



Random Packing

OVERVIEW

Packed beds formed by dumping bulk random packing elements of consistent shape and size will provide the consistent surface and voidage characteristics necessary for predictable mass transfer operations. To achieve optimum performance benefits from a packed bed, proper consideration of the design, specification and installation of the random packing and associated column internals is required.

SPECIFICATION OF RANDOM PACKING

HAT manufactures a comprehensive range of **AlphaPACK™** standard and high performance random packings as listed below.

Standard Types:



R+ Raschig Rings
(Ceramics, Glass, Metals, Carbon, Plastics)



P+ Pall Rings
(Ceramics, Metals, Plastics)



S+, S++ Saddles
(Ceramics, Plastics)

High Performance Types:



C+ Rings
(Metals, Plastic)
I+ Rings
(Metals)



SF+ Packing
(Plastics)



Random Packing

The above packings are available in several sizes as indicated on our design sheets to suit most commercial applications. They range in size from 6mm to 90mm or equivalent. It is an essentially a design consideration in specifying a packing size based on capacity and efficiency requirements. The nominal packing size specified should however not be greater than 1/10th of the column diameter.

The packing is usually specified in the lowest cost material of manufacture that will satisfy temperature and corrosion requirements. Some of the most common materials listed in order of relative cost are:

Polypropylene	(mainly aqueous systems up to 100 deg. C)
Carbon steel	(non-corrosive hydrocarbon systems)
Ceramic	(sulphuric acid & nitric acid absorbers)
Stainless steels	(most hydrocarbon systems)
PVDF, PFA	(corrosive aqueous systems up to 150 deg. C)
PVC / C-PVC	(corrosive aqueous systems up to 90 deg. C)

Other more exotic materials that may be specified include aluminium, Monel, titanium and carbon.



Random Packing

PACKED BED DESIGN

Hydraulic operation of packed beds can be accurately rated using correlations that have been developed from actual performance data. Design data for standard "generic" random packing is widely available in the public domain.

The "Generalised Pressure Drop Correlation" is the most frequently published design tool for calculating packed bed diameter and determining the operating capacity for most "generic" random packings based upon a characteristic "Packing Factor" for each packing.

Where reliable performance is required in high pressure hydrocarbon systems, more specific design models should be employed. HAT are able to provide hydraulic rating sheets indicating the calculated pressure drop, liquid hold-up and % flood for any packed bed providing that sufficient process data is made available. As a minimum, we would require a profile of internal vapour and liquid loads and actual densities as well as liquid surface tension and viscosity.

HAT have computer programs to predict mass transfer efficiency and calculate the packed bed height for the most common absorption, stripping and heat transfer systems where sufficient, reliable data is available from which to compile design models. Multicomponent distillation systems should be simulated to evaluate the number of theoretical trays required as well as providing tray by tray vapour and liquid loads and physical properties. In most cases we can predict suitable HETP's and calculate packed bed height from this data. For most "generic" type packings in distillation service, separating efficiency will deteriorate when the bed height exceeds the lower of 6 x column diameter or 6 metres due to the effects of liquid maldistribution.

Performance data used to develop the design models used by HAT are in most cases sourced from well engineered operating columns with associated internals properly designed to be compatible with the duty.

Random packing has had wide application throughout the industry for several decades. As a result, performance characteristics are well known and design data readily accessible from public domain sources. Most generic column packings can be manufactured in a wide range of commercially available materials. The **AlphaPACK** range manufactured by HAT conforms to accepted industry standards as listed below:



Random Packing

PACKING TYPE	MATERIAL	SIZE	MASS (kg/m ³)	SURFACE (m ² /m ³)	VOIDAGE %	PACKING FACTOR
R+ Raschig Ring	Ceramic	15mm	825	290	62	540
		19mm	840	260	68	255
		25mm	650	190	72	160
		38mm	600	135	74	95
		50mm	570	92	76	65
		75mm	560	79	78	36
R+ Raschig Ring	Carbon	12mm	679	360	60	450
		18mm	590	240	66	260
		25mm	600	195	65	180
		37mm	590	140	65	125
		50mm	530	98	68	65
P+ Pall Ring	Stainless Steel	16mm	580	340	93	70
		25mm	435	207	94	50
		38mm	355	128	95	28
		50mm	270	102	96	20
		90mm	230	85	97	16
C+ Ring	Stainless Steel	No.1	280	251	96	40
		No.2	227	145	96	22
		No.3	228	103	97	14
		No.4	170	80	96	10
I+ Ring	Stainless Steel	No.25	218	226	97	41
		No.40	153	151	97	25
		No.50	156	100	98	16
		No.70	117	60	98	13
P+ Pall Ring	Polypropylene	16mm	115	340	87	97
		25mm	80	196	90	64
		38mm	60	150	91	36
		50mm	60	106	91	25
		90mm	90	85	92	17
S+ Saddle	Ceramic	19mm	590	335	71	145
		25mm	580	250	77	92
		38mm	600	150	80	52
		50mm	560	110	79	40
		75mm	540	96	80	22
S+ Saddle	Polypropylene	No.1	85	190	90	36
		No.2	57	95	93	21
		No.3	45	65	94	16
SF+ Pack	Polypropylene	90mm	45	92	95	13



Random Packing

PACKED BED CAPACITY

Flooding in packed beds is characterised by unstable operation and loss of efficiency. The optimum loading point for most new columns is about 80% of the loading at the flood point. Separation efficiency will usually deteriorate rapidly at loadings below about 20% of the flood point, particularly in distillation systems.

The flood point for packed beds of generic packings can be estimated using the following correlation:-

$$C_{\text{FLOOD}} = 1 / \{3.6 \cdot F \cdot e (S \cdot X^{0.5})\} \quad (\text{m/s})$$

and:

$$\% \text{ Flood} = \frac{C_s \times 100}{C_{\text{FLOOD}} \times \text{System Factor}} \quad (\text{at constant L/G})$$

where:

$$X = (L/G) \cdot (\rho_G / \rho_L)^{0.5} \quad (\text{dimensionless})$$

$$C_s = v_s \cdot \{\rho_G / (\rho_L - \rho_G)\}^{0.5} \quad (\text{m/s})$$

$$L = \text{Liquid Rate} \quad (\text{kg/s})$$

$$G = \text{Gas Rate} \quad (\text{kg/s})$$

$$\rho_G = \text{Gas Density} \quad (\text{kg/m}^3)$$

$$\rho_L = \text{Liquid Density} \quad (\text{kg/m}^3)$$

$$v_s = \text{Superficial Gas Velocity} \quad (\text{m/s})$$

$$F = \text{Packing Factor} \quad (\text{from table})$$

$$S = \text{Packing Shape Constant}$$

The following Packing Shape Constants should be used for common packings:-

1.25 for metallic packings

1.35 for thermoplastic packings

1.55 for ceramic packings



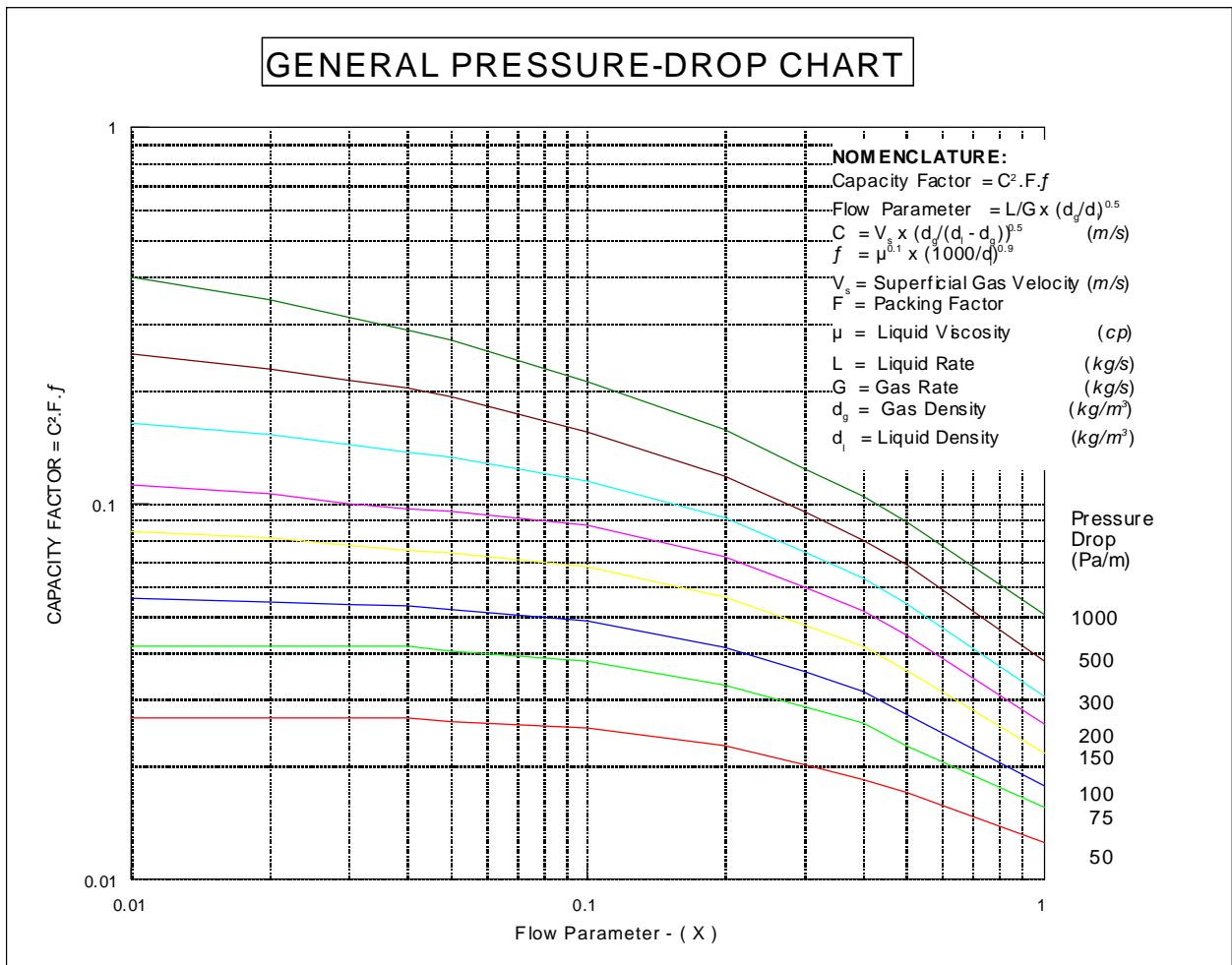
Random Packing

ESTIMATION OF PRESSURE DROP

The restriction to vapour flow across a packed bed causes a pressure drop which is normally relatively low. Nevertheless the effect of pressure loss on overall plant design and operating costs will often need to be evaluated and so it is necessary to be able to estimate this pressure loss over the expected range of operating conditions.

Pressure drop is a function of vapour and liquid rates as well as the packing shape and size. Pressure drop curves for most packings are widely published. For estimating purposes it is usually more convenient to use a "Generalised Pressure Drop Correlation" as shown below which applies a characteristic "Packing Factor" to the ordinate value to provide a set of pressure drop curves which are accurate to within 20% for most random packings.

GENERALISED PRESSURE DROP CORRELATION





Random Packing

DELIVERY AND INSTALLATION

An advantage of random column packing is that being mass produced standard elements, delivery times are relatively short. Since the same packing can be used in many applications irrespective of column size, HAT holds a substantial inventory of most **AlphaPACK** random column packings for immediate shipment at its warehouses.

Random column packing is packaged and shipped by volume. A volume adjustment factor must be applied to the calculated column geometric volume to estimate the shipping volume required to properly fill a packed bed to account for edge and settling effects. The volume adjustment factor depends upon the packing shape and size and the bed diameter.

A contingency allowance for installation losses, typically around 5%, should be added to the shipping volume calculated above.

Strict conformity with recommended installation procedure is necessary to ensure consistent duplication of design performance. Installation techniques that result in installation crew walking on or raking the packing must never be employed. Incorrect installation procedures can result in substantial packing shortfall (i.e. installed volume not sufficient for the required bed height resulting in performance losses).