,100	2,060	5	60	62
2,400	2,360	6	60	81
2,700	2,660	6	60	103
3,000	2,960	7	60	127

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Hold-down Plate RASCHIG GRID Type RG

The RASCHIG GRID is a flat bar hold-down plate with evenly distributed orifices. Its pressure drop is extremely low.

The overall heights of the plastic RASCHIG GRID are bound to 50 mm in the standard version. Nevertheless, the overall heights may also be determined differently depending on the respective load and operating temperature. The continuous length of the elements may be up to 3 m. A segmented version is also available.

The RASCHIG GRID is manufactured from various thermoplastic materials, such as polypropylene (PP), polyvinyl chloride (PVC), polyvinylidene fluoride (PVDF), etc.
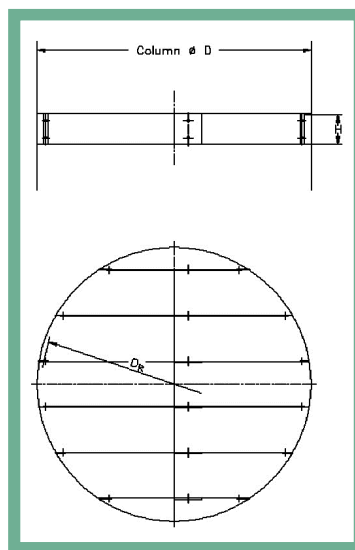
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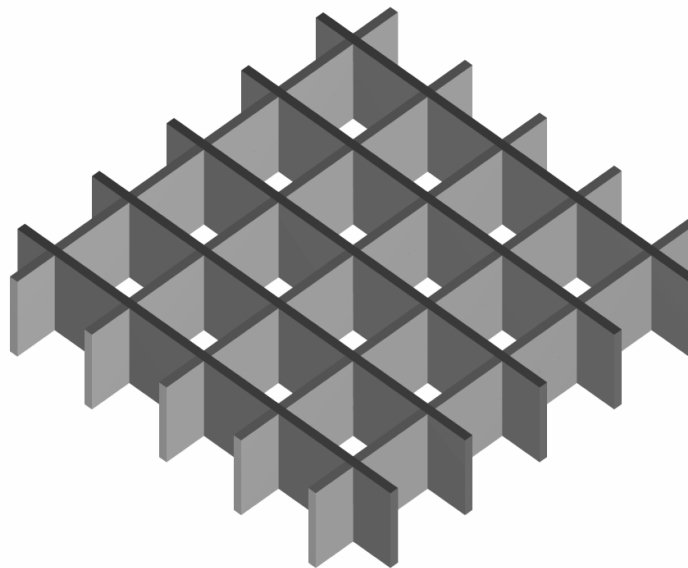
Hold-down Plate RASCHIG GRID
Type RG

Typical dimensions of the RG

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Number of segments	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
500	470	2	40	50	2
800	770	2	40	50	5
1,200	1,170	3	50	50	11
1,500	1,460	4	50	50	17
1,800	1,760	4	50	75	31
2,100	2,060	5	65	75	42
2,400	2,360	6	65	75	54
2,700	2,660	6	65	75	69
3,000	2,960	7	65	75	85

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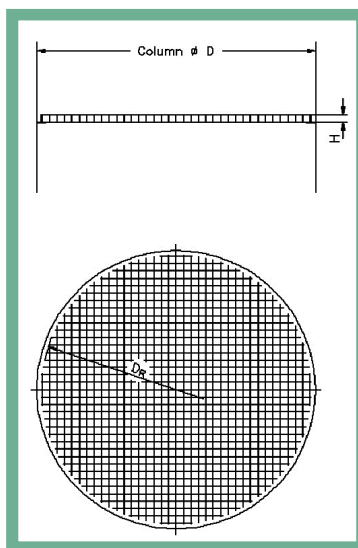
Liquid Distributors and Redistributors in Metal and Plastic

The efficiency of a packed bed is above all dependent upon an even, uniform distribution of liquid. If a packed bed does not operate satisfactorily, this is often due to faulty design or incorrect installation of the distribution system.

The most important criteria in the selection of a liquid distributor are the liquid flow rate and the properties of the liquid itself, such as:

- ⇒ fouling
- ⇒ foaming tendency
- ⇒ density
- ⇒ viscosity
- ⇒ surface tension

Depending on the process used, the most frequent irrigation rates range from

$B = 2$ m³/m²/h in the case of vacuum rectification to

$B = 300$ m³/m²/h in the case of high-pressure absorption.

When looking at these factors, it becomes clear that no one single distributor model is suitable for all requirements.

The basic version of the distributors, standardized as far as possible, must therefore be varied in accordance with the design liquid flow and the minimum and maximum flow. Normally, our liquid distributors have a standard liquid level of 25 mm and approximately 100 distribution points per m² of column cross-section under minimum load. The rate of flow in the troughs of the distributor should be not more than 1 m/s or usually below 0.5 m/s.

Perforated troughs or weirs with slits or triangular incisions are typical. Besides a sufficient number of distribution points, it is important that these are distributed as uniformly as possible over the cross-sectional area of the column. A larger number of distribution points is often found in columns with systematic mass transfer packings, such as RALU PAK 250 YC® or RASCHIG-SUPER-PAK® , since greater mass transfer efficiency is usually required in such cases.

In principle, trough distributors with weirs permit a greater operating range between maximum and minimum liquid rate than distributors with submerged orifices.

Liquid Distributors and Redistributors in Metal and Plastic

Compared to orifice type distributors, however, trough distributors with rectangular weirs are three times, and those with triangular weirs five times as sensitive to deviations in liquid level in the trough. Consequently, if care is not taken over the installation, the weir type distributor may, in practice, be less satisfactory than orifice type distributors even at full design flow. For this reason, we only supply weir type distributors if this is expressly desired. If the incoming liquids contain solid particles which may block an orifice type distributor, however, they are a useful alternative.

Liquid distributors are available in the following materials:

⇒ carbon steel

⇒ various stainless steels

⇒ special alloys, such as Monel, Hastelloy, titanium, nickel etc.

⇒ thermoplastic materials such as polypropylene, polyethylene, PVC or polyvinylidene fluoride (PVDF).

Standard material thicknesses:

3 mm for carbon steel

2 mm for stainless steels and special alloys

6 mm for thermoplastic materials

Slight deviations for the various materials are possible.

In the case of distributors made of plastics, we require details concerning the composition of the liquids and the maximum operating temperature for design purposes.

If the feed contains solids, small discharge holes in particular tend to become blocked. If, owing to small liquid loads, small downcomer holes are provided for, despite solid particles contained in the liquid, the tendency towards contamination can be reduced by covering up the holes.

Both standard and high quality liquid distributors are available.

Liquid Distributors and Redistributors in Metal and Plastic

Standard liquid distributors can be used in a liquid load range between 5 m³/m²/h. Their design is usually determined by a large number of earlier versions, and this means short design and production times as well as low costs. Standard liquid distributors are described in the following.

Table 1 gives an overview of the application areas of liquid distributors described in the following text.

Standard Distributor	Column diameter mm	Standard loading range	Liquid load u_L in m^3/m^2 h			Gas capacity factor $F_V = u_V \cdot \sqrt{\rho_V}$ in $m/s \cdot \sqrt{kg/m^3}$			Sensitivity to fouling
			$u_L < 5$	$5 < u_L < 80$	$u_L > 80$	$F_V < 1$	$1 < F_V < 2,5$	$F_V > 2,5$	
DT 1	> 800	2:1		x		x	x		yes
DT 2	> 1,200	10:1		x	x	x	x		no
DR 2	< 1,200	2:1		x	x	x	x		yes
DR 3	< 1,200	10:1		x	x	x			no
DP 1	> 100	2:1		x	x	x	x	x	yes
RP 1	> 1,200	2:1		x	x	x	x		yes
RP 2	> 300	2:1		x	x	x	x		yes
High-quality Distributor									
DT-MF	> 500	2:1 - 5:1	x	x (<10)		x	x	x	no
DT-S	> 300	2:1 - 5:1	x	x		x	x	x	no
DP-S	> 500	3:1		x		x	x		no
RP-P2	> 300	2:1			x	x			yes
DT-W	> 300	2:1		x		x	x	x	yes

Special distributor designs are available on request to allow further application conditions

Trough Distributor/Redistributor Type DT 1

Distributors of this type are used in columns with diameters of D > 800 mm. They are relatively insensitive to fluctuations of the liquid load.

They are normally designed so that the turndown ratio does not exceed 2 :1.

In order to determine the number of holes required and the diameter of these holes, knowledge concerning the quantity of liquid to be distributed is required. Owing to drag, the velocity of the flow of liquid in the distributor troughs determines the gradient of the loading height. In order to keep the differences in loading height and thus the deviations in volume rates from the discharge holes low, the velocity of flow in the weir troughs is limited to a maximum of 0.5 m/s. Transverse distributors between the troughs are possible, and reduce an uneven liquid level in the troughs, in particular in case of large column diameters.

The free areas for gas flow between the troughs are dimensioned in such a way that the arrangement of liquid distribution points for irrigating the packed bed is as uniform as possible. The perforated distributor troughs are supplied with their share of the liquid load from the parting boxes. The parting boxes and the distributor troughs are bolted to one another.
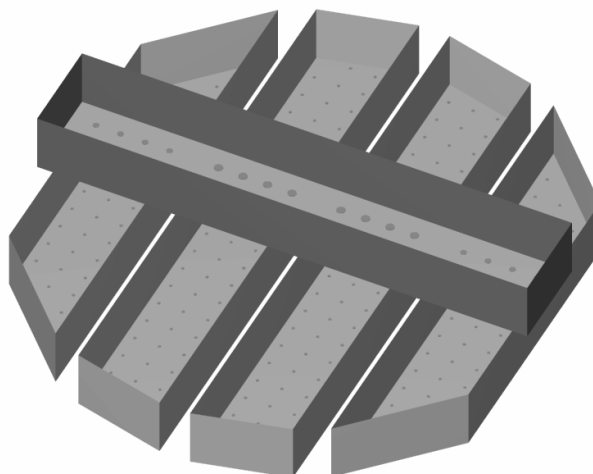
Trough Distributor/Redistributor Type DT 1

The parting boxes are supplied by the feed pipe via several discharge holes on the underside. Each discharge hole is fitted with a box or tube in order to avoid splashing. The feed pipe distributes the liquid evenly; the velocity of the liquid should be < 2.5 m/s in the central feed pipe, < 0.5 m/s in the distributor pipe, and the exit velocity in the holes of the distributor pipe should not exceed 3 m/s. It should preferably be limited to 1.5 m/s.

The feed pipe can be designed and delivered on request.

The distributors are clamped to a continuous support ring. In columns with larger diameters, one or more support beams may be necessary.

In order to guarantee perfect functioning, care should be taken to ensure that the spacing between the liquid distributor and the packed bed is approximately 100 - 250 mm. This distributor can be used for liquid loads of between 5 m³/m²/h and 80 m³/m²/h.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the troughs. In addition a wall wiper located above is needed.

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Trough Distributor/Redistributor Type DT 1

Typical dimensions of the DT 1

Inside diameter* of column - D mm	Outside diameter of plate - D_R mm	Number of troughs	Minimum width of support ring mm	Approx. weight kg
1,200	1,170	3	50	50
1,500	1,460	4	50	80
1,800	1,760	5	50	115
2,100	2,060	6	65	155
2,400	2,360	6	65	205
2,700	2,660	7	65	260
3,000	2,960	8	65	320

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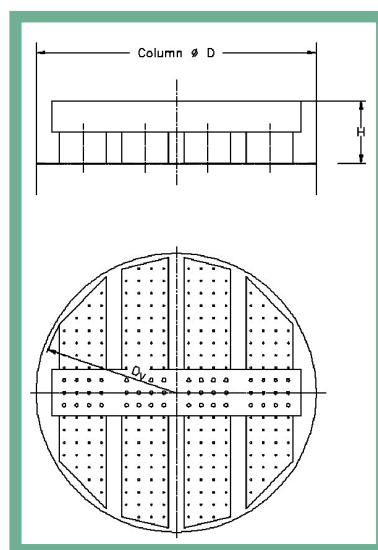
Trough Distributor/Redistributor with weirs Type DT 2

Distributors of this type are used in columns with diameters of D ≥ 1200 mm. They are relatively insensitive to fluctuations of the liquid load. Unlike the DT 1, the DT 2 has lateral discharge orifices in the form of slits or triangular openings. This makes this type of distributor highly resistant to fouling and expands the scope of application.

They are normally designed so that the turndown ratio does not exceed 10 : 1.

In order to determine the number of holes required and the diameter of these holes, knowledge concerning the quantity of liquid to be distributed is required. Owing to drag, the velocity of the flow of liquid in the distributor troughs determines the gradient of the loading height. In order to keep the differences in loading height and thus the deviations in volume rates from the discharge holes low, the velocity of flow in the weir troughs is limited to a maximum of 0.3 m/s. Transverse distributors between the troughs are possible, and reduce an uneven liquid level in the troughs, in particular in case of large column diameters. Distributors with slits or triangular openings react sensitively to uneven liquid levels since the outflowing volume flow is disproportionately dependent on the overloading height. Therefore this type of distributor is only recommended for systems which tend to become contaminated or if a high degree of flexibility is required.
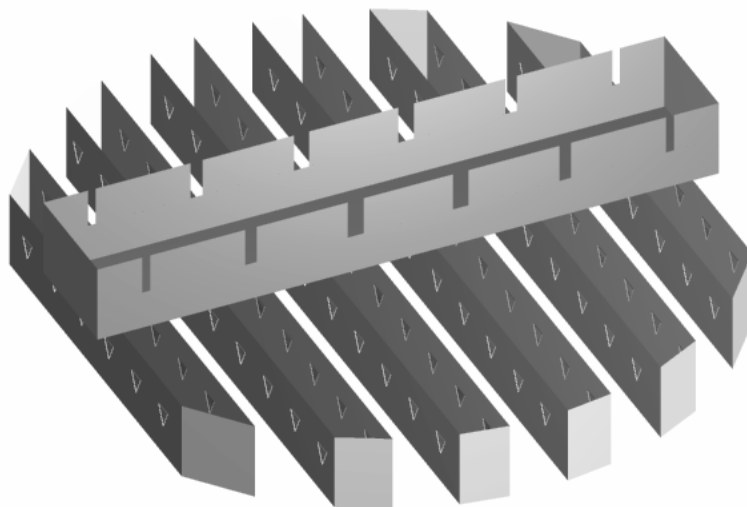
Trough Distributor/Redistributor
with weirs Type DT 2

The free areas for gas flow between the troughs are dimensioned in such a way that the arrangement of liquid distribution points for irrigating the packed bed is as uniform as possible. The distributor troughs with lateral openings are supplied with their share of the liquid load from the parting boxes. The parting boxes and the distributor troughs are bolted to one another.

The parting boxes are fed by the feed pipe via several discharge holes on the underside. Each discharge hole is fitted with a box or tube in order to avoid splashing. The feed pipe distributes the liquid evenly; the velocity of the liquid should be < 2.5 m/s in the central feed pipe, < 0.5 m/s in the distributor pipe, and the exit velocity in the holes of the distributor pipe should not exceed 3 m/s. It should preferably be limited to 1.5 m/s.

The feed pipe can be designed and delivered on request

The distributors are clamped to a continuous support ring. In columns with larger diameters, one or more support beams may be necessary.

In order to guarantee perfect functioning, care should be taken to ensure that the spacing between the liquid distributor and the packed bed is approximately 100 - 250 mm. This distributor can be used for liquid loads of between 5 m³/m²/h and 80 m³/m²/h.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the troughs. In addition a wall wiper located above is needed.

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Trough Distributor/Redistributor with weirs Type DT 2

Typical dimensions of the DT 2

Inside diameter* of column – D mm	Outside diameter of distributor - D_R mm	Number of troughs	Minimum width of support ring mm	Approx. weight kg
1,200	1,170	4	50	45
1,500	1,460	6	50	71
1,800	1,760	7	50	102
2,100	2,060	8	65	139
2,400	2,360	9	65	181
2,700	2,660	11	65	229
3,000	2,960	12	65	283

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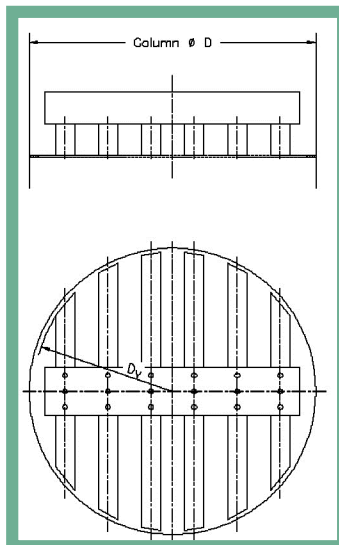
Distributor/Redistributor with Gas Risers Type DR 2

Liquid distributors of the DR 2 type are intended for use in columns with diameters from 150 mm to 1200 mm. The distributor consists of a pan with discharge holes for the liquid and gas risers for the rising gas. In addition, a ring-shaped gas entry cross-section is provided between the inner wall of the column and the outer perimeter of the pan. Downwards of a certain size and under the corresponding operating conditions the gas risers are no longer necessary; their absence in this case is not detrimental to the functioning of the unit. The discharge holes in the base of the pan are arranged in such a way that they ensure a supply of liquid to the cross-sectional area of the column which is as uniform as possible.

The DR 2 is supported by a support ring or by suitable brackets. Distributors of this type are normally equipped with several lugs distributed evenly around the circumference; 3 for single-piece versions, and 4 and 6 for the two-piece and three-piece versions, respectively. Special securing devices are not normally necessary but can be provided on request.
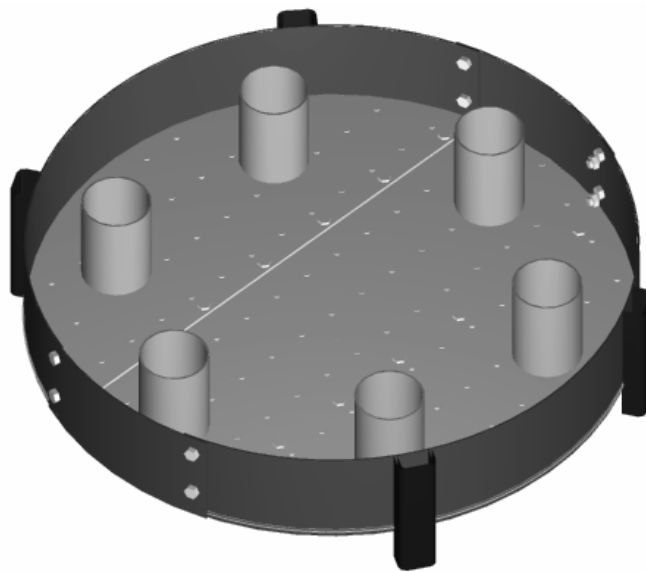
Distributor/Redistributor with Gas Risers Type DR 2

For columns with diameters up to 800 mm, the supply of liquid is effected by means of a pipe which is bent downwards onto the center of the distributor. For diameters over 800 mm, we recommend a sprinkler pipe which is perforated on the underside. In both cases the exit velocity of the liquid should not considerably exceed 1.5 m/s. The feed pipe is also available together with the distributor upon request.

The load range; i.e. the turndown ratio, is 2 : 1 for the standard version, 4 : 1 for special versions upon request.

We require details of the desired liquid load range for design purposes.

The DR 2 weir-riser distributor can be used for liquid loads > 5 m³/m²/h.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the pan. In addition a wall wiper located above is needed.

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Distributor/Redistributor with Gas Risers Type DR 2

Typical dimensions of the DR 2

Inside dia meter* of column - D mm	Outside dia meter of dis tributor - D_V mm	Outside diameter of pan - D_T mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
300	290	250	20	220	3
400	380	350	25	250	6
500	480	450	25	250	10
600	570	520	30	250	14
800	770	700	40	250	19
1,000	970	900	50	250	28
1,200	1,170	1,100	50	250	36
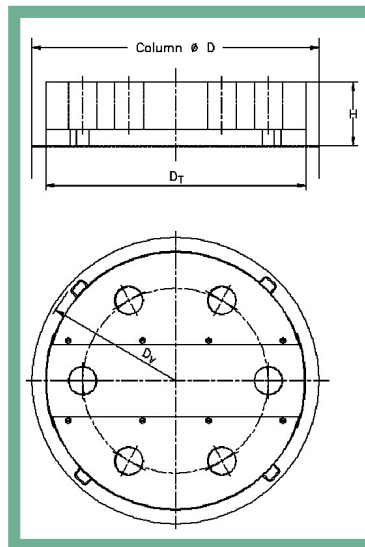
Distributor/Redistributor with Gas Risers Type DR 3

Liquid distributors of the DR 3 type are intended for use in columns with diameters from 150 mm to 1200 mm. The distributor consists of a pan with rectangular slits or triangular notches as discharge orifices for the liquid in the riser pipes, which also serve as gas risers. In addition, a ring-shaped gas entry cross-section is provided between the inner wall of the column and the outer perimeter of the pan. The advantage of the slits and notches in the risers is that they are less prone to fouling than perforations in the underside. The risers in the base of the pan are arranged in such a way that they ensure a supply of liquid to the cross-sectional area of the column which is as uniform as possible. Since the liquid in narrow cross-sections of the distributor flows towards the gas and sweeping away of the liquid must be avoided, this distributor is limited as regards a characteristic max. gas load in the risers.

The DR 3 is supported by a support ring or by suitable brackets. Distributors of this type are normally equipped with several lugs distributed evenly around the circumference; 3 for single-piece versions, and 4 and 6 for the two-piece and three-piece versions respectively. Special securing devices are not normally necessary but can be provided on request.
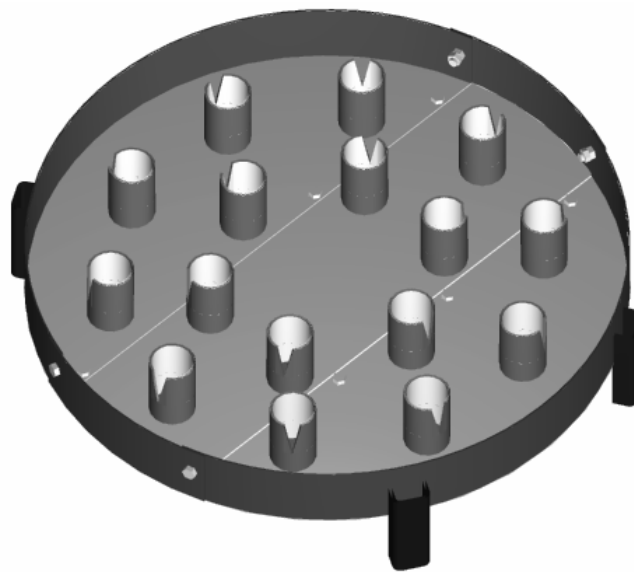
Distributor/Redistributor with Gas Risers Type DR 3

For columns with diameters up to 800 mm, the supply of liquid is effected by means of a pipe which is bent downwards onto the center of the distributor. For diameters over 800 mm, we recommend a sprinkler pipe which is perforated on the underside. In both cases the injection velocity of the liquid should not considerably exceed 1.5 m/s. The feed pipe is also available together with the distributor upon request.

The load range; i.e. the turndown ratio, is 10 : 1 for the standard version.

We require details of the desired liquid load range for design purposes.

The DR 3 distributor can be used for liquid loads from 5 m³/m²/h to 80 m³/m²/h.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the pan. In addition a wall wiper located above is needed.

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DistributorRedistributor with Gas Risers Type DR 3

Typical dimensions of the DR 3

Inside dia meter* of column - D mm	Outside dia meter of dis tributor - D_V mm	Outside diameter of pan - D_T mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
300	290	250	20	150	5
400	380	350	25	160	8
500	480	450	25	160	13
600	570	520	30	160	17
800	770	700	40	160	26
1,000	970	900	50	160	37
1,200	1,170	1,100	50	160	53

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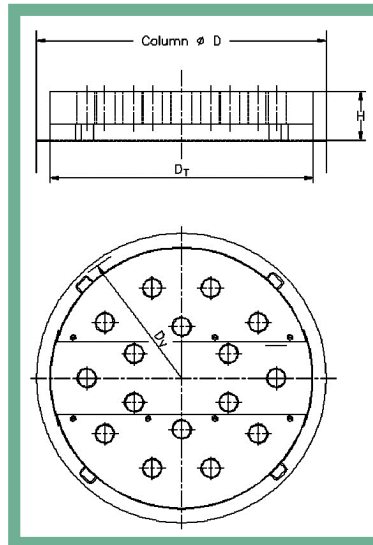
Pipe Liquid Distributor Type DP 1

Pipe distributors are installed in columns in cases where an even, uniform distribution of liquid is of prime importance. The arrangement of the holes on the underside of the distribution pipes is dependent upon the number of drip points; i.e., upon the liquid flow rate. The uniform irrigation of packed beds or packings is determined by the spacing between the holes and the distance between the distributor and the top of the bed. The angled orientation of the holes also enables uniform distribution between the pipes

The free gas cross-section of the pipe distributor is normally such that there is no mentionable pressure drop.

The pipe liquid distributor is available in two different versions; as a closed system with a feed pipe, and as an open system with a feed trough or a conical feed funnel.

The closed system can also be used with higher levels of liquid admission pressure without producing additional pressure drops.

The dimensions of the discharge holes depend mainly upon the admission pressure, the liquid rate and the properties of the liquid. The liquid should be as clean as possible, in order to prevent blockages in the distributor system and at the discharge holes. If necessary, a liquid filter should be installed at the feed pump.
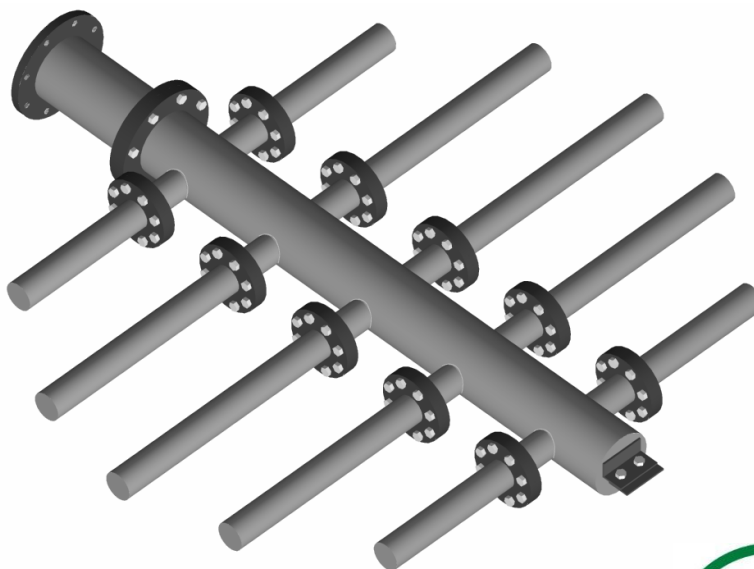
Pipe Liquid Distributor Type DP 1

It is important to select the correct discharge velocity of the liquid; i.e., to ensure that the drops are distributed when they fall upon the packed bed. The drop spectrum should ensure that there is no entrainment; i.e., that the drops are not swept away. An additional demister can be fitted in order to prevent discharge of extremely fine droplets and liquid mist, see spray distributor type DP-S.

Pipe distributors are relatively unaffected in their efficiency by nonhorizontal installation. The flow range of the liquid load can be extended to 2 : 1 in closed systems, provided that sufficient admission pressure is present for the maximum load. Owing to the flange connections at the downcomer pipes and at the feed pipe, the pipe liquid distributor can be taken apart and is thus also suitable for installation via manholes. Please state the manhole width when placing orders or submitting inquiries.

The pipe liquid distributor normally lies on a support ring, in the closed system on a bracket for the main header. The supporting devices and the connecting flange inside the column are to be supplied by the customer. Flange connections in accordance with DIN standards are used for the standard versions. Any deviating flange dimensions desired should be stated when ordering.

Pipe distributors are also frequently used as initial distributors in weir trough or perforated base distributors. They distribute the liquid evenly; the velocity should be < 2.5 m/s in the central feed pipe, < 0.5 m/s in the distributor pipe, and the exit velocity in the holes of the distributor pipe should not exceed 3 m/s. It should preferably be limited to 1.5 m/s.
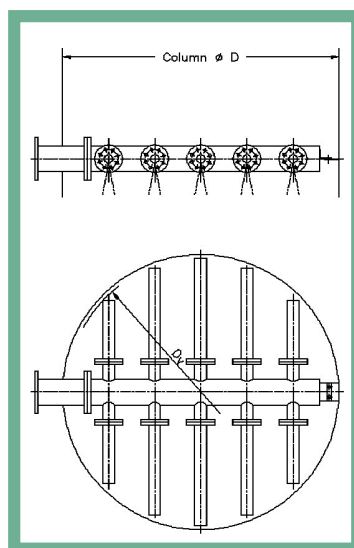
All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

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Pipe Liquid Distributor Type DP 1

Typical dimensions of the DP 1

| Inside diameter* of column- D mm	Outside diameter of distributor- D_v mm	Feed pipe DN mm	Number of distributor pipes per side	Approx. weight kg
500	460	50	3	6.5
600	560	50	3	8
800	760	80	4	12
1,000	950	80	4	22
1,200	1,150	100	5	36
1,500	1,440	100	5	45
1,800	1,740	125	6	71
2,100	2,030	150	6	83
2,400	2,330	175	7	117
2,700	2,620	200	8	200
3,000	2,920	200	8	215

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Liquid Redistributor/Distributor Type RP 1

Redistributors of the type RP 1 are used in columns with a diameter of D ≥ 1200 mm. The liquid redistributor has the task of collecting and redistributing the liquid falling from an upper packed bed. It can also be designed in the form of a feed distributor.

The RP 1 consists of distributor troughs which are open in the direction facing the column wall, allowing transfer to take place over the entire distributor base. In larger columns with diameters D > 1500 mm, the troughs are centerline connected by means of transverse troughs which are supported by a support beam. The ends of the gas risers are sealed by means of spacer plates in the area of the support ring.

In order to prevent the downcoming liquid from raining into the gas risers, the latter are provided with covers. Due to the segmental design of the redistributor, it can be installed via manholes with a nominal diameter of 500 mm. The RP 1 lies on a closed support ring and is fixed with special clamps. In order to obtain good distribution of the liquid, care should be taken to ensure that the maximum horizontal deviation of the support ring does not exceed 0.2 % of the column diameter. The load range of the redistributor of the type RP 1 is normally 2 : 1. This liquid redistributor can be used for liquid loads of between 5 m³/m²/h to 80 m³/m²/h.

In case of a distributor design gas chimneys will not be covered by hats and will be supplied with a parting box. The parting box is supplied by the feed pipe via several discharge holes on the underside.
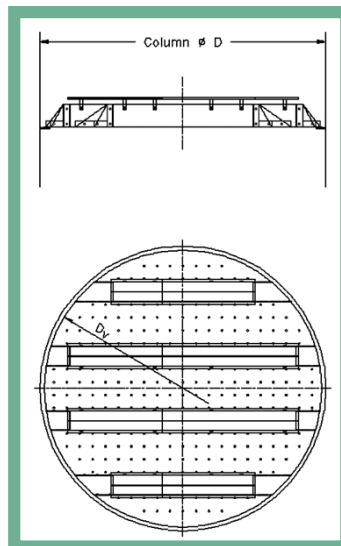

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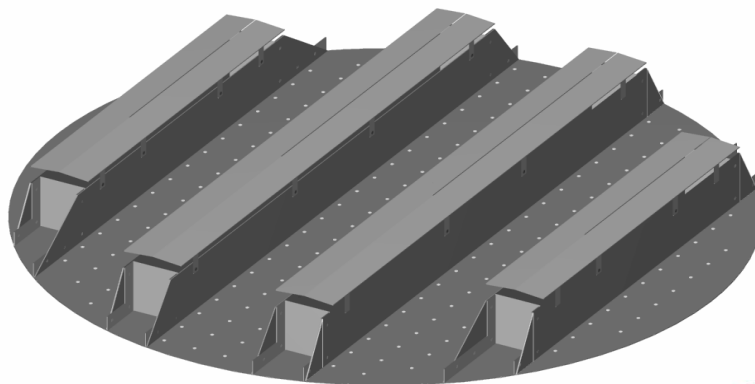
Liquid Redistributor/Distributor Type RP 1

All weights we give are based on standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

Typical dimensions of the RP 1

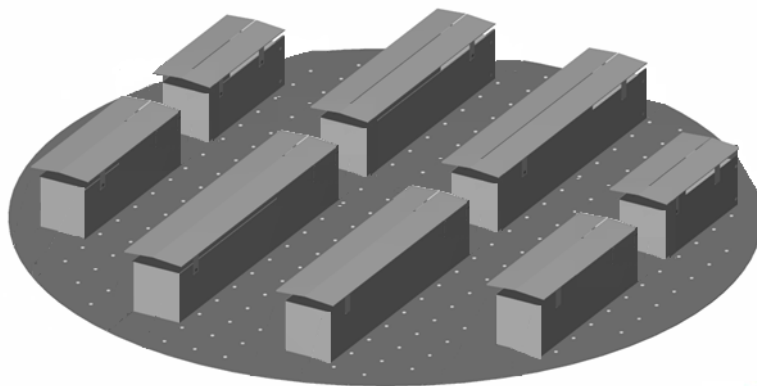| Inside diameter* of column – D mm	Outside diameter of distributor D_V mm	Number of risers	Minimum width of support ring mm	Approx. weight kg
1,200	1,170	3	50	42
1,500	1,460	4	50	65
1,800	1,760	4	50	85
2,100	2,060	5	65	115
2,400	2,360	5	65	140
2,700	2,660	6	65	180
3,000	2,960	6	65	210

Liquid Redistributor/Distributor Type RP 2

For columns with a diameter > 300 mm, we recommend the use of this type of distributor. Whereas the DR 2 liquid distributor features a pan with raised edges, the RP 2 is designed in the form of a flat disk with gas risers. It is attached to a support ring by means of special clips. For columns with a diameter of D < 500 mm, the distributor in the standard version is a single unit which can be clamped between the column flanges.

The liquid flows through the discharge holes in the base, while the rising gas passes through the gas risers. The latter are covered by hoods in order to prevent the liquid from raining through.

The load range of the RP 2 is normally a turndown ratio of 2 : 1. This can, however, be extended to 4 : 1 on request. This liquid redistributor can be used for liquid loads of between 5 m³/m²/h to 80 m³/m²/h. Special designs are capable of higher liquid loads.

All weights we give are based on standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

In case of a distributor design gas chimneys will not be covered by hats and will be supplied with a parting box. The parting box is supplied by the feed pipe via several discharge holes on the underside.


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Liquid Redistributor/Distributor Type RP 2

Typical dimensions of the RP 2

Inside diameter* of column – D mm	Outside diameter of distributor - D_V mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
300	**	-	250	5
500	**	-	250	11
1,000	970	50	250	34
1,500	1,460	50	250	80
2,000	1,960	65	250	142
2,500	2,460	65	250	220
3,000	2,960	65	250	320

* The above dimensions serve merely as examples.
   Intermediate dimensions are, of course, also available.
** Clamped between the container flanges as standard.
   Outside diameter should be stated when ordering.

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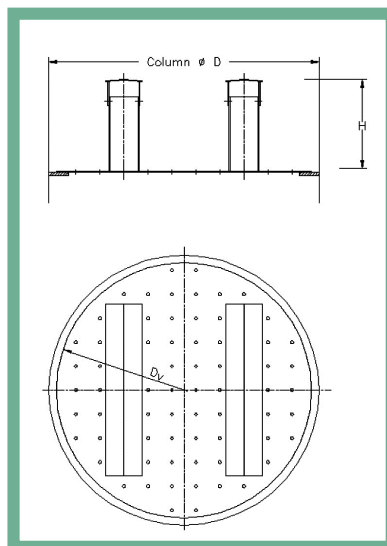
Definition of High quality Liquid Distributors

High quality liquid distributors are designed for the individual application. They ensure optimized distribution of liquid even under critical operating conditions and thus achieve optimal mass transfer effect of the packed bed. Owing to the more complex design work they involve, they cause greater costs and longer delivery times. They can be used both under standard conditions (2 to 80 m³/m²/h) and even with very small (0.025 to 2 m³/m²/h) and very large liquid loads (over 80 up to 300 m³/m²/h).

A high quality liquid distributor ensures a largely homogeneous distribution of liquid over the column cross-section. The distribution quality of liquid distributors can be examined on a test-bed designed especially for this purpose. A prime feature of high quality liquid distributors is that the deviation in the volume rates from the discharge holes is a minimum. This applies to the entire loading range of a distributor.

The number of distribution points per m² of cross-sectional area of the column ma be adapted to the type of packing used. The greater the geometric surface area of a packed bed, the number of drip points used in the design may be increased. For instance, in structured packings with a geometric surface area of 250 m²/m³ over 200 drip points per m² of cross-sectional area of the column can be provided.

Furthermore, a high quality liquid distributor ensures minimum entrainment. This may be accomplished by means of downcomer pipes guiding the liquid directly to the packed bed. As a result, the exit orifices for the liquid are far from the narrow flow cross-section between the distributor troughs or in the vapor risers, in which high flow velocities of the gas or vapor flow favor entrainment. Furthermore, the supply of liquid takes place far from the areas of great inflow turbulence in the narrow spaces between the risers, which may cause irregular turbulence of the liquid.

Optimized design can pay special attention to blockage problems and resist fouling.

The following aspects are also considered.

Horizontal Orientation

A largely horizontal orientation of the liquid distributor is achieved by adjusting the distributor troughs by means of screws, i.e. they do not lie firmly on a support ring. The permissible tolerance in the horizontal position is max. 3 mm.

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Definition of High quality Liquid Distributors

Distribution of the Downcomer Points

An important criterion for a high quality liquid distributor is the even distribution of liquid over the column cross-section. In addition to a number of distribution points adjusted to the packing, for instance, the peripheral distance of the outermost liquid feed point from the column wall is adjusted to the process conditions according to the influencing variables. It is borne in mind here that a distance which is too small would cause too much liquid to be led directly to the column wall, while a distance which is too large would result in an unwetted peripheral zone. In order to avoid no-flow zones below wide support rings, it is possible to suspend the liquid distributor from the support ring. This avoids the narrow and critical column cross-sections often resulting from the high position of the support rings for liquid distributors.

Height of the Troughs

In order to enable as low flow velocities as possible in distributor troughs with a large, free column cross-section, the distributor troughs are designed higher and narrower than in standard versions. The flow velocities in the distributor troughs are < 0.5 m/s with a minimum loading height of > 30 mm. The load range of the liquid distributor defines the height of the distributor troughs. The limitation of velocity ensures an even liquid level in the troughs and has the result that the discharge behavior from the distributor is not influenced by high flow velocities transversely to the discharge orifices.

Distance from the Packed Bed

In particular with large gas loads the liquid from the distributor trough is fed directly onto the packed bed. This prevents the jet of liquid from hitting the bed and minimizes the formation and entrainment of drops of liquid with the gas or vapor current. The following special designs make this possible

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Definition of High quality Liquid Distributors

The downcomer spouts guide the liquid through the pipes arranged at the distributor floor directly to the surface of the packed bed. This prevents entrainment of liquid which might otherwise take place due to the high gas flow velocities between the distributor troughs in cases of large gas loads. The flexibility in the liquid load can be increased to up to 1:10 by means of a multi-stage arrangement of the holes.

The downcomer pipes have the advantage over the downcomer spouts that they are not prone to contamination. The downcomer pipes protrude into the inside of the distributor troughs and have a downcomer hole approx. 20 mm above the distributor floor. Dirt particles settle therefore in the troughs on the floor owing to the low flow velocity, whereas the clear liquid runs through the holes in the pipes. In this design, too, the flexibility in the liquid load can be increased to 1:10 by means of a multi-stage arrangement of the holes.

Fig.: a) Downcomer spouts; b) Downcomer pipe; c) Multi-Flow System;

d) Distributors with shaped drip sheet

c)

d)

a)

b)
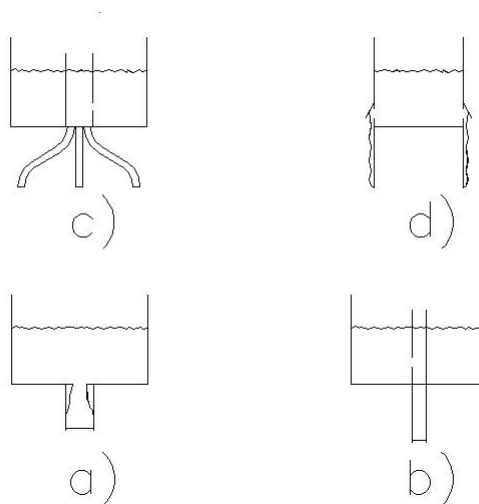
Definition of High quality Liquid Distributors

In the Multi-Flow System several downcomer points are combined in one riser pipe. The riser pipe contains holes or slits and distribution channels. The latter guide the liquid directly to the upper edge of the packed bed. Since the holes or slits are arranged above the distributor floor, this distribution system is not prone to contamination. The distributor troughs can be designed narrower owing to the lateral deflection of the liquid through the distributor channels so that the free column cross-section increases. This system is well-suited both for very small and for large liquid loads (uL > 0.025 m³/m²/h). In case of small liquid loads a special version can ensure even distribution.

Distributors with shaped downcomer sheets enable the design of narrow trough systems, thus increasing the free cross-section. The liquid is led through the covered holes directly onto the downcomer sheet which has defined distribution points owing to its lower edge. Since this design also has the downcomer orifices arranged above the trough floor, the system is not prone to contamination.

Preliminary Distribution of the Liquid

In particular in large column cross-sections or large liquid loads, a good preliminary distribution of the liquid is critical for the good functioning of a distributor. As a rule, the preliminary distribution takes place via a pipe distributor system with discharge orifices into the troughs or parting boxes of the liquid distributor lying below. In order to ensure an exit volume rate from the downcomer orifices of the pipe distributor are as even as possible, the flow velocity in the pipes and the discharge holes is to be limited. Thus the liquid velocity should not exceed 2.5 m/s in the central feed pipe, be < 0.5 m/s in the distributor pipe, and the exit velocity in the holes of the distributor pipe should not exceed 3 m/s. It should preferably be limited to 1.5 m/s. The distance between the discharge holes should not exceed 1.5 m in order to avoid long flow paths in the distributor troughs lying below. In order to prevent uncontrolled violent influx of liquid into the distributor troughs, an anti-splash device is arranged at the pipes and a perforated sheet worked into the troughs as a flow breaker.

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Definition of High quality Liquid Distributors

Transverse Distribution of Distributor Troughs

In order to avoid large flow lengths and high flow velocities, the distributor troughs may be interconnected by means of cross-channels. The even liquid level in the distributor troughs can be significantly improved, for instance by transverse distribution after a flow length of 1.5 m.

Distributors for Liquids Prone to Fouling

Liquid orifices in the floor of the distributor troughs are very easy to make, but are particularly prone to fouling. Orifices in the lateral walls of the distributor troughs or in downcomer pipes are suitable designs for systems prone to fouling. Owing to low flow velocities in the distributor troughs, the dirt settles on the floor, while the orifices remain clear. From time to time such distributors should be cleaned. The flexibility of the distributors can be increased to 1:10 by making slits or notches. However, the possible maldistribution due to differing liquid levels is greater in these versions, since the quantity outflowing depends disproportionately on the overloading height.
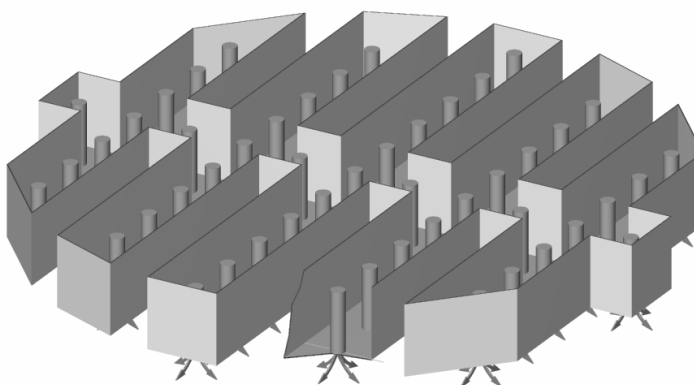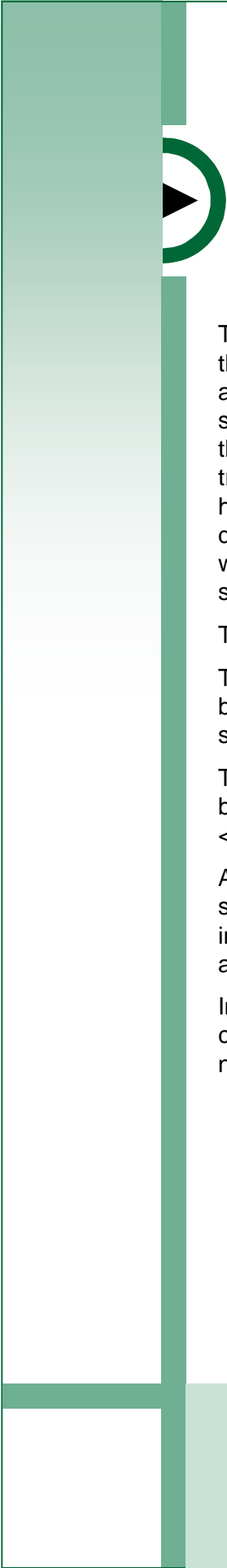
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High quality
Liquid Distributor/Redistributor
Type Multi-Flow DT-MF

Distributors of this design are used in columns with D > 500 mm. They are relatively unaffected by fluctuations in the quantity of liquid and are suitable for systems prone to contamination. Owing to the design of the liquid distribution channels this distributor can also be used in large gas or vapor loads. This is possible because the liquid is supplied at the lower edge of the distributor far from the narrow flow cross-section. The flexibility in the liquid load can be increased to 1:5 by means of a multi-stage arrangement of the holes.

They are normally designed so that the turndown ratio does not exceed 2 : 1.

In order to determine the number of holes required and the diameter of these holes, knowledge concerning the quantity of liquid to be distributed is required. Owing to drag, the velocity of the flow of liquid in the distributor troughs determines the gradient of the loading height. In order to keep the differences in loading height and thus the deviations in volume rates from the discharge holes low, the velocity of flow in the weir troughs is limited to a maximum of 0.5 m/s. Transverse distributors between the troughs are possible, and reduce an uneven liquid level in the troughs, in particular in case of large column diameters.

High quality
Liquid Distributor/Redistributor
Type Multi-Flow DT-MF

The free areas for gas flow between the troughs are dimensioned in such a way that the arrangement of liquid distribution points for irrigating the packed bed is as uniform as possible. The lateral distributor troughs are supplied with their share of liquid from the main distributor trough. The main distributor trough and the lateral distributor troughs are bolted together. The general main distributor trough is on a level with the lateral troughs. This saves overall height. In case of high liquid flow rates and column diameters the liquid is supplied through a pipe distributor system. Discharge holes from the pipe distributor can be provided with an anti-splash device. The exit velocity in the holes of the distributor pipe should not exceed 3 m/s. It should preferably be limited to 1.5 m/s.

The feed pipe can be designed and delivered on request.

The distributors are clamped to a continuous support ring and can be adjusted by means of bolts if necessary. In columns with larger diameters, one or more support beams may be necessary.

The liquid is guided though the distribution channels directly onto the packed bed. This distributor can be used for liquid loads of between 0.025 m³/m²/h and < 10 m³/m²/h or by special design also higher .

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.
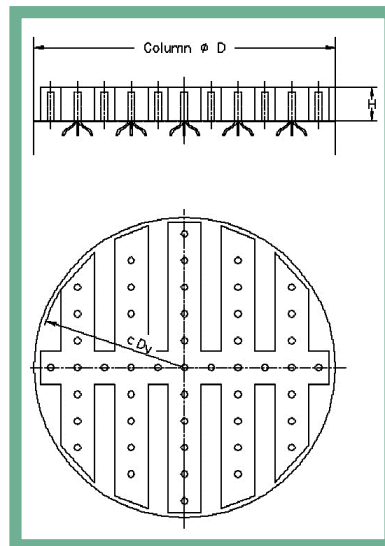
In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the troughs. In addition a wall wiper located above is needed.

High quality
Liquid Distributor/Redistributor
Type Multi-Flow DT-MF

Typical dimensions of the DT-MF

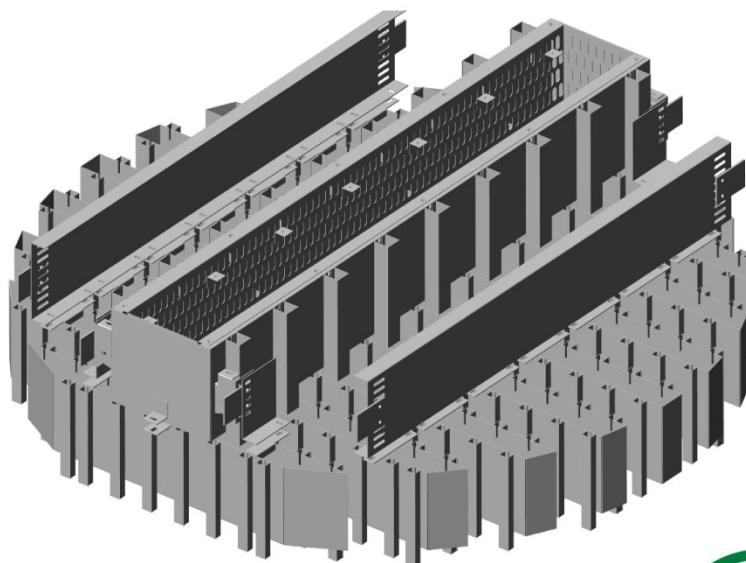| Inside diameter* of column - D mm	Outside diameter of distributor - D_V mm	Number of trough	Minimum width of support ring mm	Overall height –H mm	Approx. weight kg
500	480	3	25	250	20
800	770	3	30	250	45
1,000	970	4	40	250	65
1,200	1,170	4	40	300	95
1,500	1,460	5	40	300	110
1,800	1,760	6	50	300	155
2,100	2,060	7	50	300	210
2,400	2,360	8	65	300	275
2,700	2,660	9	65	300	345
3,000	2,960	10	65	300	425

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High quality
Liquid Distributor/Redistributor
System Distributor DT-S

Distributors of this design are used in columns with D > 300 mm. They are relatively unaffected by fluctuations in the quantity of liquid and are suitable for systems prone to contamination. Owing to the design of the liquid distribution channels this distributor can also be used with large gas or vapor loads. This is possible because the liquid discharges via a guide sheet. The shaped distribution edge of the guide sheet permits an even distribution of liquid onto the column cross-section.

They are normally designed so that the turndown ratio does not exceed 2 : 1.

In order to determine the number of holes required and the diameter of these holes, knowledge concerning the quantity of liquid to be distributed is required. Owing to drag, the velocity of the flow of liquid in the distributor troughs determines the gradient of the loading height. In order to keep the differences in loading height and thus the deviations in volume rates from the discharge holes low, the velocity of flow in the weir troughs is limited to a maximum of 0.5 m/s. Transverse distributors between the troughs are possible, and reduce an uneven liquid level in the troughs, in particular in case of large column diameters.

High quality
Liquid Distributor/Redistributor
System Distributor DT-S

The free areas for gas flow between the troughs are dimensioned in such a way that the arrangement of liquid distribution points for irrigating the packed bed is uniform. The perforated distributor troughs are fed with their share of liquid from the parting boxes. The parting boxes and distributor troughs are bolted together. The parting boxes are supplied via the feed pipe via several discharge holes on the underside. The discharge holes are provided with a box or length of pipe to prevent splashing. The exit velocity of the liquid in the holes should not exceed 3 m/s. It should preferably be limited to 1.5 m/s.

The feed pipe can be designed and delivered on request.

The parting box rests on a support ring, while the distributor troughs are suspended and have screws for horizontal adjustment. In columns with larger diameters, one or more support beams may be necessary.

This distributor can be used for liquid loads of between 3 m³/m²/h and 80 m³/m²/h.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.
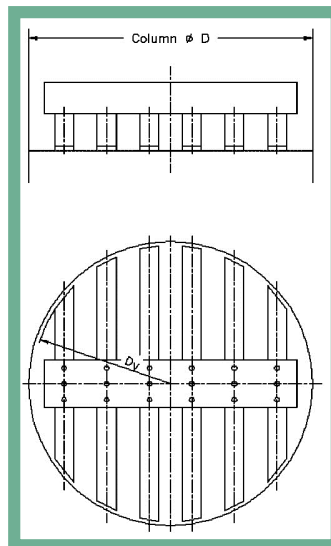
In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the troughs. In addition a wall wiper located above is needed.

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High quality
Liquid Distributor/Redistributor
System Distributor DT-S

Typical dimensions of the DT-S

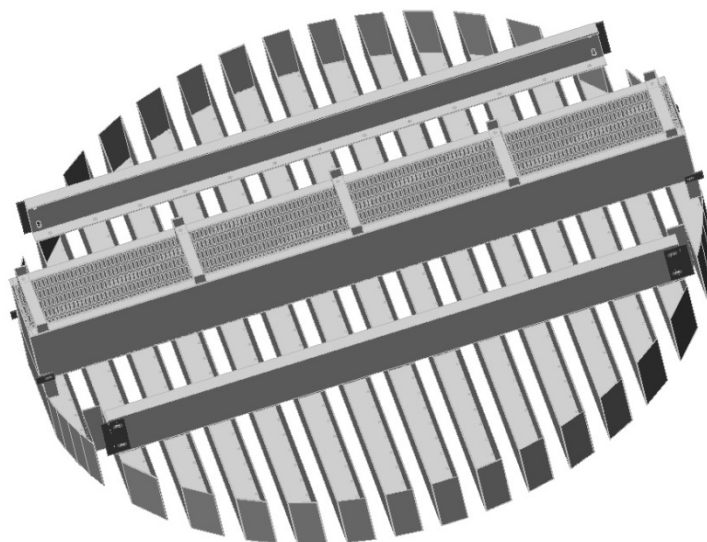| Inside diameter* of column - D mm	Outside diameter of distributor - D_V mm	Number of troughs	Minimum width of support ring mm	Approx. weight kg
500	480	4	25	18
800	770	5	30	42
1,000	970	6	40	62
1,200	1,170	7	40	85
1,500	1,460	5	40	135
1,800	1,760	9	50	190
2,100	2,060	11	50	250
2,400	2,360	13	65	340
2,700	2,660	15	65	430
3,000	2,960	16	65	520

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High quality
Liquid Distributor/Redistributor
Multi-Channel Distributor DT-W

Distributors of this design are used in columns with D > 300 mm. They are relatively unaffected by fluctuations in the quantity of liquid and are suitable for systems prone to contamination. Owing to the design of the liquid distribution channels this distributor can also be used with large gas or vapor loads.

They are normally designed so that the turndown ratio does not exceed 2 : 1.

In order to determine the number of holes required and the diameter of these holes, knowledge concerning the quantity of liquid to be distributed is required. Owing to drag, the velocity of the flow of liquid in the distributor troughs determines the gradient of the loading height. In order to keep the differences in loading height and thus the deviations in volume rates from the discharge holes low, the velocity of flow in the weir troughs is limited to a maximum of 0.5 m/s. Transverse distributors between the troughs are possible, and reduce an uneven liquid level in the troughs, in particular in case of large column diameters.

High quality
Liquid Distributor/Redistributor
Multi-Channel Distributor DT-W

The free areas for gas flow between the troughs are dimensioned in such a way that the arrangement of liquid distribution points for irrigating the packed bed is uniform. The perforated distributor troughs are fed with their share of liquid from the parting boxes. The parting boxes and distributor troughs are bolted together. The parting boxes are supplied via the feed pipe via several discharge holes on the underside. The discharge holes are provided with a box or length of pipe to prevent splashing. The exit velocity of the liquid in the holes should not exceed 3 m/s. It should preferably be limited to 1.5 m/s.

The feed pipe can be designed and delivered on request.

The parting box rests on a support ring, while the distributor troughs are suspended and have screws for horizontal adjustment. In columns with larger diameters, one or more support beams may be necessary.

This distributor can be used for liquid loads of between 3 m³/m²/h and 80 m³/m²/h.

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.
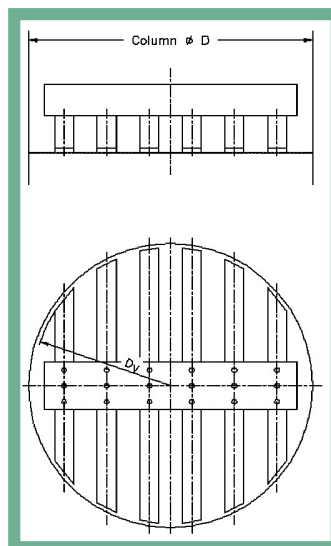
In case of a redistributor design the gas chimneys will be covered by hats to collect the liquid into the troughs. In addition a wall wiper located above is needed.

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High quality
Liquid Distributor/Redistributor
Multi-Channel Distributor DT-W

Typical dimensions of the DT-W

Inside diameter* of column - D mm	Outside diameter of distributor - D_V mm	Number of troughs	Minimum width of support ring mm	Approx. weight kg
500	480	3	25	18
800	770	4	30	45
1,000	970	5	40	70
1,200	1,170	6	40	100
1,500	1,460	7	40	160
1,800	1,760	9	50	230
2,100	2,060	10	50	311
2,400	2,360	12	65	400
2,700	2,660	14	65	510
3,000	2,960	15	65	630

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Spray Distributor Type DP-S

Spray distributors are a popular choice for gas cooling processes since the large surface of the drops produced contributes towards effective heat exchange. Furthermore, spray distributors make possible a homogeneous distribution of liquid, in particular where small quantities of liquid are involved. As a rule, fully conical nozzles are used since these enable comprehensive distribution. Another advantage of spray distributors is that they are insensitive to horizontal adjustment, which is advantageous for large column diameters. Furthermore, liquids containing solid particles can be distributed without problems to the nozzles with a high differential pressure.

In order to achieve perfect function, a spray distributor with several nozzles must be arranged so that the spray cones overlap when they fall on the packings. It is only in this way that it can be ensured that liquid reaches each section of the column. It also follows that sufficient liquid reaches the column wall. In order to minimize the distance between the distributor nozzles and the bed, most fully conical nozzles are used with a spray cone of 120°. This normally results in distances of between 600 and 800 mm to the packed bed.
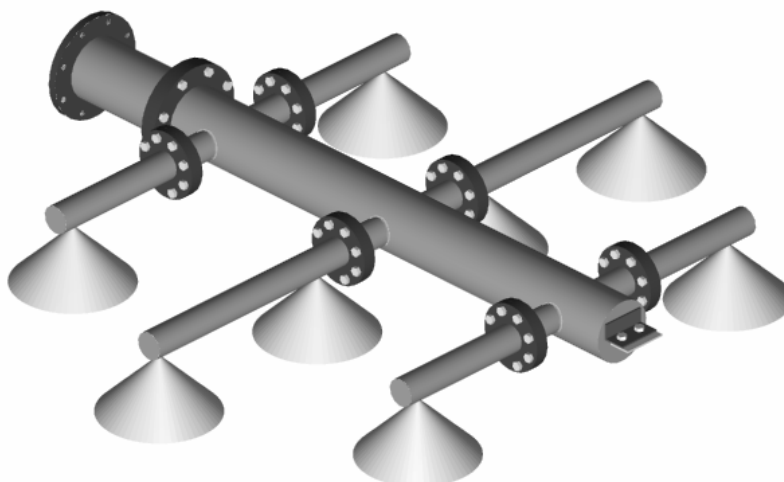
Spray Distributor Type DP-S

The disadvantage of spray distributors is that they always create a spectrum in the drop diameter. Small drops in particular are swept away with a gas counterflow, see attached figures. The spectrum of the drop diameter created is determined by the differential pressure of the nozzles. Standard differential pressures for nozzle-type distributors are around 3 bar which results in a largely homogeneous distribution of liquid. If the aim is to minimize the drop spectrum the differential pressures of the nozzles can be reduced to as low as 0.5 bar. Such nozzles are, however, larger in their execution and therefore more expensive. Owing to entrainment an eliminator plate should be installed above the nozzle-type distributor.

Fig. 1 and 2: Critical drop size to sweep with gas flow as a function of gas capacity factor.

$\nu_v = 5 \cdot 10^{-5}$ m^2/s; $\rho_L = 1000$ kg/m^3

$\nu_v = 1{,}5 \cdot 10^{-5}$ m^2/s; $\rho_L = 1000$ kg/m^3
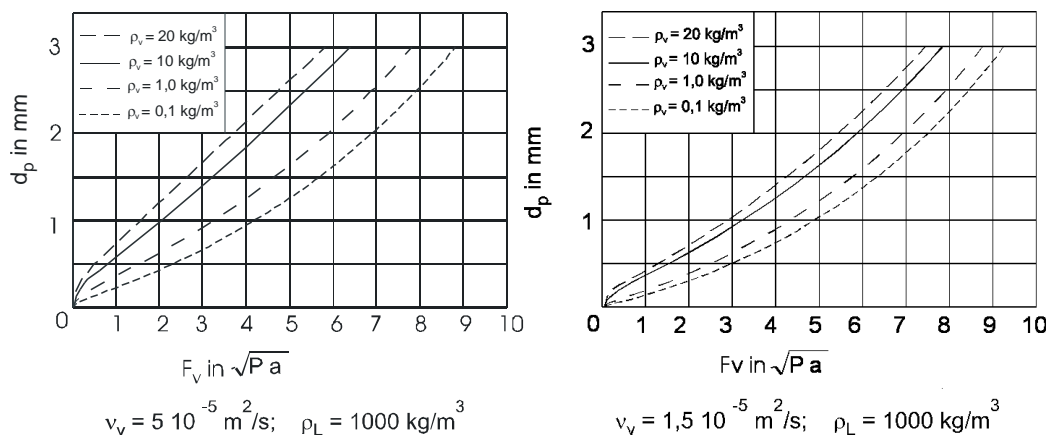
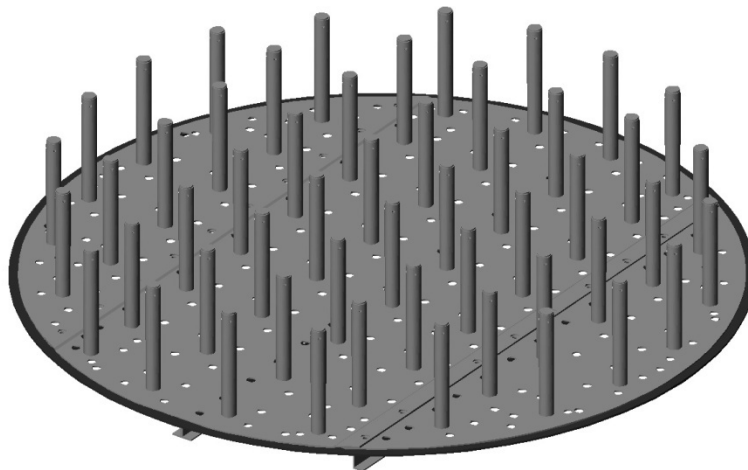# Liquid / Gas Redistributor/Distributor Type RP-P2

The Liquid / Gas Redistributor Type RP-P2 is developed for applications under process conditions from moderate to very high liquid loads (50 - >200 m^3/m^2h) besides very low gas loads ($F_v < 0,1$ $Pa^{0,5}$).

Especially in high liquid loaded services, large and dense liquid films flow downwards counter current to a small amount of gas with lower kinetic energy. This can create, effects like vapor channelling or vapor back mixing, which is especially sensitive to applications with critical separation task.

To avoid a loss in column performance Liquid / Gas Redistributor Type RP-P2 is designed to ensure excellent gas distribution to the packed bed above and excellent liquid redistribution to the packed bed below.

The Liquid / Gas Redistributor Type RP–P2 is derived from the deck type redistributor RP-2 and is equipped with piped chimney risers incl. directional gas orifices for the vapor phase. The liquid will leave the redistributor via bottom orifices in the tray floor.

The loading range of the RP-P2 is normally a turndown ratio of 2 : 1. This can, however, be extended to larger operating ranges on request.

Liquid / Gas Redistributor/Distributor Type RP-P2

Typical dimensions of the RP - P2

Inside diameter* of column – D mm	Outside diameter of distributor - D_V mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
300	**	-	250	3
500	**	-	250	9
1,000	970	50	250	32
1,500	1,460	50	250	71
2,000	1,960	65	250	126
2,500	2,460	65	250	196
3,000	2,960	65	250	282

* The above dimensions serve merely as examples.
   Intermediate dimensions are, of course, also available.
** Clamped between the column flanges as standard.
   Outside diameter can be stated when ordering.

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Gas / Vapor Distributor in Metal and Plastic

As much as possible, homogeneous distribution of the gas or vapor phase is also important for effective mass transfer in mass transfer columns since otherwise the mass transfer efficiency will drop due to back mixing. A distribution system is to be provided for both small as well as particularly large gas volume rates as well as with increasing column diameters, see the attached figure. Modern gas / vapor distribution systems have the task of achieving a phase distribution with a small pressure drop.

From dumped packings or structured packings the liquid generally drips into the bottom of the column. The lower section of the bed usually bears the greatest load, and thus an even distribution of the gas / vapor phase reduces the flooding phenomena and the entrainment of drops.

The gas / vapor inlets must be positioned sufficiently below the packings. In columns with a diameter of 1 m the distance should be 400 mm from the top of the nozzle to the packed bed and with column diameters of between 1 m and 2 m a distance of approx. 700 mm is to be provided. In larger columns a distance of at least 1000 mm is suggested.

Fig.: Discription of flow behaviour at the bottom of columns for low and high gas flow rates.
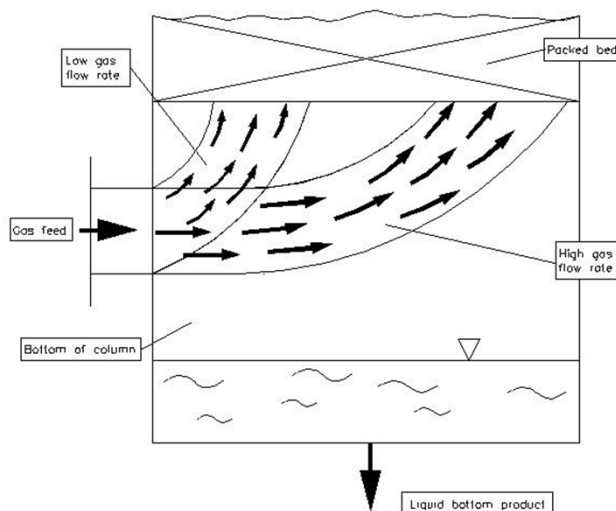
Gas Distributor Type GV 1

The GV 1 pipe distributor is from the design point of view the most simple and therefore the most cost-effective option for gas / vapor introduction. The inlet pipe is either perforated or slit on the underside or executed as an open pipe section. The gas exits downwards from the orifices, is deflected and flows into the packed bed. The arrangement of the orifices prevents the liquid from entering the gas / vapor inlet, see the attached figure. A disadvantage of this design is that in particularly large gas volume rates or inlet pipes a significant portion of the column cross-section is covered.Thus high flow velocities for the gas or vapor occur with the corresponding pressure drops and possible entrainment of drops.

Fig.: Gas Distributor Type GV 1
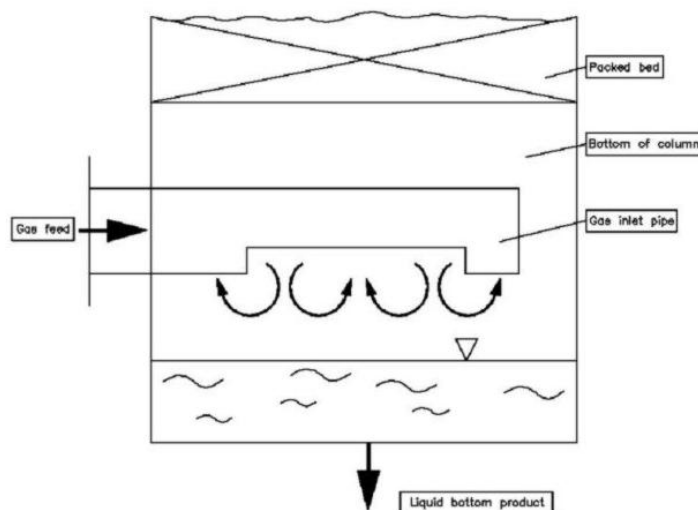
Gas Distributor Type GV-P1

The Gas Distributor Type GV-P1 is developed for applications under process conditions from moderate to very high liquid loads (50 - >200 m^3/m^2h) besides very low gas loads ($F_v < 0,1$ $Pa^{0,5}$).

Especially in high liquid loaded services, large and dense liquid films flow downwards counter current to a small amount of gas bubbles with lower kinetic energy. This can create, effects like vapor channelling or vapor back mixing, which is especially sensitive to applications with critical separation task.

In case vapor channeling can be expected, the GV-P1 ensures a good vapor distribution from the beginning on and avoid the formation of vapor channeling.

The Gas Distributor GV-P1 consist of a pipe system with a homogeneous pitch for the gas diffuser elements rising upwards including gas orifices.

Especially in cases with minor installation spaces the GV-P1 is preferred against the GV-P3 model.
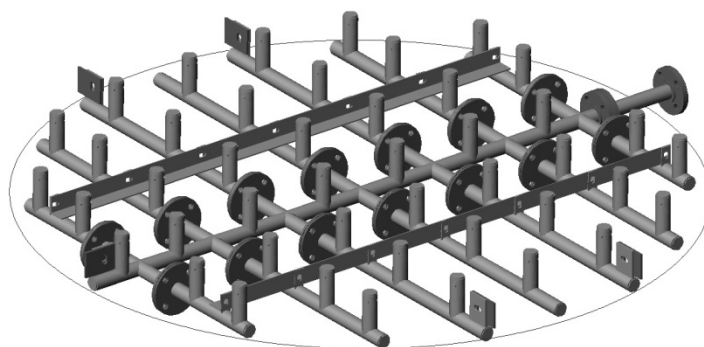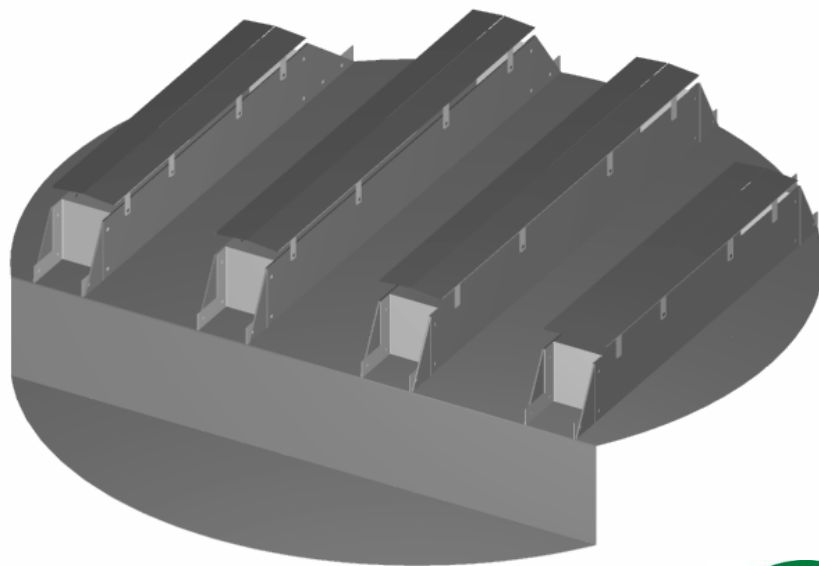
Gas Distributor Type GV 2

GV 2 gas / vapor distribution systems with guide vanes are complex structures but efficient with large column diameters. They encourage the distribution of the gas / vapor phase through increased turbulence and reduced pressure drop, promoting the agglomeration of the drops, see the attached figure. The design has gained popularity under the name "Schoepen Toeter".
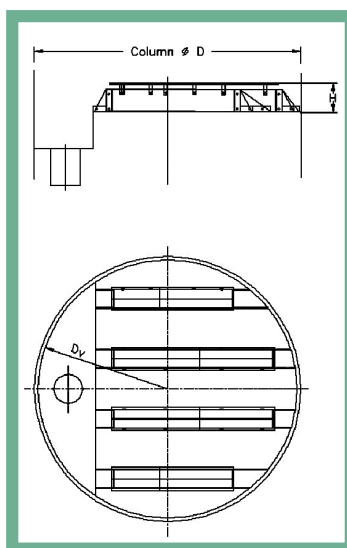
Fig.: Gas Distributor Type GV 2

Gas feed

Guiding structure
for gas distribution
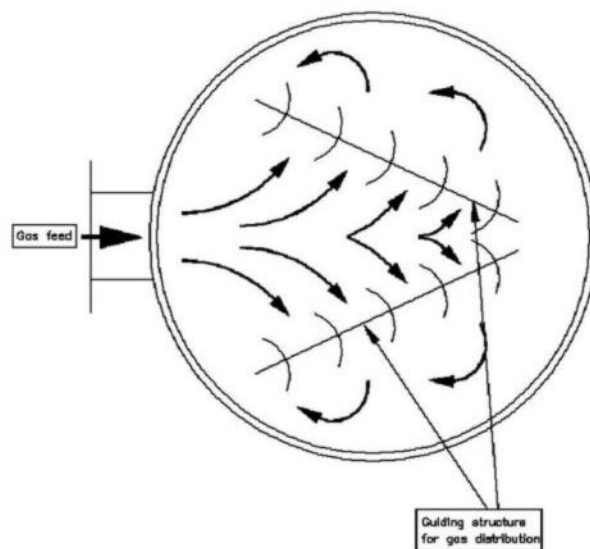
Gas Distributor Type GV 3

A GV 3 liquid collection base with gas risers permits effective and inexpensive gas distribution. The principle of action is based on the pressure drop of the base, which should have a value of at least 1 mbar. This distribution system, which is similar to the RP 1, has the advantage that the liquid and the gas / vapor phases are separate and the liquid is led to the bottom of the column through a downcomer shaft. Drops therefore do not form, and for this reason large gas / vapor loads can be permitted, see the attached figure.

Gas Distributor Type GV 3

Typical dimensions of the GV 3

Inside diameter* of column – D mm	Outside diameter of distributor -D_V mm	Minimum width of support ring mm	Number of risers	Overall height - H mm	Approx. weight kg
500	480	30	2	250	11
800	770	40	2	250	23
1,000	970	50	3	250	34
1,200	1,170	50	3	250	45
1,500	1,460	50	4	250	65
1,800	1,760	50	4	250	85
2,100	2,060	65	5	250	115
2,400	2,360	65	5	250	140
2,700	2,660	65	6	250	180
3,000	2,960	65	6	250	210

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Gas Distributor Type GV-P3

The Gas Distributor Type GV-P3 is developed for applications under process conditions from moderate to very high liquid loads (50 - >200 m^3/m^2h) besides very low gas loads ($F_v < 0,1$ $Pa^{0,5}$).

Especially in high liquid loaded services, large and dense liquid films flow downwards counter current to a small amount of gas bubbles with lower kinetic energy. This can create, effects like vapor channelling or vapor back mixing, which is especially sensitive to applications with critical separation task.

In case vapor channeling can be expected, the GV-P3 can ensure good vapor distribution from the beginning on and avoid the formation of vapor channeling.

The Gas Distributor Type GV-P3 is derived from the deck type gas distributor GV-3 and is equipped with piped chimney risers incl. directional gas orifices for the vapor phase. The liquid will leave the redistributor via a lateral downcomer shaft or down pipes.

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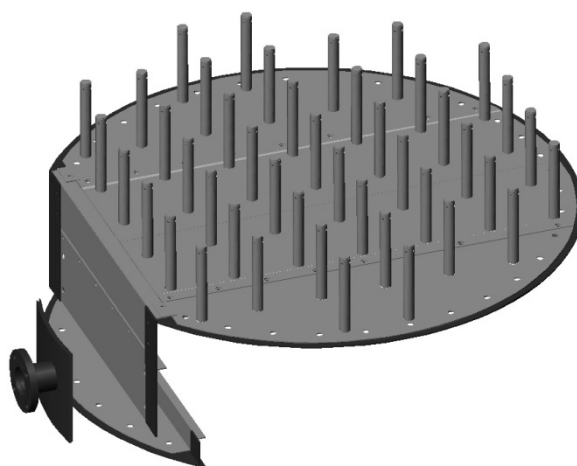
Gas Distributor Type GV-P3

Typical dimensions of the GV-P3

Inside diameter* of column – D mm	Outside diameter of distributor - D_V mm	Minimum width of support ring mm	Overall* height – H mm	Approx. weight kg
500	480	30	250	8
800	770	40	250	20
1,000	970	50	250	32
1,200	1,170	50	250	45
1,500	1,460	50	250	71
1,800	1,760	50	250	102
2,100	2,060	65	250	138
2,400	2,360	65	250	181
2,700	2,660	65	250	229
3,000	2,960	65	250	282

* for standard version

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# Gas-liquid Phase Separators in Metal and Plastic

All too often the feed into a mass transfer column is not exclusively liquid or gaseous but a mixture of gas and liquid. If the phases are not separated outside the column a special design is needed to separate the phases inside the mass transfer column.

Owing to the evaporation of a portion of the liquid due to pressure reduction during feed into the mass transfer column, the mean volume flow of the feed and thus the velocity in the feed pipe increases. The structures listed below must therefore permit effective phase separation despite high feed velocities.

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Two-phase Double-shell Flashbox Type FB 1

The design shown in the attached figure can be used for phase separation with column diameters of up to 1.2 m. In a double-shell inlet pipe first the two-phase flow is led into the central feed pipe. The gas enters the interstitial space of the double-shell pipe through a perforation in the upper side while the liquid flows out downwards through discharge holes. The gas is diverted downwards in the double-shell pipe and enters the column at the side from the outer pipe shell. The Double-shell Flashbox is particularly advantageous in cases where the gas portion is small.
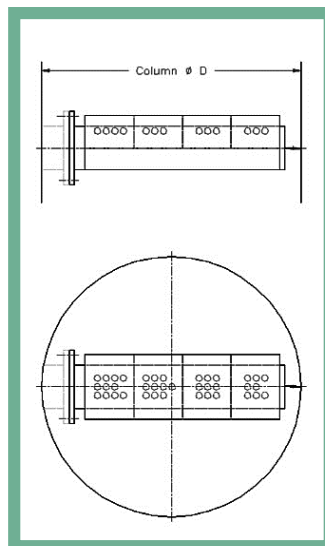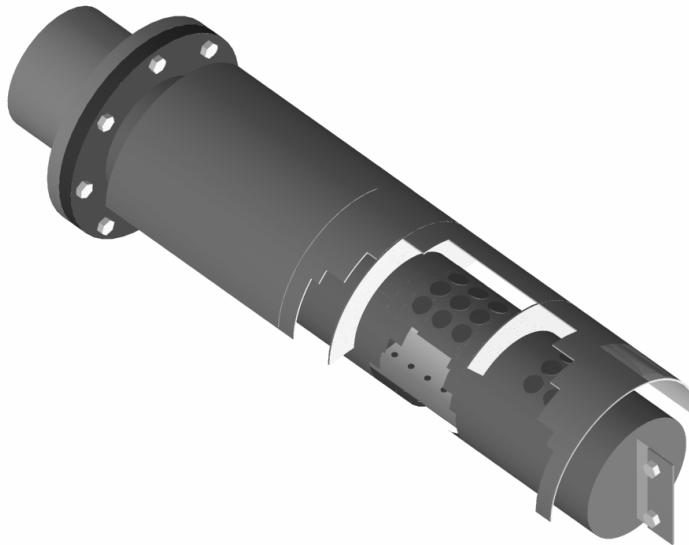
Two-phase Centrifugal Flashbox
Type FB 2

In columns with a diameter of up to 1.2 m the flashbox shown in the attached figure can be used. The two-phase mixture first flows into a vertically arranged cylindrical channel which brings about effective separation of the phases as a result of the centrifugal acceleration. The gas or vapor then exits the flashbox through the top, while the liquid flows into a liquid redistributor below, through a downcomer shaft. The Centrifugal Flashbox offers the advantage of being able to separate off large gas portions from the feed.

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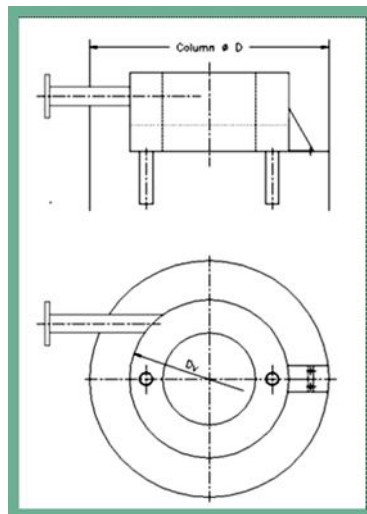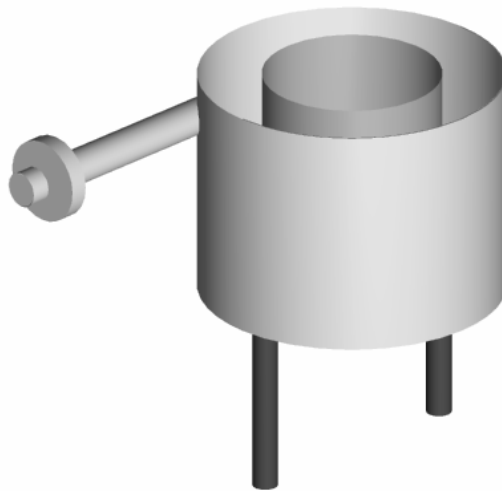
Two-phase Flash Gallery Type
FB 3

Two-phase separation in the Flash Gallery takes place in analogy to the Centrifugal Flashbox through a circulating current in an annular channel along the inside wall of the column. It is suitable for large column diameters. The annular channel lies on a support ring and contains for instance discharge holes in the channel floor which lead the liquid directly onto the redistributor lying below. The gas can exit the annular channel upwards along the entire length of the annular channel, see the attached figure. In particular with large column diameters and feed quantities a parting system can be achieved for the Flash Gallery, too, by means of a pipe distributor. The pipe distributor permits the feed into various sections of the annular channel.
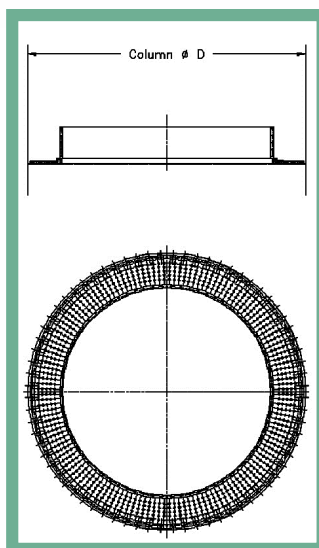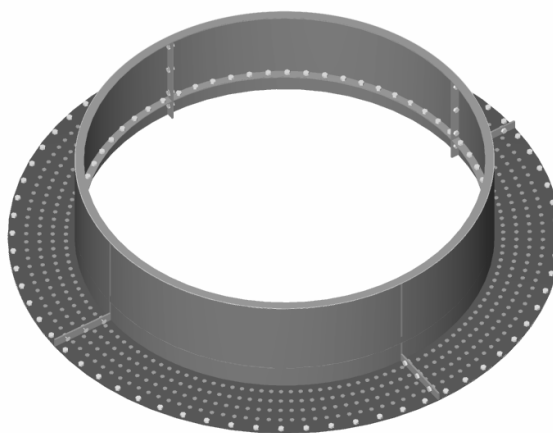
Column ⌀ D

Liquid Collectors in Metal and Plastic

Liquid collectors are needed in a rectifying column for instance when, because of the feed of liquid, thorough mixing is required between the liquid dripping out of the bed from above and the feed. If a drop in mass transfer efficiency is to be avoided, a redistribution of the liquid phase is necessary after a certain bed height. Another application results when, owing to high gas flow velocities, drop entrainment is to be avoided in a gas inlet system by leading the liquid phase separately around the gas inlet system.

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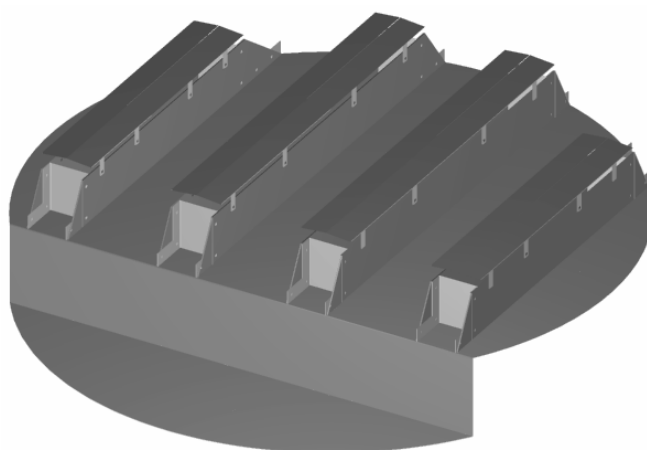
Liquid Collector Type CP 1

Type CP 1 collectors are used in columns with a diameter ≥ 1200 mm. The design is executed in analogy to the RP 1 liquid redistributor, but instead of discharge holes it has a lateral downcomer shaft, see the attached figure. For a 100% liquid collection Raschig recommends a liquid collector type CP 2.

The CP 1 consists of collection troughs which are open to the column wall, thus allowing the exchange of liquid on the entire collection base. In case of larger column diameters (> 1500 mm) the troughs are centerline connected by means of transverse troughs which are supported by a support beam. The ends of the gas risers are sealed by means of spacer plates in the area of the support ring.

In order to prevent the downcoming liquid from raining into the gas risers, the latter are provided with covers.

Owing to the segmental design of the collector, it can be installed via manholes with a nominal diameter of 500 mm. The CP 1 lies on a closed support ring and is fixed with special clamps.
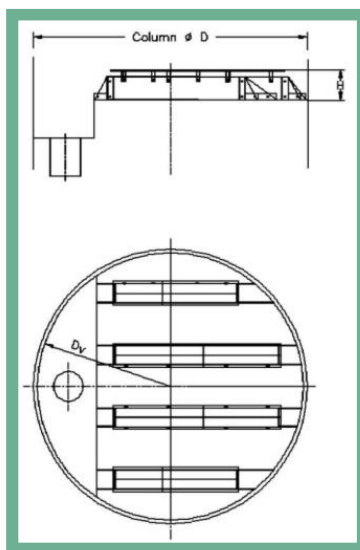
All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

Liquid Collector Type CP 1

Typical dimensions of the CP 1

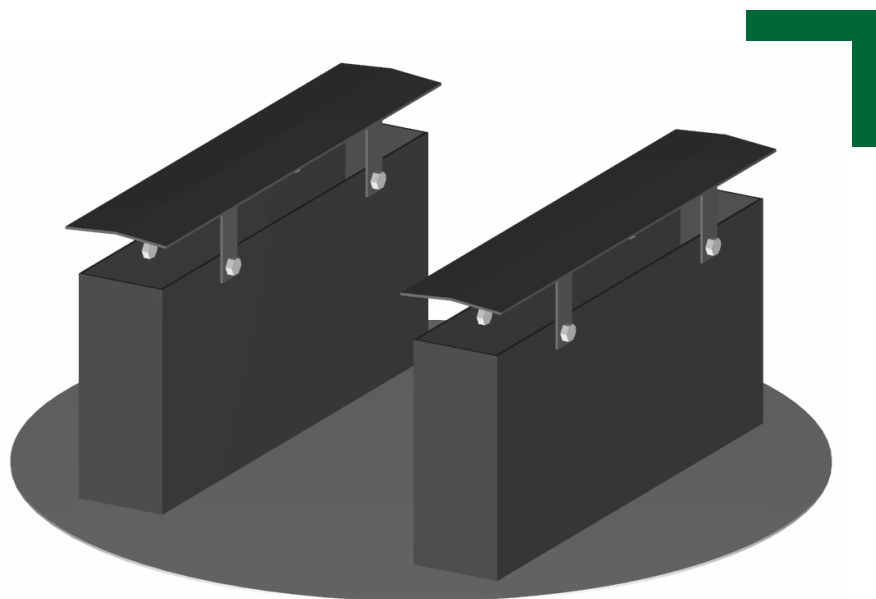| Inside diameter* of column - D mm	Outside diameter of collector - D_v mm	Minimum width of support ring mm	Number of risers	Overall height – H mm	Approx. weight kg
1,200	1,170	50	3	200	42
1,500	1,460	50	4	200	61
1,800	1,760	50	4	200	80
2,100	2,060	65	5	200	110
2,400	2,360	65	5	200	135
2,700	2,660	65	6	200	170
3,000	2,960	65	6	200	200

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Liquid Collector Type CP 2

We recommend this type of collector for columns with a diameter of > 300 mm. The design is executed in analogy to the RP 2 liquid redistributor, but instead of discharge holes it has a lateral downcomer shaft, see the attached figure. On customers request this collector permits 100% liquid collection, thus excluding leakage rates.

The CP 2 is designed as a flat disk with gas risers. It is fixed to a support ring by means of special clamps. For columns with a diameter < 500 mm the collector is supplied in one piece in the standard version. In order to prevent the downcoming liquid from raining into the gas risers, the latter are provided with hoods.
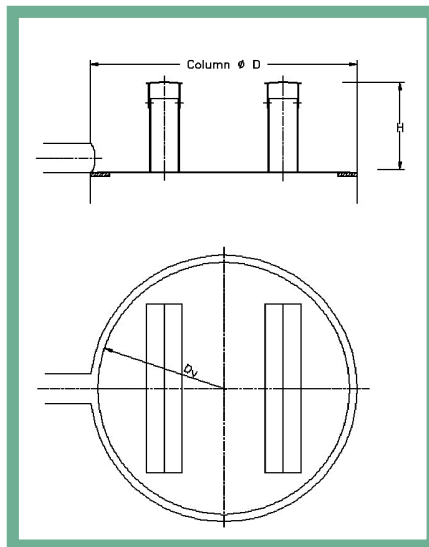
All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.
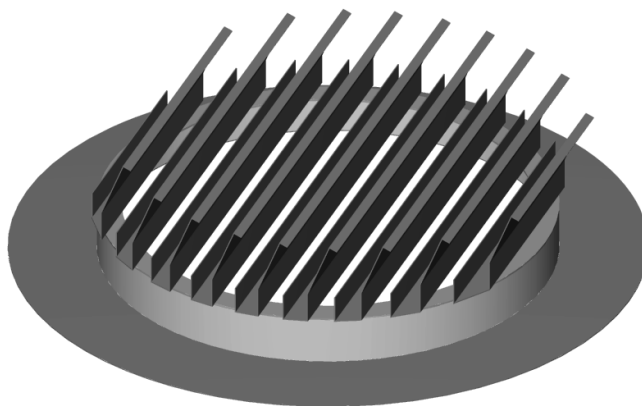
Liquid Collector Type CP 2

Typical dimensions of the CP 2

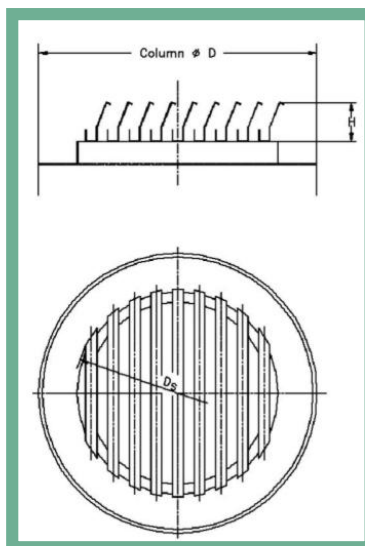| Inside diameter* of column – D mm	Outside diameter of collector - D_v mm	Minimum width of support ring mm	Overall height - H mm	Approx. weight kg
300	**	-	200	5
400	**	-	200	8
500	**	-	200	11
600	570	30	200	15
800	770	40	200	23
1,000	970	50	200	34
1,200	1,170	50	200	45

Liquid Collector Type CV 1

The CV 1 liquid collector is a lamellar collector according to the attached figure. The inclined and overlapping lamellas ensure far-reaching collection of the liquid and a small pressure drop. The channels at the lower end of the lamellas lead the collected liquid into an annular channel which follows the column wall. In larger columns or with larger liquid loads the lamellae are also available in a segmented version and with transverse central troughs for increased liquid distribution.

Liquid Collector Type CV 1

Typical dimensions of the CV 1

Inside diameter* of column – D mm	Outside diameter of collector - D_V mm	Ring channel mm	Overall height - H mm	Approx. weight kg
800	670	80	200	18
1,000	850	100	200	25
1,200	1,050	100	200	41
1,500	1,350	100	250	62
1,800	1,550	150	250	82
2,100	1,850	150	250	115
2,400	2,150	150	250	160
2,700	2,400	200	250	195
3,000	2,700	200	250	250

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Combined Designs

For all our liquid distributors we also offer a hold-down plate / distributor combination. The covering of all gas orifices with expanded metal provides retention grids which prevent the metal and plastic packings from being carried upwards through the liquid distributors.

The following standard combinations are available:

DT 1/HL   RP 1/HL

DR 2/HL   RP 2/HL

Many other combinations are possible. Just ask us to help you select the right internals for your process.

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General Notes on Installation and Arrangement in the Columns

The sketches show typical examples of the arrangement of tower internals; these positional arrangements have proven their worth in practice over the years for both large and small diameters. The manholes, which have been sketched in places above the support plates are often useful when removing the tower packings. It is advisable to arrange the liquid distributors and redistributors in such a way that they are accessible from above, as this facilitates alignment, easy cleaning and position checks.

Columns with diameters of D < 700 mm are often provided with flange connections at the level of the distributors or redistributors in order to facilitate installation and removal. It is recommended that columns of larger dimensions be provided with manholes. The figures recommended for the distance between the top of the packed bed and the liquid distributors have proven their worth in practice, but must be checked as to their suitability for individual requirements. The spacing may increase as the result of different process conditions. This type of increase can also be caused by the settling of the random packed bed after commissioning.

It is a good idea to assemble the individual parts of internals with the ad of drawings before installing them in the column, and then to install them in the column in the correct order. Once installed, the individual parts can then be aligned, bolted and attached to the support ring, insofar as this is necessary.

The manholes should have an inner diameter of at least 480 mm. Personnel should never walk or tread on the internals themselves, with the exception of the support plates; it is therefore advisable to install walk planks. Comprehensive installation instructions can be supplied for orders comprising several internals, and we will dispatch an installation supervisor on request to assist the customer's installation team.

General Notes on Installation and Arrangement in the Columns

Column: D < 700 m
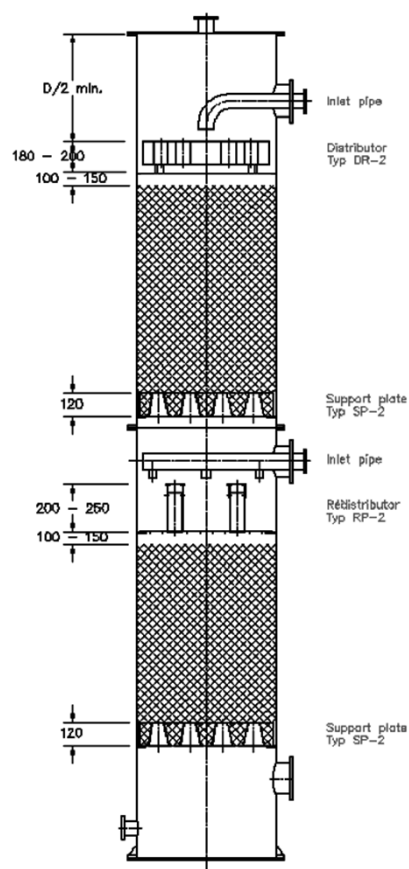
Column: D > 700 mm
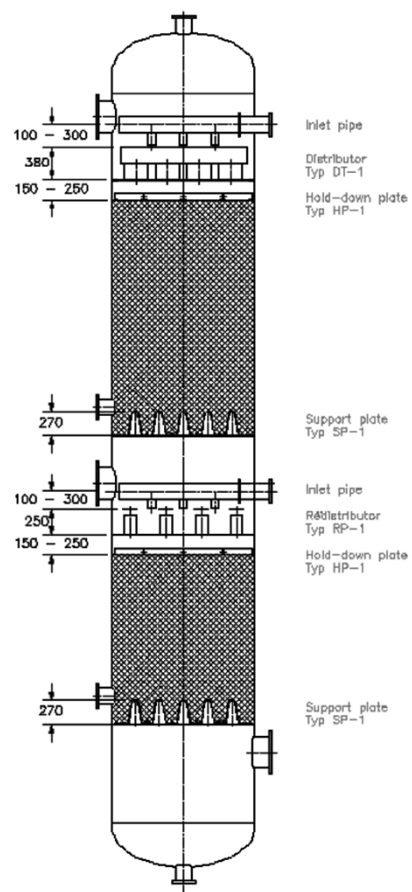
Weights

All weights we give are with reference to the standard wall thicknesses in stainless steel. To determine the weights of other materials please use the table included in the last chapter. We would like to stress that these are mere approximations.

Material	Standard wall thickness mm	Factor for calculation of weight
Carbon steel	3	1.5
Stainless steel	2	1.0
Hastelloy	2	1.2
Titanium	2	0.57
Polypropylene	6	0.36
PVC	6	0.51
PVDF	5	0.68

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