MASS TRANSFER PRODUCTS

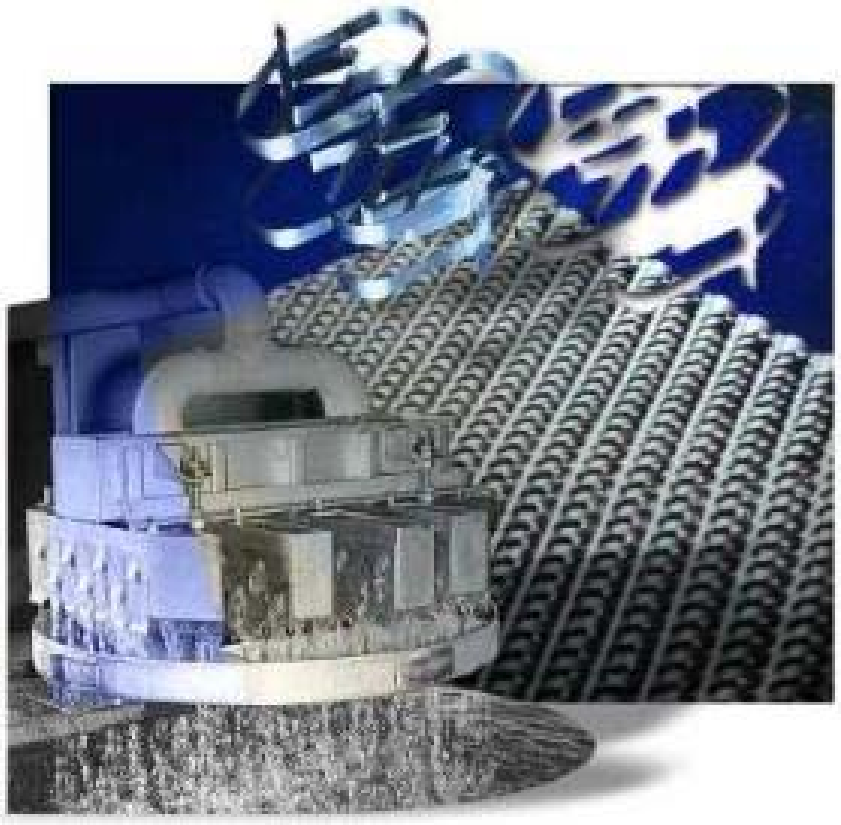
Product Bulletin 101

To be a global player in the field of separation technology, Raschig is more than just a supplier of random packings. We offer a wide range of trays and structured packings in addition to high performance random packings to meet customers' needs.

Superior performance by design™

RASCHIG GMBH

JAEGER PRODUCTS, INC.



For decades, Raschig has reacted to constant changes driven by Market forces and Global supply and demand. This is reflected in Raschig's mass transfer portfolio and the desire to utilize the most efficient devices, which are highlighted below.

RASCHIG JAEGER TECHNOLOGIES

A new Alliance in Mass Transfer Business.
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INDEX

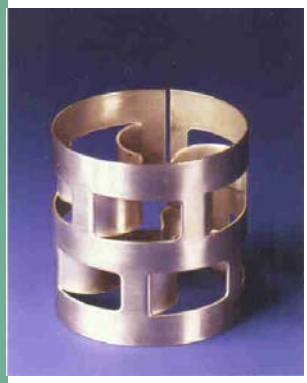
RASCHIG JAEGER TECHNOLOGIES

Metal Packings
Process Data

Raschig Super-Ring (FRI-tested)

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
0.1	715	560.000	490	96
0.3	230	180.000	315	96
0.5	275	145.000	250	97
0.6	310	74.000	215	98
0.7	240	45.500	180	98
1	220	32.000	150	98
1.5	170	13.100	120	98
2	165	9.500	100	98
3	150	4.300	80	98

Pall-Ring (FRI-tested)



Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
10x0,3	520	770.000	515	94
15x0,3	385	240.000	360	95
25x0,5	385	51.000	215	95
25x0,6	460	51.000	215	95
38x0,6	310	14.500	135	96
50x0,8	320	6.300	105	96
80x1,2	300	1.600	80	96

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Metal Packings
Process Data

Ralu-Ring

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
25x0,4	310	51.000	215	98
38x0,4	210	14.500	135	97
38x0,5	260	14.500	135	97
50x0,4	160	6.300	105	98
50x0,5	200	6.300	105	98

Raschig-Ring

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
5x5x0,3	1.000	5.000.000	1.000	87
6x6x0,3	900	4.000.000	900	89
8x8x0,3	700	1.500.000	630	91
10x10x0,3	600	770.000	500	92
10x10x0,5	920	770.000	500	89
12x12x0,3	500	450.000	430	94
12x12x0,5	820	450.000	430	90
15x15x0,3	380	230.000	350	95
15x15x0,5	600	230.000	350	92
25x25x0,5	400	50.000	220	95
25x25x0,8	600	50.000	220	92
35x35x0,8	430	19.000	150	93
50x50x0,8	320	6.500	110	95
80x80x1,2	300	1.600	65	96
100x100x1,5	300	1.450	65	94

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Metal Packings
Process Data

All of the given weights refer to the stainless steel (AISI 304) in the indicated material thickness.

Other wall thickness available upon request.

The weights for other metals are obtained by multiplication with the following factors:

Aluminium	0,35
Monel and Nickel	1,13
Copper	1,14
Brass	1,09
Titan	0,6
Hastelloy	1,3

Plastic Packings
Process Data

Raschig Super-Ring

Size	Weight kg/m³	Number pc./m ³	Surface m²/m³	Free Vol. %
0.6	62	54.000	206	93
2	55	9.000	100	96

Ralu-Flow

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
1	55	33.000	165	95
2	54	4.600	100	95

Ralu-Ring

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
15	80	170.000	320	94
25	56	36.000	190	94
38	65	13.500	150	95
50	60	6.300	110	95
90	40	1.000	75	90
125	30	800	60	97

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Plastic Packings
Process Data

Pall-Ring

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
15	110	268.640	350	88
25	75	54.600	220	91
90	50	1.240	90	94

Super-Torus-Saddle

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
1	70	36.600	240	90
2	62	5.600	110	94
3	41	1.245	90	96

Hacketten

Size	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
45	58	11250	135	94
90	48	1660	128	94

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Multiplication factors to determine the weights for the high-performance thermoplastics listed below:

Multiplication factors to determine the weights for the high-performance thermoplastics listed below:

Polyethersulfone (PES)	1,85
Polyphenylene sulfide (PPS)	1,80
Liquid crystal polymer (LCP)	1,83
Polyvinylidene fluoride (PVDF)	2,0
fluor. Ethylenpropylene (FEP)	2,40
Perfluoralkoxypolymer (PFA)	2,40
Ethylen-Chlortrifluorethylen (E-CTFE)	1,97
Ethylen-Tetrafluorethylen (E-TFE)	2,20
Polyarylether Ketone (PAEK)	1,44
Polypropylene 30 % fiberglass-reinforced	1,25
Polyethylene	1,10

Ceramic Packings and Balls

Process Data

Torus-Saddle

Size mm	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
12	700	740.000	522	73
20	660	230.000	390	74
25	630	84.000	255	74
38	620	25.000	166	75
50	580	9.300	120	77
90	580	1.800	85	79

Balls

Ball-∅ inch	Ball-∅ mm	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
1/8	3 – 5	1.400	8.000.000	620	44
1/4	6 – 7	1.400	4.750.000	420	44
3/8	9 – 10	1.400	1.140.000	390	44
1/2	12 – 13	1.400	80.000	314	45
5/8	15 – 16	1.400	330.000	210	45
3/4	19 – 20	1.350	142.000	157	45
1	25 – 26	1.250	71.000	125	45
1 1/2	35 – 38	1.250	24.000	85	48
2	50 - 52	1.300	8.500	65	45

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Ceramic Packings and Balls
Process Data

Pall-Ring

Size mm	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
25	620	39.900	220	75
35	540	16.300	165	78
50	555	5.700	120	78
80	520	1.470	80	79
100	500	750	55	81

Raschig-Ring

Size mm	Weight kg/m³	Number pc./m³	Surface m²/m³	Free Vol. %
5	900	5.121.000	1.000	56
6	800	4.800.000	940	58
8	850	1.261.000	550	65
10	900	672.000	440	65
12	820	400.000	360	67
15	700	200.000	310	70
25	600	87.700	195	73
35	570	16.400	140	76
50	555	6.300	100	77
80	535	1.470	60	77
100	500	750	44	81

Resistance table for Ceramic and hard porcelain

The data listed in this table is based on experience gained in actual operation as well as on laboratory studies. In some cases, data from the raw clay suppliers has been incorporated in the evaluations.
The figures given refer to the maximum operating temperature. No entry means "normally, no temperature influence".
This data is reliable, but it does not represent a direct or indirect guarantee for resistance under operating conditions.

Acetic acid 5%	A 120	Monoethanolamine	A
Acetic acid 95%	A 180	Nitric acid 10%	A 100
Acetone	A	Nitric acid 70%	A
Ammonia sulfate		Oleic acid	A
Aniline	A	Phenol	A 100
Benzol	A	Phosphoric acid 10%	C 120
Bromine/water	A 100	Phosphoric acid 85%	C 150
Butanol	A	Potassium carbonate 40%	A 150
Carbon tetrachloride (dry)	D	Potassium chromate (saturated solution)	A
Carbon tetrachloride (moist)	A	Potassium hydroxide 30%	C 40
Chlorine (dry)	A	Sodium carbonate 10%	A 150
Chlorine (moist)	A	Sodium chloride 10%	A
Chlorobenzol	A	Sodium hydroxide solution 5%	B 40
Chloroform	A	Sodium hydroxide solution 10%	C 40
Chloronitrous acid	A	Sodium hydroxide solution 30%	C 40
Chrome acid (20%)	A	Sodium hypochlorite + Cl_2	A 100
Citric acid	A	Sodium hypochlorite + NaOH	C 40
Diethanolamine	A	Sulfuric acid + hydrochloric acid	A 150
Ethanol	A 150	Sulfuric acid + nitric acid	A 150
Ethylene dichloride	A	Sulfuric acid 10 %	A 120
Ethylene glycol	A	Sulfuric acid 72%	A
Hydrochloric acid 10%	A 120	Sulfuric acid 98%	A
Hydrochloric acid 35%	A 120	Terpentine	A
Hydrofluoric acid 5%	D	Toluene	A
Hydrogen superoxide 30%	A	Trichloroethylene (dry)	D
Kerosine	A	Trichloroethylene (moist)	A
Methanol	A 150	Triethanolamine	A 150
Methyl ethylene ketone	A	Water	A
Monochlorobenzol	A		

A = no noticeable effect
B = slight effect
C = noticeable effect – limited service life
D = strong effect – not resistant

Structured Packings
Process Data

Raschig Super-Pak

Size	Style	Surface m^2/m^3	Free Vol. %
100	Y	100	98
150	Y	150	98
200	Y	200	98
250	Y	250	98
300	Y	300	98
350	Y	350	97
400	Y	400	97
500	Y	500	96
750	Y	750	96

Raschig-Pak

Size	Style			Surface m^2/m^3	Free Vol. %
125	X	Y	-	125	98
200	X	Y	-	200	98
250	X	Y	HC	250	98
300	X	Y	-	300	98
350	X	Y	HC	350	97
500 Gauge		-	-	500	95

Further sizes are available on request.

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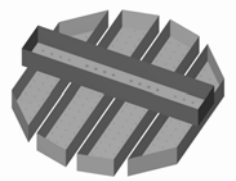
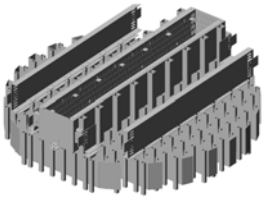
Internals

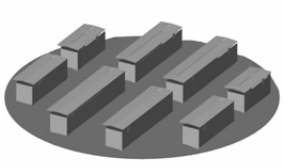
For optimum performance, proper liquid and vapour distribution are of critical importance. To complement the random and structured packings are a wide range of internals such as high quality liquid distributors besides the standard type, support plates, hold-down plates, gas/vapour distributors, liquid collectors and gas/liquid flash devices.



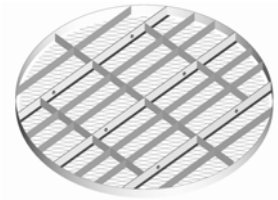
Liquid Distributor



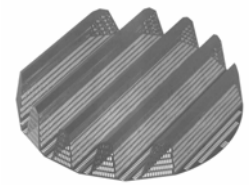
Liquid Distributor



Liquid Collector



Hold-down Plate



Packing Support Plate

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The Importance of Internals in Packed Columns

Nowadays, the ever-increasing efforts to achieve a process with optimal chemical engineering characteristics demand modern mass-transfer columns, i.e. high mass-transfer efficiency but a minimal energy requirement. These demands can only be met by the use of modern packed beds if the internals in the 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 on mass transfer efficiency of uniform distribution over the column cross-section.

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.

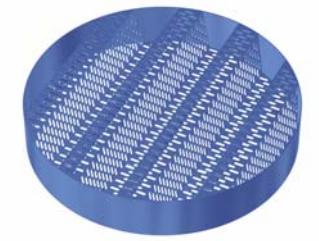
Furthermore, there have been cases in which the tower packings have been damaged or even swept away due to the absence of a hold-down plate. The costs arising from the resultant malfunction in the downstream plant installations due to this damage are generally higher than the price of a hold-down plate.

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. 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.

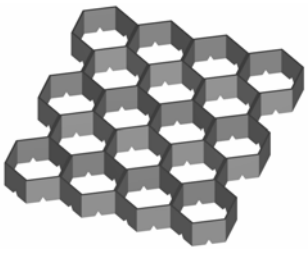
Support Plates in Metal and Plastic

Multibeam Support Plate
Type SP1
∅ > 1200 mm
for metal and plastic packings

Multibeam Support Plate
Type SP2 and SP3
100 mm < ∅ < 1200 mm
for metal and plastic packings



Hexa-Grid Support Plate
Type SP-HG
∅ < 500 mm
for metal and plastic packings
for fouling services



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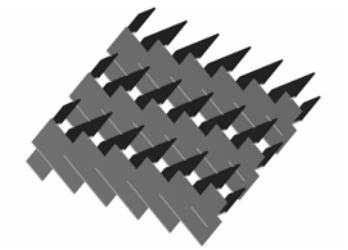
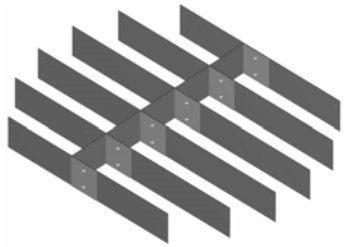
Support Plates in Metal and Plastic

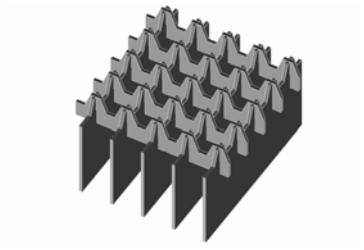
Cross-Flow-Grid Support Plate
Type SP-CF
∅ > 500 mm
for metal and plastic packings
for fouling services and
enhanced gas distribution



Flat Bar Plate
Type SP-P
∅ > 500 mm
for structured packings



Raschig-Super Grid Support Plate
Type RSG in plastic
∅ > 500 mm
for plastic packings



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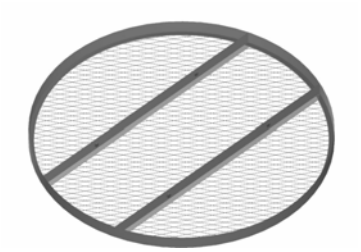
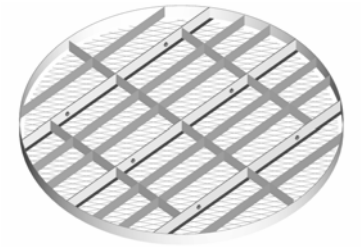
Hold-down Plates in Metal and Plastic

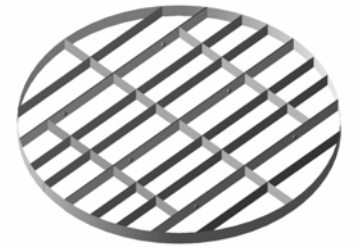
Hold-down Plate
Type HP1
∅ > 300 mm
for metal and plastic packings



Hold-down Plate
Type HP2
∅ > 300 mm
for ceramic packings



Hold-down Plate
Type HP-P
∅ > 300 mm
for structured packings



Hold-down Plate Raschig Grid
Type RG in plastic
∅ > 300 mm
Fot plastic packings

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Liquid Distributors and Redistributors in Metal and Plastic

Standard liquid distributors can be used in a liquid load range above 5 $m^3/m^2/h$. 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.

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

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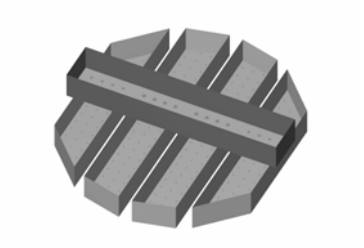
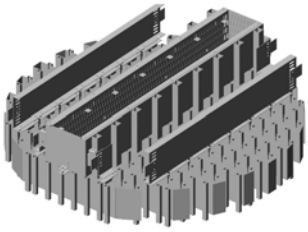
Liquid Distributors and Redistributors in Metal and Plastic

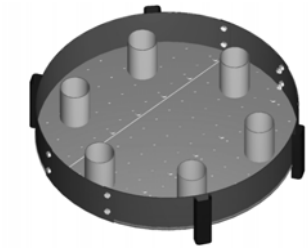
Trough Distributor
Type DT 1
∅ > 800 mm



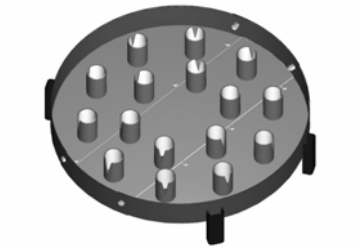
Trough Distributor
Type DT 2
∅ > 1200 mm
for fouling service



Distributor with Gas Risers
Type DR 2
150 mm < ∅ < 1200 mm



Distributor with Gas Risers
Type DR 3
150 mm < ∅ < 1200 mm
for fouling service



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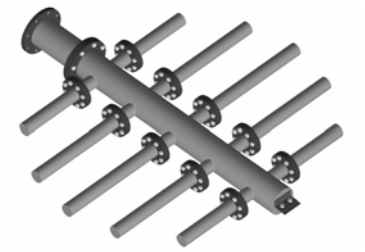
Liquid Distributors and Redistributors in Metal and Plastic

Pipe Liquid Distributor

Type DP 1

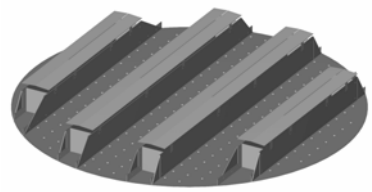
∅ > 100 mm



Liquid Redistributor

Type RP 1

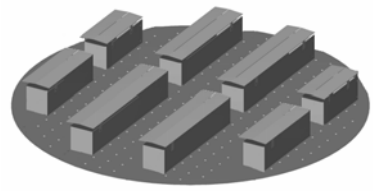
∅ > 1200 mm



Liquid Redistributor

Type RP 2

∅ > 300 mm



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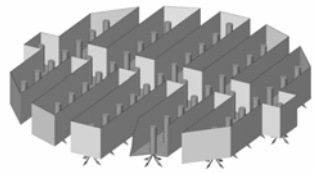
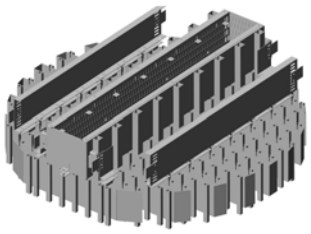
Definition of High quality Liquid Distributors

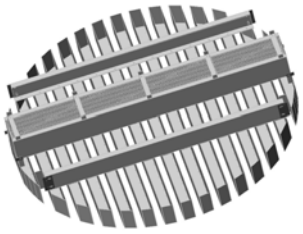
High quality Liquid Distributor
Type Multi-Flow DT-MF
∅ > 500 mm
for very low liquid rates



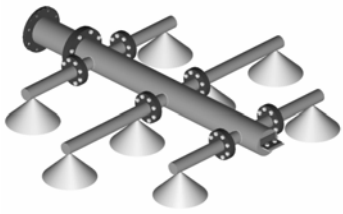
High quality Liquid Distributor
System Distributor DT-S
∅ > 300 mm
for low to medium liquid rates



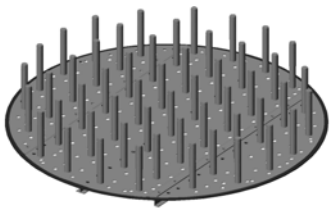
High quality Liquid Distributor
Type Multi-Channel DT-W
Ø > 300 mm
For medium liquid rates



Spray Distributor
Type DP-S
∅ > 500 mm



High quality Liquid Redistributor
Type RP-P2
∅ > 300mm
Redistributor for extreme low gas flow rates
(Fv < 0,1 Pa^0,5) beside high liquid rates
(uL > 100 m3/m2h)



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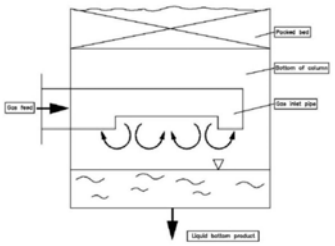
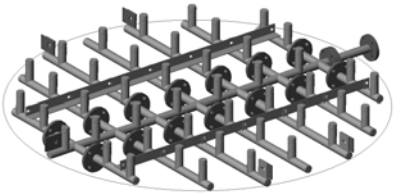
Gas / Vapor Distributor in Metal and Plastic

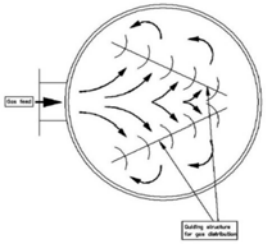
Gas Distributor
Type GV 1
∅ > 800 mm



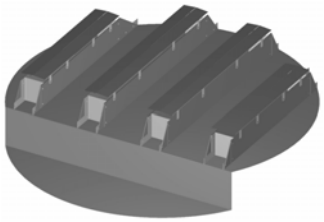
Gas Distributor
Type GV-P1
∅ > 300 mm
for extreme low gas flow rates (Fv < 0,1 Pa^0,5)
beside high liquid rates (uL > 100 m3/m2h)



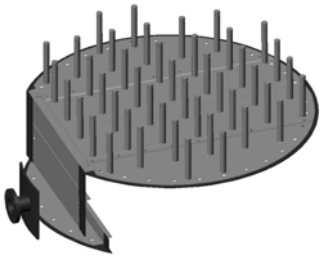
Gas Distributor
Type GV 2
∅ > 500 mm



Gas Distributor
Type GV 3
∅ > 800 mm



Gas Distributor
Type GV-P3
Ø > 800mm
for extreme low gas flow rates (Fv < 0,1 Pa^0,5)
beside high liquid rates (uL > 100 m3/m2h)



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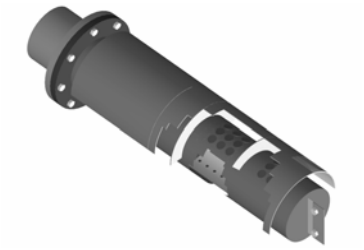
Gas-liquid Phase Separators in Metal and Plastic

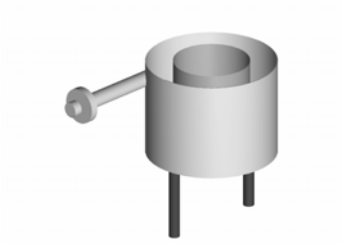
Two-phase Double-shell Flashbox

Type FB 1



Two-phase Centrifugal Flashbox

Type FB 2



Two-phase Flash Gallery

Type FB 3

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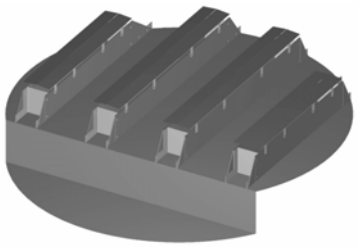
Liquid Collectors in Metal and Plastic

Liquid Collector

Type CP 1

∅ > 1200 mm



Liquid Collector

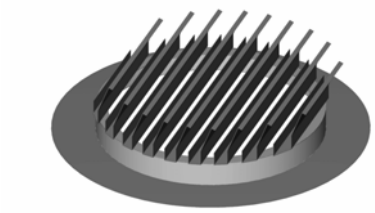
Type CP 2

∅ > 1200 mm

Liquid Collector

Type CV 1

∅ > 800 mm



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Tray Technology

Sieve trays

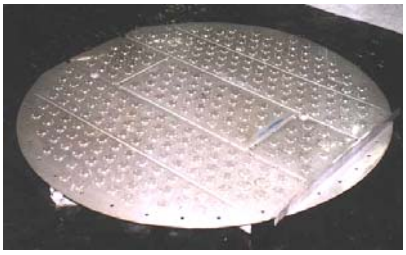
Sieve trays are flat perforated plates in which vapour is forced through the holes into the cross flowing liquid. Vapour flow prevents liquid from leaking (weeping) through the holes. At low vapour velocities, liquid weeping through the holes occurs, which bypasses a portion of the tray active area and reduces efficiency, giving sieve trays relatively low turndown (approx. 2-2.5:1).

Raschig has the capability to design and manufacture virtually any type of sieve tray. Tray hole sizes down to 3.2 mm in diameter are offered.

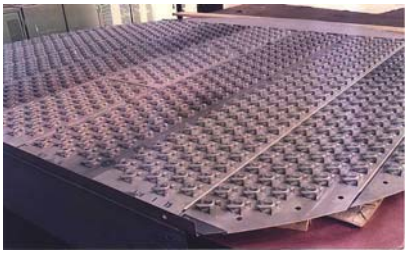
Valve Trays

Valve trays are essentially flat perforated trays with moveable or fixed valve units with or without a cage structure covering the holes. Moveable valves are disk-shaped type devices which are enclosed within a cage structure or contain legs formed out of the valve disk. Fixed valves are units with integral legs formed out of the tray deck.

Raschig can offer several different valve units according to the application



Tray with Moveable Valves



Tray with Caged Valves

Tray with Fixed Valves

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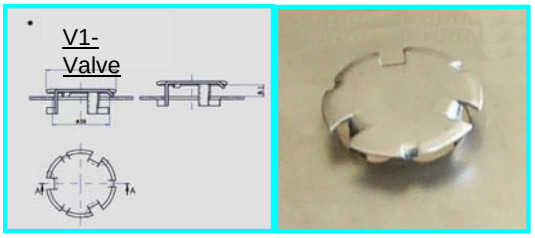
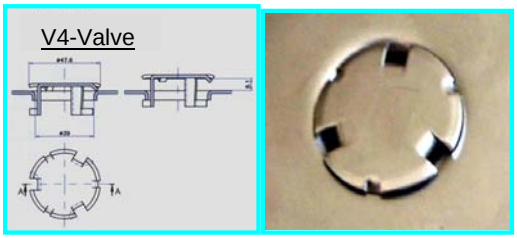
RJ-V1 Moveable Float Valve

The valve unit contains anti-stick features with spacer tabs extending from the valve disk. The RJ-V1 also has anti-rotating features in that the tray orifices each have an extension from the tray floor. Flush seating and multiple weighted valves are optional.



RJ-V4 Moveable Float Valve

The RJ-V4 valve is a low pressure drop general purpose unit in that the tray deck consists of a venturi-shaped orifice rather than a sharp-edge orifice. The RJ-V1 is used as the moveable float valve unit. It has the same restrictive legs bent downwards from the disk and anti-stick spacers. If desirable, flush seat and multiple weighted RJ-V4 valves are available.



RJ-V0 Fixed Valve

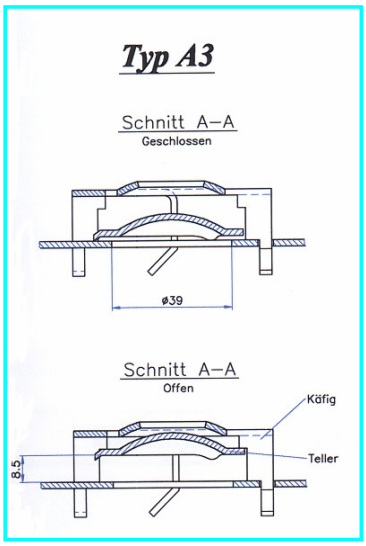
The RJ-V0 valve is a fixed unit punched out of the tray deck at a fixed vertical curtain distance. The main advantage of fixed valves is that the vapour flow creates a sweeping action along the tray floor which eliminates deposits of solid salts, and is therefore desirable for fouling applications. Also the RJ-V0 has no moving parts which makes it suitable for corrosive media.

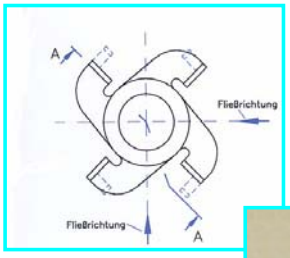
RJ-V6 Bubble Cap / Valve

The RJ-V6 is a hybrid between a bubble cap and valve tray. The advantage of this hybrid bubble cap / valve type is that a minimum liquid head can be maintained on the tray even at very low liquid and vapour rates. Consequently it has a greater operating range than the moveable float valve tray.

RJ-A3 Caged Float Valve

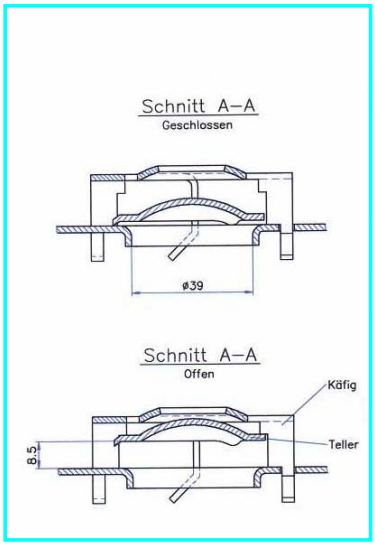
The RJ-A3 is a two-piece valve unit to maximize vapour rate flexibility. It comprises of a moveable light weight valve disk which is enclosed in an open orifice cage structure with four legs that are attached firmly to the tray floor.

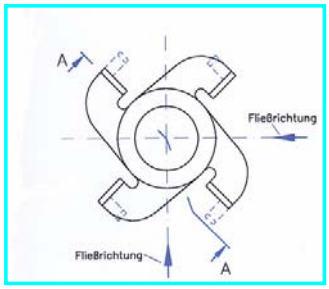




RJ-A6 Caged Float Valve

This valve type is the same as the RJ-A3 caged float valve except that the tray deck consists of a venturi-shaped orifice rather than a sharp-edge orifice. The venturi opening offers lower vapour rate flexibility due to the lower pressure drop.





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Bubble Cap Trays

Bubble cap trays consist of a flat perforated deck in which the holes are enclosed with vapour or gas chimney risers and caps in the form of inverted cups mounted on top of the risers. This gives the bubble cap tray the advantage to operate at extremely low liquid and vapour rates.

Dualflow Trays

Dualflow trays are essentially sieve trays without downcomers such that the entire tray active area is perforated with holes. Hole sizes range between 12.5 to 25 mm in diameter. Tray action occurs through the continuous countercurrent passage of vapour and liquid through the tray holes. High open hole area dualflow trays have a higher capacity and lower pressure drop compared to conventional distillation trays
at the same tray spacing and are best suited for processing fluids that form polymers or have a high solids content.

Side-to-Side Baffle Trays and Disc & Donut Trays

These two tray types are located inside a column in such a manor that the liquid and vapour are brought in to direct contact by forcing vapour through falling liquid. Tray panels are flat or slightly inclined decks that occupy 40-60 % of the column cross-sectional area. At a given tray spacing, both tray types offer a higher capacity and lower pressure drop compared with conventional sieve and valve trays.The trade-off is a considerably lower contacting efficiency.With both baffle trays and disc & donut trays having an extremely high open area, they are most suitable for dirty service and heavy fouling applications..

Comparison of Common Conventional Tray Types

TRAY TYPE	BUBBLE CAP	DUALFLOW	SIEVE	VALVE (Moving / Non-Moving)
Capacity	Moderate	Very High	High	High to very high
Pressure Drop	High	Low to Moderate	Low to Moderate	Moderate. Older designs were somewhat higher.Recent designs same as sieve trays.
Efficiency	Moderate (0.6 – 0.8)*	Lower compared to others (0.5 – 0.7)*	High (0.7 – 0.9)*	High (0.7 – 0.9)*
Turndown	Very high Can handle very low liquid rates	Low. Not suitable for varying loads	Approx. 2:1. Unsuitable for varying loads operation	Approx. 3-5:1 Higher turndown designs can be provided on request.
Maintenance	Relatively high	Low	Low	Low to moderate
Fouling Tendency	High. Tends to accummulate solid particles	Extremely low. Best choice for Severe fouling	Low	Low to moderate
Main Application	Very low flow conditions Where leakage needs to be minimized	Capacity Revamps Where efficiency and Turndown not Critical High fouling and corrosive services.	Most columns where Turndown not important	Most Columns Services where turndown important
Cost	High - approx. 2-3 times that for sieve trays	Low	Low	Marginally higher than sieve trays

* Within optimum operating range.

RASCHIG JAEGER TECHNOLOGIES

Locations / production sites

Ludwigshafen and Espenhain, Germany
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El Dorado, Kansas
Monterrey, Mexico

Furthermore we cooperate with reliable partners all over the world

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