Raschig Super-Ring®

Product Bulletin 250

The development of the new „Raschig Super-Ring®" packing element sets new standards in the field of separation technology, as the designers of the Raschig Super-Ring have succeeded in finding an optimum link to those demands which a modern, high-performance packing element must fulfil under industrial conditions.

Superior performance by design™

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Raschig Super-Ring®

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Raschig Super-Ring®

Aspects involved in the design of modern packing elements

Packing elements are successfully used in the chemical industry and related sectors, as well as in environmental protection installations, i.e. in absorption, desorption, extraction and rectification columns. The manifold process engineering demands on modern packing elements are determined by these thermal separation processes.

High-performance packing elements are intended to bring about effective mass transfer between the phases flowing through the columns. Large interfacial area and uniform distribution of the phases over the column cross-section are desirable. A high loading capacity permits high column throughputs, while low pressure drop results in low operating costs.

Loading capacity

Counter-current packed columns are preferably operated below, or in the immediate vicinity, of the so-called loading point, this being characterised by the fact that the falling film is backed up by the counter-current gas stream at higher loads. The loading point of a packing element is defined by its fluid dynamic properties. Fluid dynamic studies in the past have repeatedly shown that the droplets forming in a column packing are entrained earlier than down-ward flowing liquid films at high gas loads. In contrast to previous packing element designs, the Raschig Super-Ring® meets this demand in that it was purposely designed without any projecting metal tongues which could act as dripping points.

Liquid and gas distribution

The most uniform possible distribution of the liquid and gas phase across the packing element itself and the entire column cross-section is one of the fundamental prerequisites for a column packing that works effectively. If, at the same time, a low resistance to fluid flow of the gas phase is to ensure the minimum possible pressure drop, the structure must be largely open. The alternating wave structure of the Raschig Super-Ring® has not only created a form which is open on all sides but, at the same time, has also realised a large number of contact points for homogeneous liquid and gas distribution.

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Mass transfer

Effective mass transfer between the phases demands not only a large interfacial area, but also the most turbulent possible flow conditions and frequent renewal of the phase interfaces. With the Raschig Super-Ring®, several thin films of liquid displaying turbulent flow are formed on the sinusoidal webs and are constantly intermixed as the result of the recurrent contact points within the packing element.

Performance data of the Raschig Super-Ring®

Experimental studies have confirmed the relationships described above. The following Figures show the pressure drop of the Raschig Super-Ring® as a function of the gas capacity factor at various liquid loads. As a result of a very open structure of the Raschig Super-Ring®, the pressure drop of the dry packing is already lower than that of a 50 mm metal Pall ring. The differences increases at higher liquid loads. The Raschig Super-Ring® generates also a substantially lower pressure drop than other high-performance packing elements made of metal with a nominal size of 50 mm.

The loading capacity of the Raschig Super-Ring® can also been seen from the following Figures. The Raschig Super-Ring® not only has a higher loading capacity than the 50 mm metal Pall ring, but also displays a substantially higher loading capacity than previous modern packing element designs.

The Figures show also the results of trials involving the absorption of ammonia from air in water. The separation efficiency of this new packing element is thus up to 14% better than that of a 50 mm metal Pall ring or previous high-performance metal packing elements.

Furthermore, the low specific packing weight of the Raschig Super-Ring® allows the design of low-cost supporting elements in the columns. The Raschig Super-Ring® is also lighter than other packing element designs, but without sacrificing stability. Experimental studies have shown that packing heights of 15 m and more can be realised owing to the alternating wave frequency and amplitude of the metal webs of the Raschig Super-Ring®.

The alternating wave structure additionally prevents entanglement of the packing element within the packing, thus guaranteeing problem-free assembly and dismantling in a column. Owing to its open structure, the Raschig Super-Ring® is also suitable for liquids contaminated with solids. Table 1 shows the technical data of the Raschig Super-Ring®.

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The alternating wave structure additionally prevents entanglement of the packing element within the packing, thus guaranteeing problem-free assembly and dismantling in a column. Owing to its open structure, the Raschig Super-Ring® is also suitable for liquids contaminated with solids. Table 1 shows the technical data of the Raschig Super-Ring®.

Technical data of the Raschig Super-Ring® in metal:

Size	Material	Surface m^2/m^3	Free Vol. %
0.1	Metal	450	95
0.3	Metal	315	96
0.5	Metal	250	97
0.6	Metal	215	98
0.7	Metal	180	98
1	Metal	150	98
1.5	Metal	120	98
2	Metal	100	98
3	Metal	80	98
4	Metal	70	98

Technical data of the Raschig Super-Ring® in plastics:

Size	Material	Surface m^2/m^3	Free Vol. %
0.3	Plastic	325	92
0.6	Plastic	205	93
2	Plastic	100	96
3	Plastic	75	97

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Compensation for the "decrease in volume"

for dumped Packings

The values indicated in the tables for dumped packings are valid for a diameter ratio of the vessel to the packing size of D/d = 20.

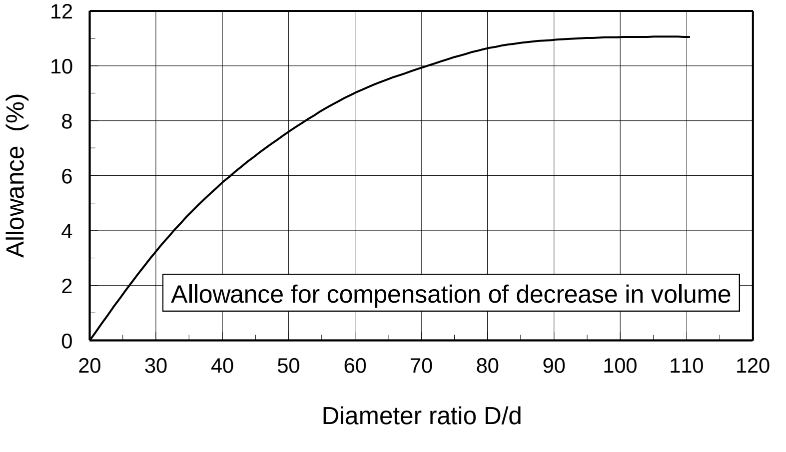
Since the arrangement of the packings is less compact near the vessel wall than in the interior of the bed, the number of packings per cubic meter increases with the diameter ratio.

The above diagram shows by which "allowance" the theoretically calculated vessel volume for diameter ratios of more than 20 must be increased in order to completely fill the space required.

If the plastic or metal packings are, for instance, thrown into the column, this may result in a further decrease in volume due to abnormally compact packing.

D = diameter of the vessel to be filled

d = diameter or nominal size of the packings

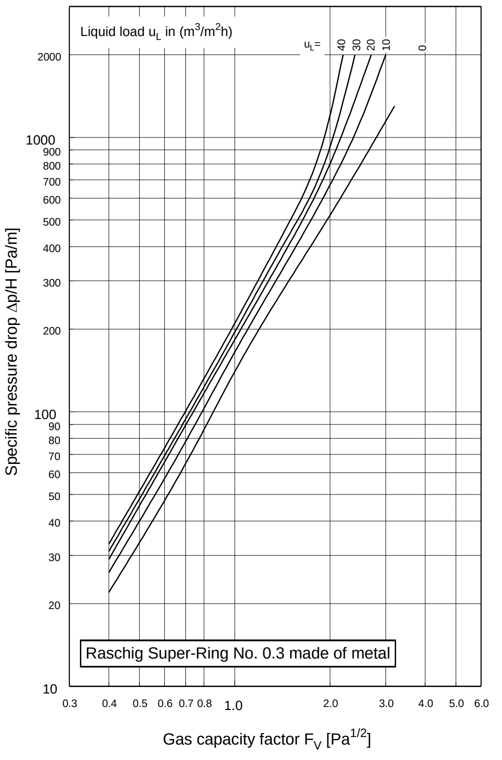


Pressure drop of metal RASCHIG SUPER-RING®

system: air/water

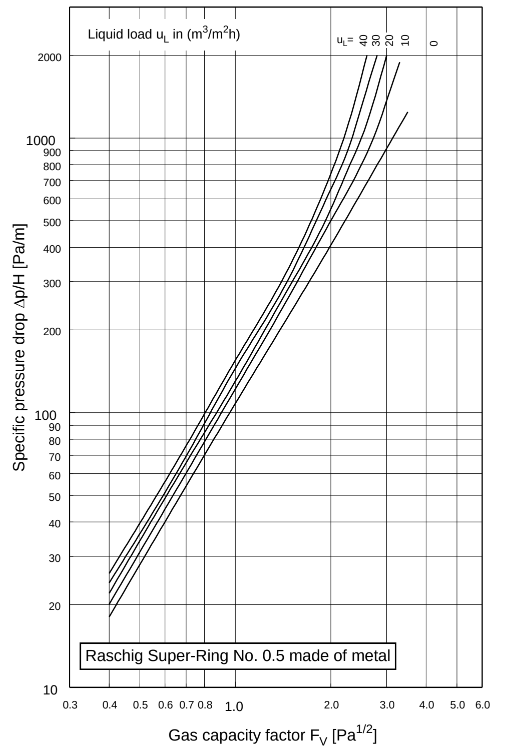
RASCHIG SUPER-RING® #0.3

Column diameter: 0.288 m
Packing height: 1.0 m



RASCHIG SUPER-RING® #0.5

Column diameter: 0.288 m
Packing height: 1.0 m



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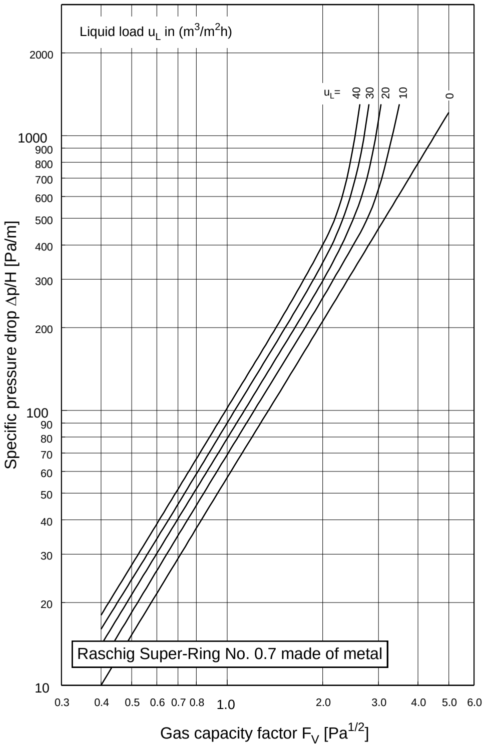
Pressure drop of metal RASCHIG SUPER-RING®

system: air/water

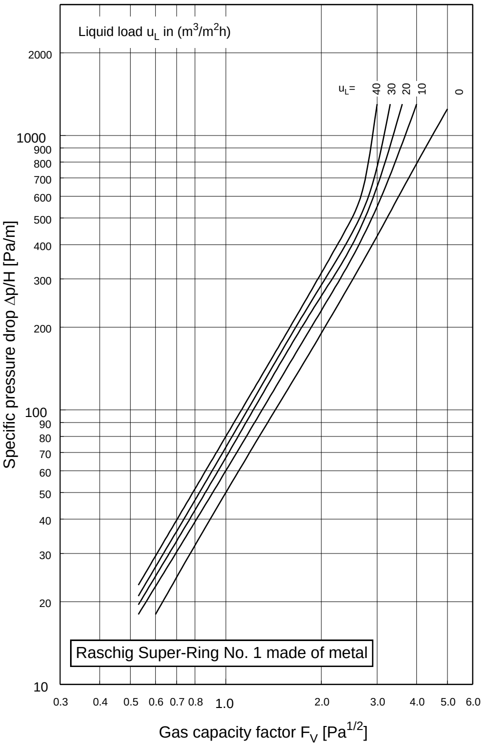
RASCHIG SUPER-RING® #0.7

Column diameter: 0.288 m
Packing height: 2.0 m



RASCHIG SUPER-RING® #1

Column diameter: 0.288 m
Packing height: 2.0 m

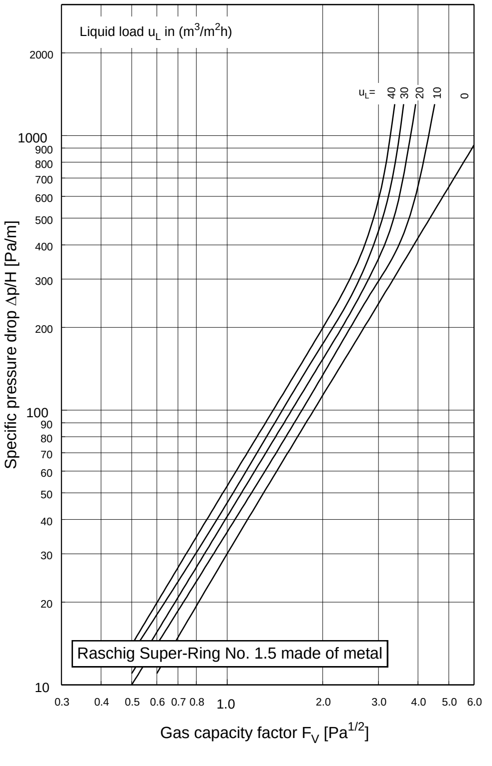


Pressure drop of metal RASCHIG SUPER-RING®

system: air/water

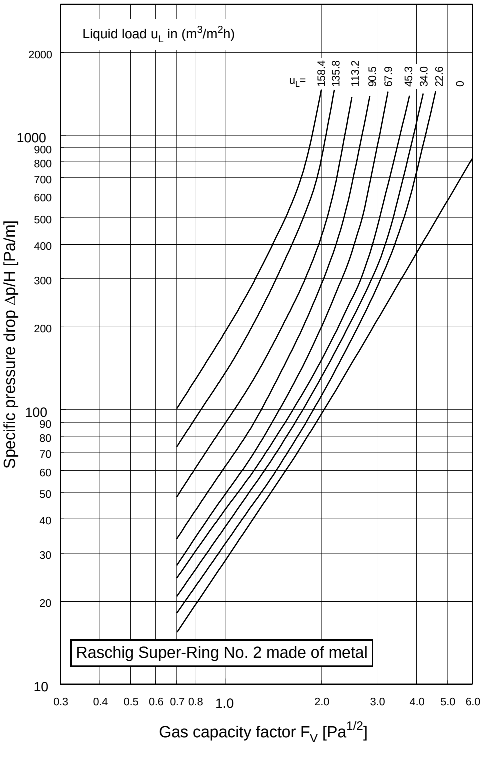
RASCHIG SUPER-RING® #1.5

Column diameter: 0.288 m
Packing height: 2.0 m



RASCHIG SUPER-RING® #2

Column diameter: 0.75 m
Packing height: 3.0 m

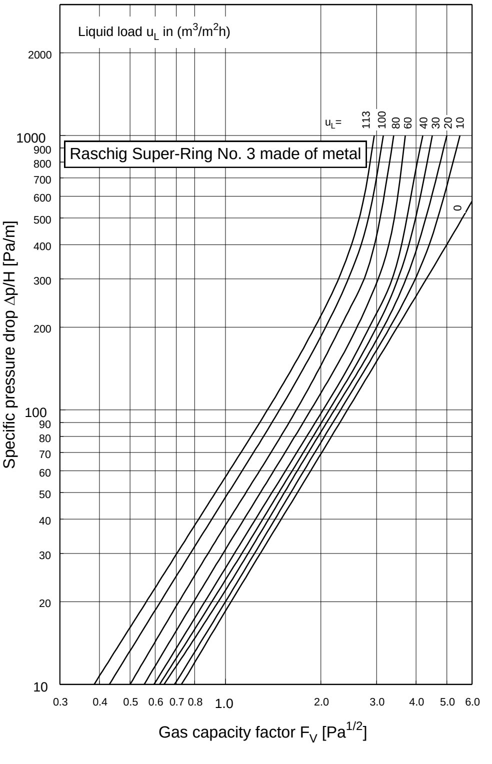


Pressure drop of metal and plastic RASCHIG SUPER-RING®

system: air/water

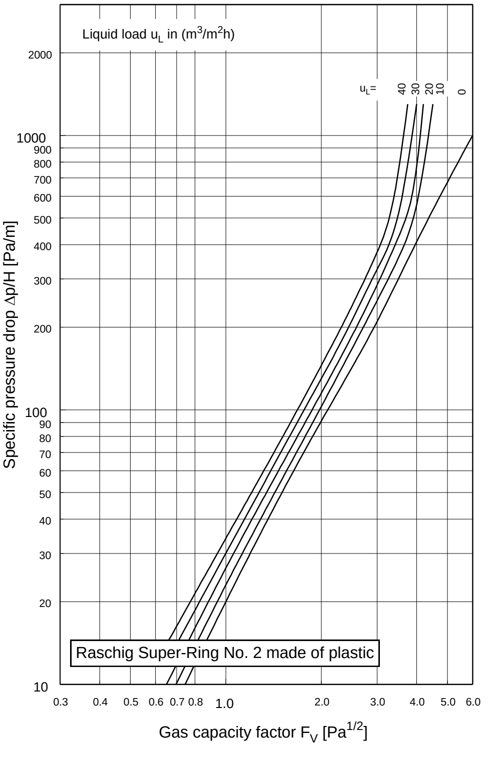
RASCHIG SUPER-RING® #3

Column diameter: 0.440 m
Packing height: 2.0 m



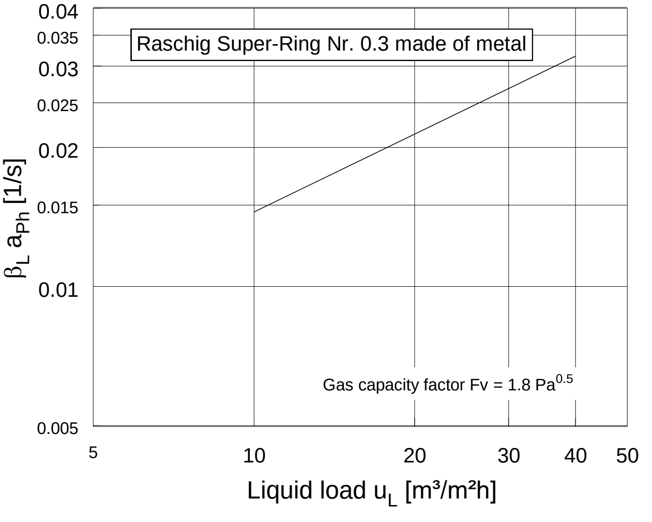
RASCHIG SUPER-RING® #2

Column diameter: 0.288 m
Packing height: 2.0 m



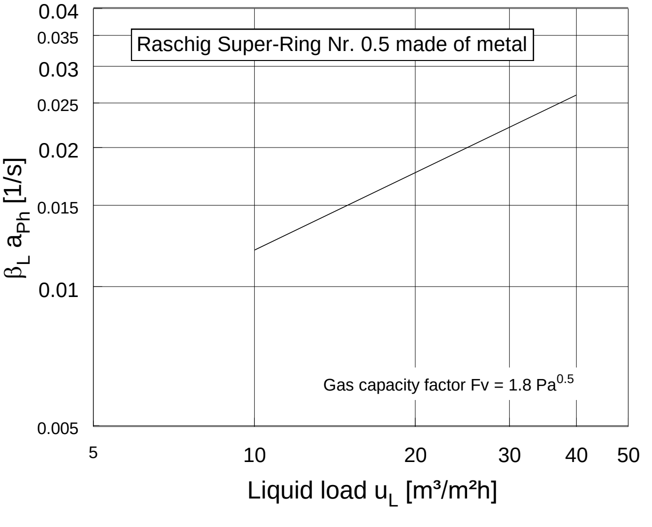
Transfer efficiency of metal RASCHIG SUPER-RING®

in the desorption of CO2 from water into an atmospheric air-stream



RASCHIG SUPER-RING® #0.3

Column diameter: 0.288 m
Packing height: 1.0 m

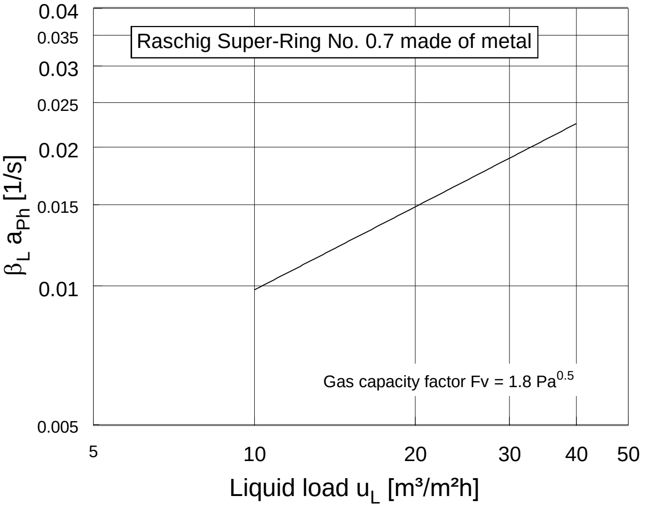


RASCHIG SUPER-RING® #0.5

Column diameter: 0.288 m
Packing height: 1.0 m

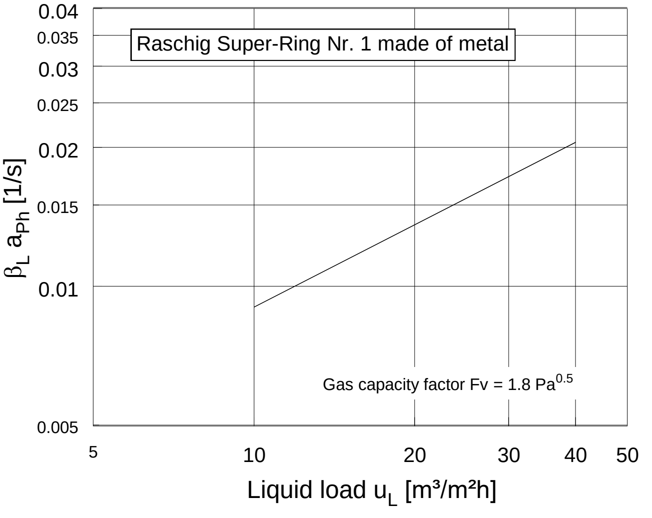
RASCHIG

Transfer efficiency of metal RASCHIG SUPER-RING®
in the desorption of CO2 from water into an atmospheric air-stream



RASCHIG SUPER-RING® #0.7

Column diameter: 0.288 m
Packing height: 2.0 m



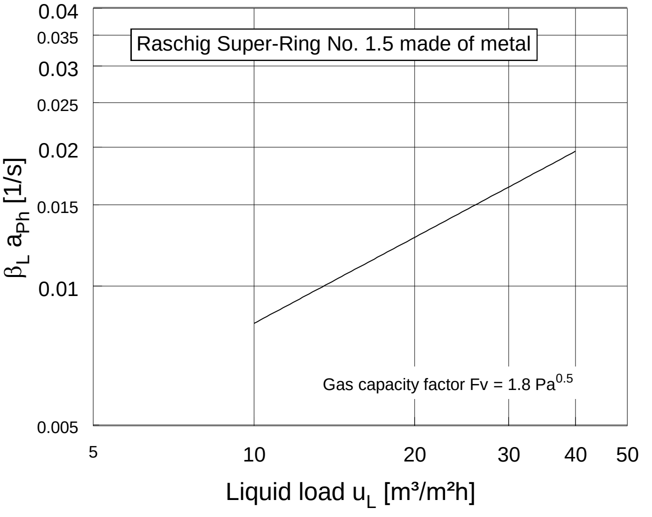
RASCHIG SUPER-RING® #1

Column diameter: 0.288 m
Packing height: 2.0 m

RASCHIG

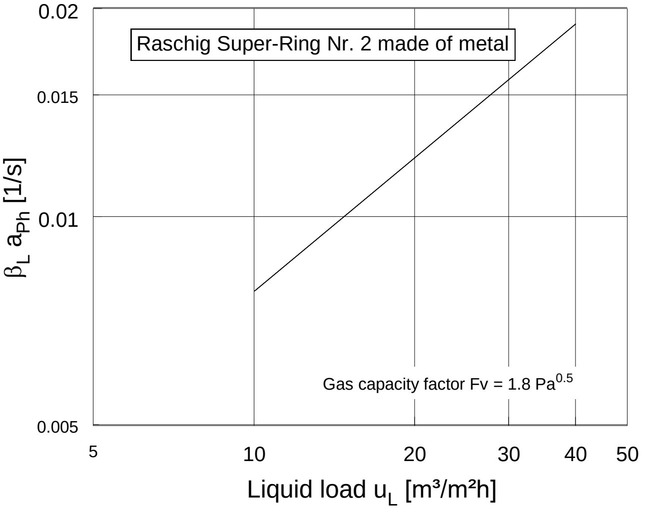
Transfer efficiency of metal RASCHIG SUPER-RING®

in the desorption of CO_2 from water into an atmospheric air-stream



RASCHIG SUPER-RING® #1.5

Column diameter: 0.288 m
Packing height: 2.0 m



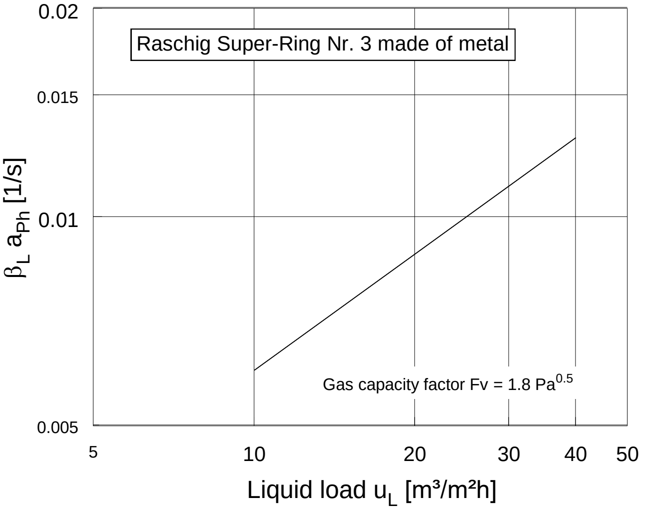
RASCHIG SUPER-RING® #2

Column diameter: 0.288 m
Packing height: 2.0 m

RASCHIG

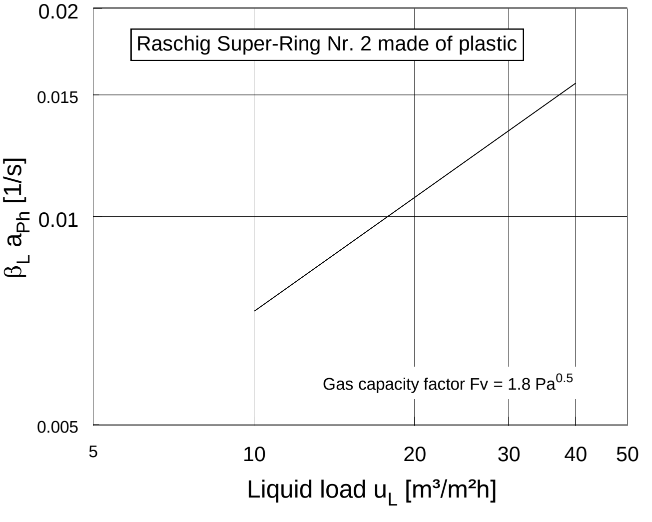
Transfer efficiency of metal and plastic RASCHIG SUPER-RING®

in the desorption of CO2 from water into an atmospheric air-stream



RASCHIG SUPER-RING® #3

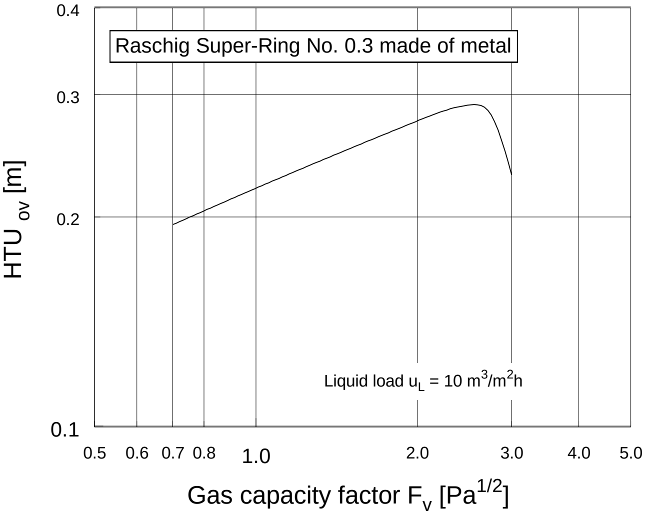
Column diameter: 0.288 m
Packing height: 1.0 m



RASCHIG SUPER-RING® #2

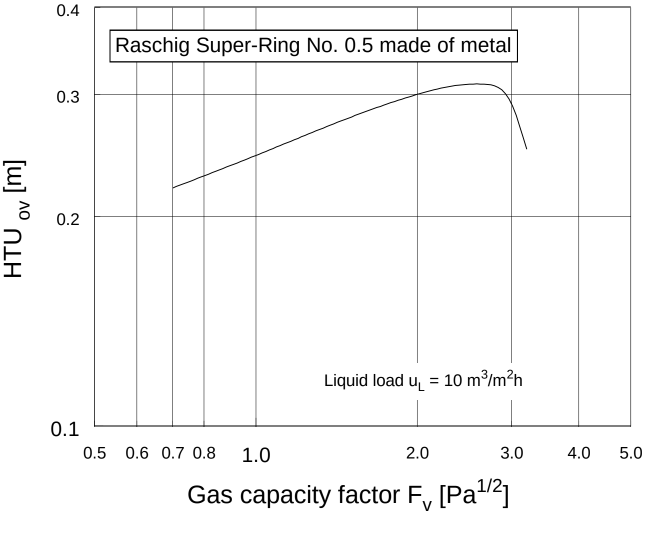
Column diameter: 0.288 m
Packing height: 2.0 m

Height of a transfer unit HTU_{ov} for metal
RASCHIG SUPER-RING®
for the absorption of NH_3 from air in water in the gaseous phase



RASCHIG SUPER-RING® #0.3

Column diameter: 0.288 m
Packing height: 1.0 m

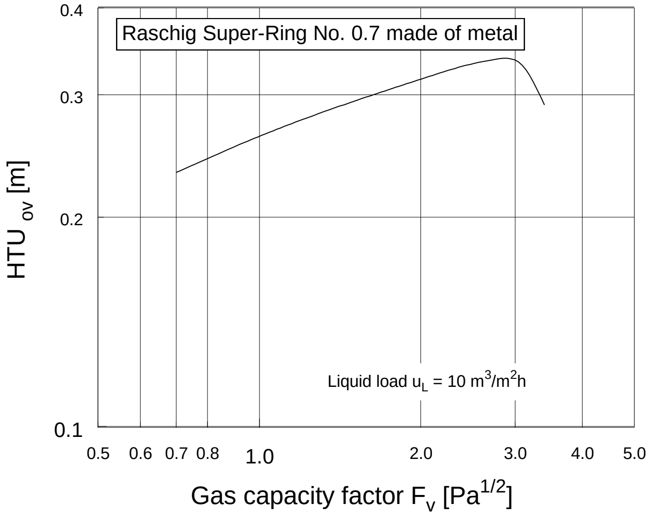


RASCHIG SUPER-RING® #0.5

Column diameter: 0.288 m
Packing height: 1.0 m

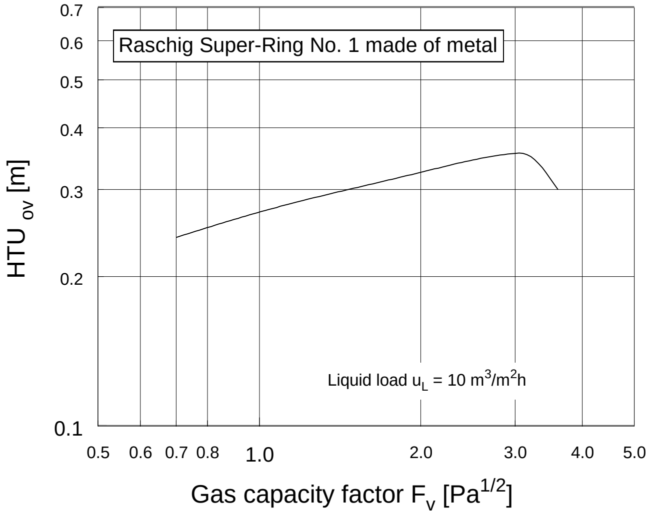
Height of a transfer unit HTU_{ov} for metal RASCHIG SUPER-RING®

for the absorption of NH_3 from air in water in the gaseous phase



RASCHIG SUPER-RING® #0.7

Column diameter: 0.288 m
Packing height: 2.0 m



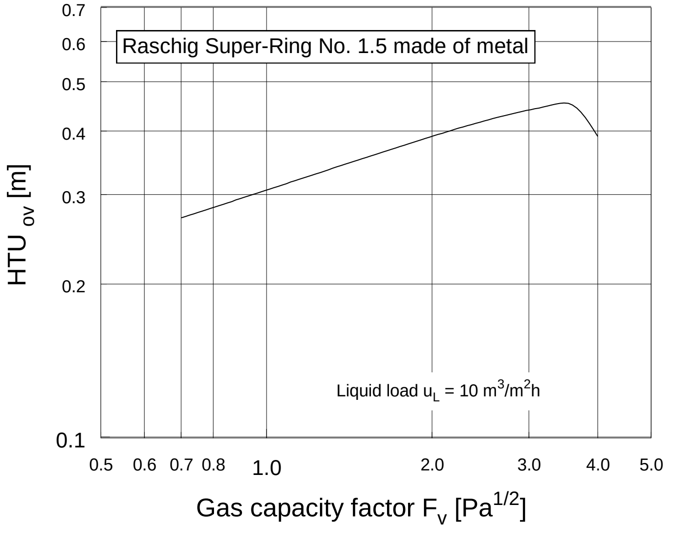
RASCHIG SUPER-RING® #1

Column diameter: 0.288 m
Packing height: 2.0 m

RASCHIG

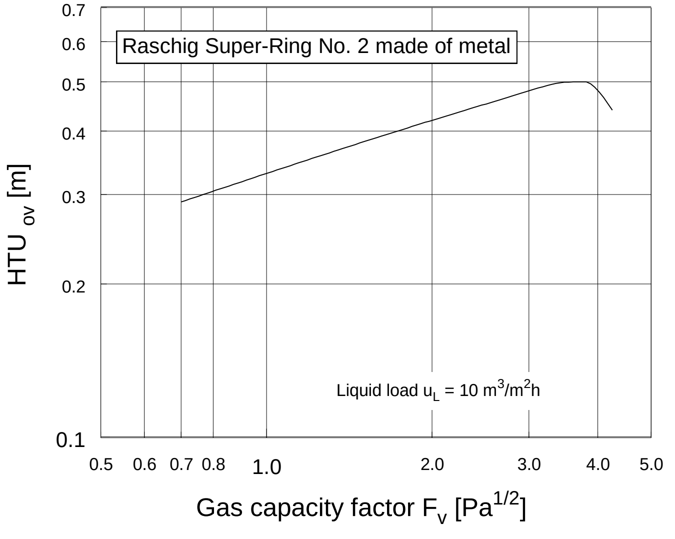
Height of a transfer unit HTU_{ov} for metal RASCHIG SUPER-RING®

for the absorption of NH_3 from air in water in the gaseous phase



RASCHIG SUPER-RING® #1.5

Column diameter: 0.288 m
Packing height: 2.0 m



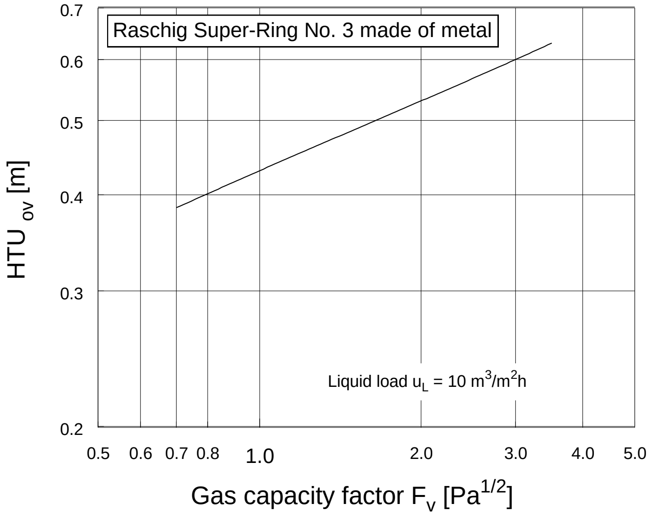
RASCHIG SUPER-RING® #2

Column diameter: 0.288 m
Packing height: 2.0 m

RASCHIG

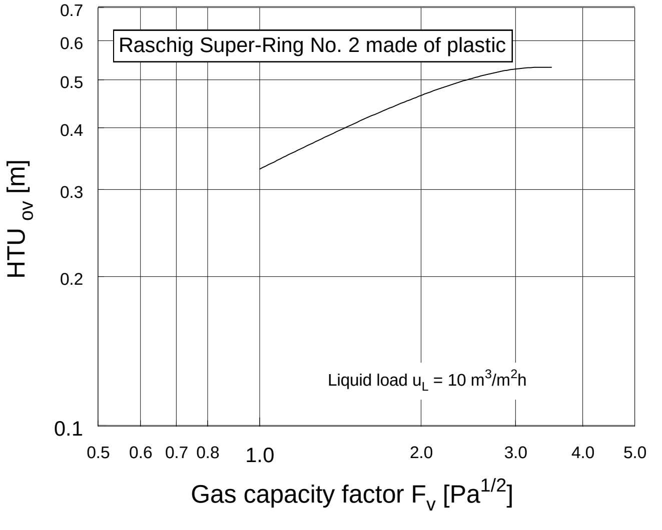
Height of a transfer unit HTU_{ov} for metal and plastic RASCHIG SUPER-RING®

for the absorption of NH_3 from air in water in the gaseous phase



RASCHIG SUPER-RING® #3

Column diameter: 0.288 m
Packing height: 2.0 m



RASCHIG SUPER-RING® #2

Column diameter: 0.288 m
Packing height: 2.0 m

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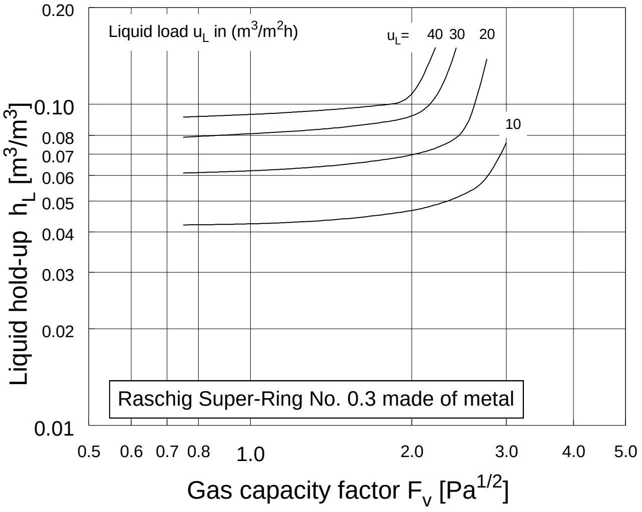
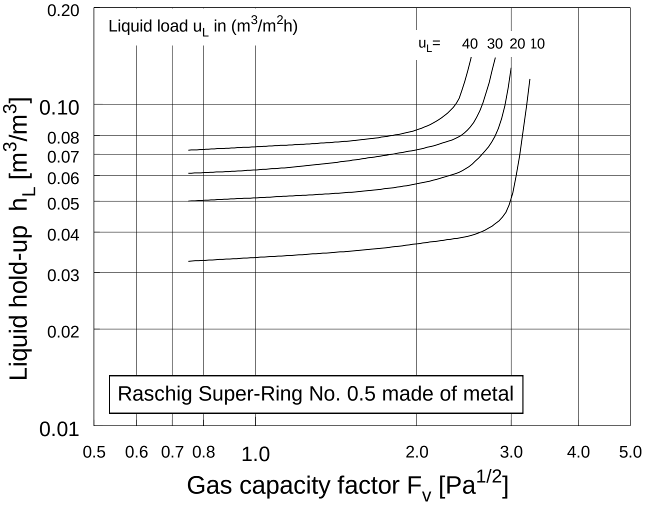
Liquid hold-up in columns with metal RASCHIG SUPER-RING®

system: air/water



RASCHIG SUPER-RING® #0.3

Column diameter: 0.288 m
Packing height: 1.0 m

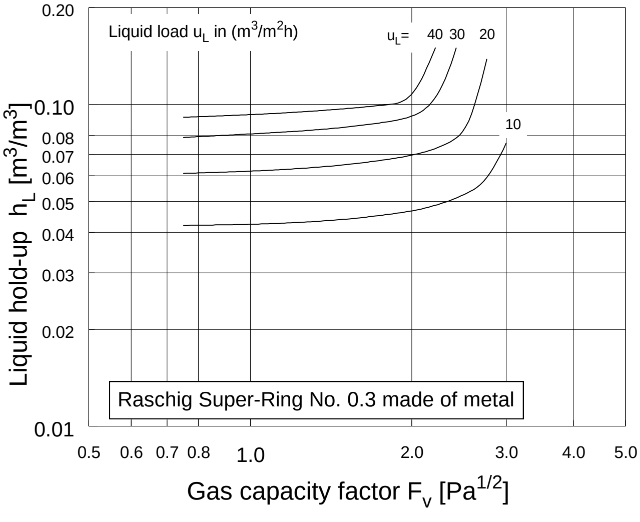


RASCHIG SUPER-RING® #0.5

Column diameter: 0.288 m
Packing height: 1.0 m

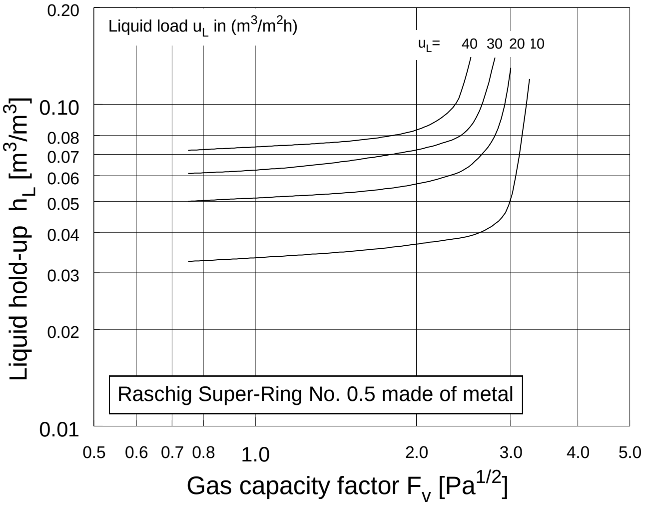
Liquid hold-up in columns with metal RASCHIG SUPER-RING®

system: air/water



RASCHIG SUPER-RING® #0.3

Column diameter: 0.288 m
Packing height: 1.0 m

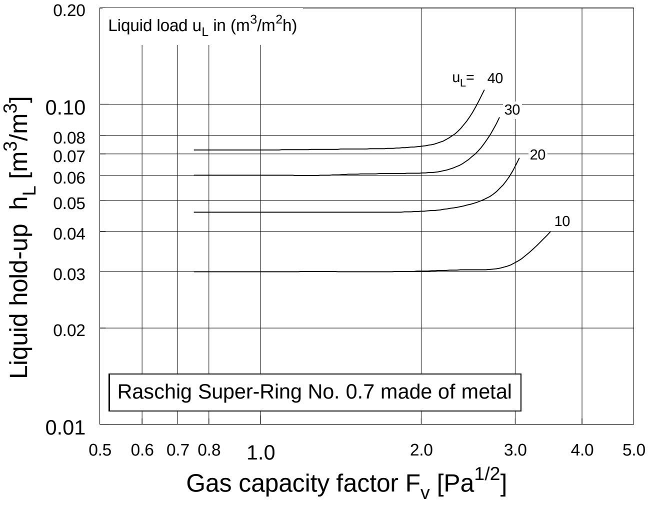


RASCHIG SUPER-RING® #0.5

Column diameter: 0.288 m
Packing height: 1.0 m

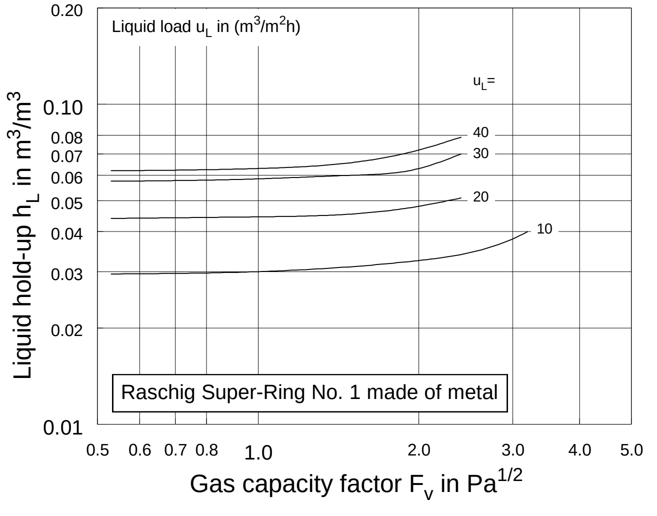
Liquid hold-up in columns with metal RASCHIG SUPER-RING®

system: air/water



RASCHIG SUPER-RING® #0.7

Column diameter: 0.288 m
Packing height: 2.0 m

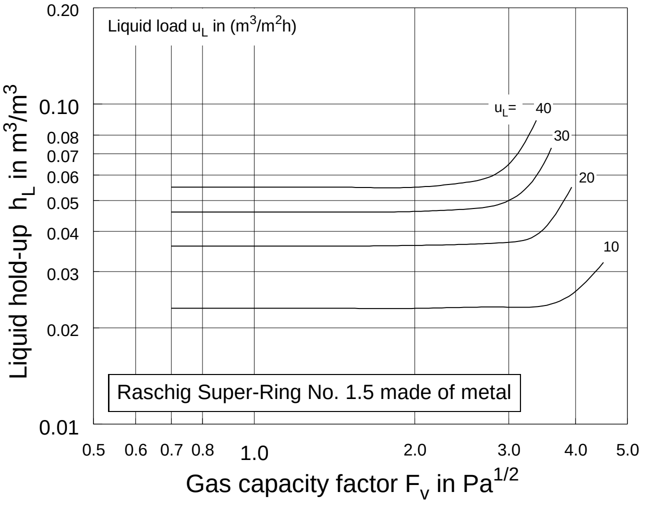


RASCHIG SUPER-RING® #1

Column diameter: 0.288 m
Packing height: 2.0 m

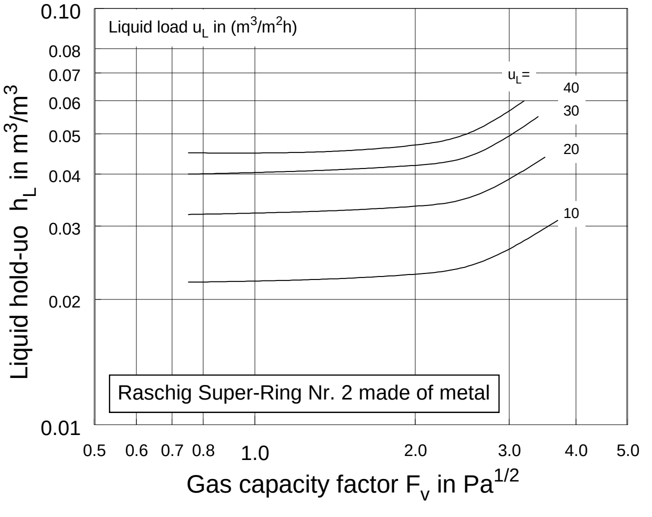
Liquid hold-up in columns with metal RASCHIG SUPER-RING®

system: air/water



RASCHIG SUPER-RING® #1.5

Column diameter: 0.288 m
Packing height: 2.0 m



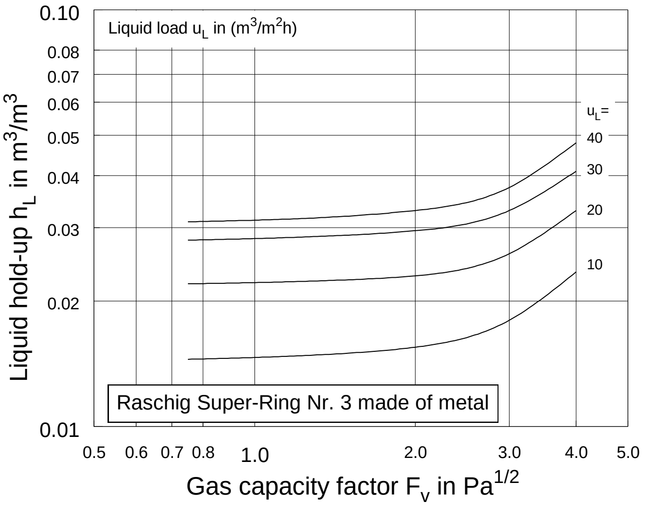
RASCHIG SUPER-RING® #2

Column diameter: 0.288 m
Packing height: 2.0 m

RASCHIG

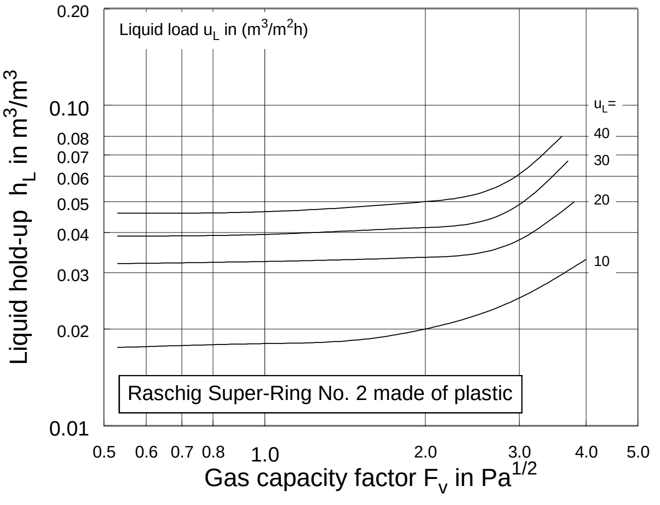
Liquid hold-up in columns with metal and plastic RASCHIG SUPER-RING®

system: air/water



RASCHIG SUPER-RING® #3

Column diameter: 0.288 m
Packing height: 2.0 m



RASCHIG SUPER-RING® #2

Column diameter: 0.288 m
Packing height: 2.0 m

Concluding remarks

The Raschig Super-Ring® demonstrates that this high-performance packing element meets the numerous demands of process engineering in an outstanding manner. The above description illustrates that a modern packing element design today must fulfil a number of fluid dynamic conditions. This is particularly true because, in most applications, only a fraction of the surface of a filling material is wetted and used for mass transfer between the phases. However, unused surfaces can easily corrode or generate unnecessary pressure drop. The Raschig Super-Ring® offers decisive advantage in this context, as its surface utilisation has been optimised in terms of process engineering.

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Nomenclature

Latin symbols

a	m^2/m^3	specific surface area of packing
a_{Ph}	m^2/m^3	specific effective surface area of packing
C_S	m/s	$= u_V (\rho_V /(\rho_L - \rho_V))^{1/2}$ capacity factor
D_S, d_S	m	column diameter
F_V, F_G	$m/s\ (kg/m^3)^{1/2}$	$= u_V (\rho_V)^{1/2}$ gas capacity factor
F	-	Packing factor
g	m/s^2	$= 9.81\ m/s^2$, acceleration
H	m	section height
HETP	m	height equivalent to a theoretical plate
HTU_{OV}	m	overall gas side height of a transfer unit
$k_G a_{Ph}$	1/s	volumetric mass transfer coefficient in gas phase
$k_L a_{Ph}$	1/s	volumetric mass transfer coefficient in liquid phase
L	kg/h	Liquid mass flow rate
h_L	m^3/m^3	superficial liquid hold-up
n_{th}	-	number of theoretical stages
p	bar	pressure
u_L	m^3/m^2h	superficial liquid velocity
u_V	m/s	superficial gas velocity
V, G	kg/h	Vapor mass flow rate

Greek symbols

$\beta_V a_{Ph}$	1/s	volumetric mass transfer coefficient in gas phase
$\beta_L a_{Ph}$	1/s	volumetric mass transfer coefficient in liquid phase
ρ_L	kg/m^3	liquid density
ρ_V	kg/m^3	gas density
$\Delta p/H$	mbar/m	specific pressure drop
η	Pas, kg/(ms)	dynamic viscosity

Subscripts

Fl	flooding condition
L	liquid phase
V	vapour phase