Jaeger Tri-Packs / Hacketten

Product Bulletin 600

Superior performance by design™

Raschig GmbH - Jaeger Products, Inc

RASCHIG JAEGER TECHNOLOGIES

A new Alliance in Mass Transfer Business.
Together we are creating more!

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Raschig Jaeger Technologies – September 2006

In order to establish a new alliance in mass transfer business RASCHIG GmbH and its parent company PMC GLOBAL INC have acquired JAEGER PRODUCTS INC., a Houston Texas based company, which is a major manufacturer of tower packings, column internals and speciality trays and very active in the Mass Transfer and Environmental Business.

RASCHIG JAEGER will be integrated into the PMC network of highly specialized, internationally operating companies and will therefore be better prepared to meet increased globalization and further improved customer orientation. Wherever in the world – in all continents – RASCHIG JAEGER is on the spot.

Synergies

This strategic acquisition combining RASCHIG and JAEGER into one larger group gives a great advantage to our customers giving them access to products of both entities in Europe, The Americas and in other parts of the world. It will create new dimensions in mass transfer technology. The advantages of our process engineering know-how and our technologies benefit even more the planning, modernization and construction of our clients' processes. And: saving energy and investment cost is part of it.

The new alliance offers a diverse array of products to meet the mass transfer needs of the industries. While specializing in high performance products, the comprehensive products line of RASCHIG JAEGER also includes traditional fractional trays as well as structured and random packing types that best fit the application.

Leading In-house distributor test-facility

The company operates one of the largest in-house distributor test-facilities worldwide. Liquid distributors can be tested up to 12m in diameter at a maximum liquid load of 2400m3 per hour.

All products of RASCHIG JAEGER are the result of consistent development work long years of experience. Comprehensive quality management in all stages of production and the principle of offering complete solutions are the basis of our excellent reputation – worldwide.

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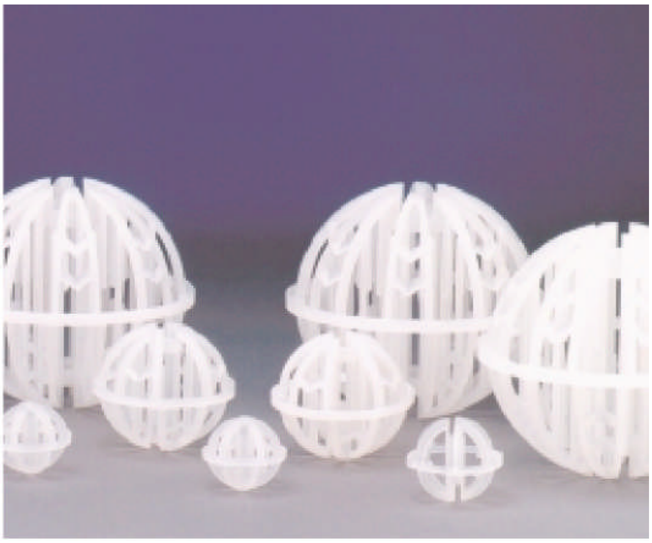

Jaeger Tri-Packs®

Features

• Jaeger Tri-Packs® are hollow, spherical packings made of injection molded plastic, available in four diameters: 1", $1^{1/4}$", 2", and $3^{1/2}$".

• Symmetrical geometry made from a unique network of ribs, struts, and drip rods.

• High active surface areas.

• Extremely low pressure drops.

• Extremely high operating capacities.

Benefits

• High mass and heat transfer rates.

• Excellent gas and liquid dispersion characteristics.

• Resist nesting, making removal easy.

• Installs to packed position - no settling.

• Available in a wide variety of plastics.

• Predictable performance.

Jaeger Tri-Packs®-PP are NSF Certified to ANSI/NSF Standard 61 when made in polypropylene

Specifications & Physical Properties

Materials

Twelve standard, injection moldable plastics are available:

- Polypropylene (PP)
- Polyethylene (PE)
- Polypropylene Glass-Filled (PPG)
- Noryl® (PPO)
- Polyvinylchloride (PVC)
- CorzanTM (CPVC)
- TopEx® (LCP)
- Kynar® (PVDF)
- Halar® (ECTFE)
- Teflon® (PFA)
- Tefzel® (ETFE)
- Tefzel® Glass-Filled (ETFE-G)

Other plastics are available on request.

IMPORTANT NOTE:
Design data presented in this bulletin are for preliminary calculations only. Contact Jaeger before finalizing calculations.

Jaeger TRI-PACKS® is a Registered Trademark of Jaeger PRODUCTS, INC.

Properties Table

Size (in.)	1	1 1/4	2	3 1/2
Geometric Surface Area (ft^2/ft^3)	85	70	48	38
Packing Factor (1/ft)	28	25	16	12
Void Space (%)	90	92	93.5	95
Bulk Density (lb/ft^3) (PP)	6.2	5.6	4.2	3.3

Maximum Operating Temperatures for Plastic Jaeger Tri-Packs

Jaeger Tri-Packs® are available in a variety of injection-molded plastics for different applications. The maximum operating temperatures for these different resins vary from material to material and are also affected by specific process variables. The data presented below correspond to maximum continuous operating temperatures at atmospheric pressure and systems that are essentially air and water. The presence of solvents, acids, free radicals, and oxidants needs to be considered. Furthermore, these temperatures correspond to the maximum recommended bed depth for each packing size and material. These maximum bed depths are different depending on the application. Consult with Jaeger in respect to the maximum bed depth for your particular application.

Material	Maximum Temperature (Deg. F) (1 atm, air/water, at max. recommended depth)	Bulk Density Factor
Polyvinyl Chloride (PVC)	140	1.50
Polyethylene (PE)	160	1.02
Polypropylene (PP)	180	1.00
Corzan™ (CPVC)	230	1.74
Chlorinated Polyvinyl Chloride (CPVC)	210	1.74
Polypropylene - Glass-Filled (10-30%) (PP-G)	210-230*	1.17-1.38*
Noryl® (PPO)	230	1.24
Kynar® (PVDF)	280	1.98
Halar® (ECTFE)	290	1.86
Tefzel® (ETFE)	350	1.93
Teflon® (PFA)	400	2.45
Tefzel® - Glass Filled (25% Glass) (ETFE-G)	410	2.2

*Depending on glass content.

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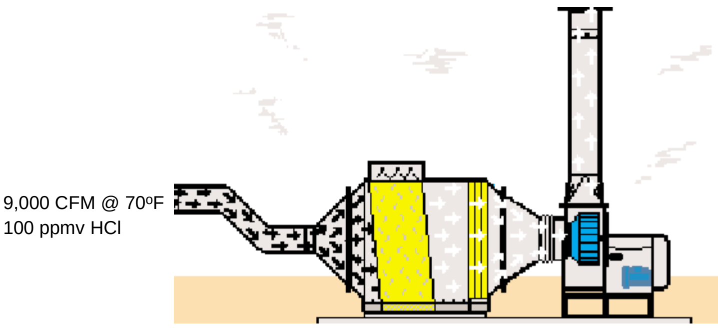
Performance Comparison

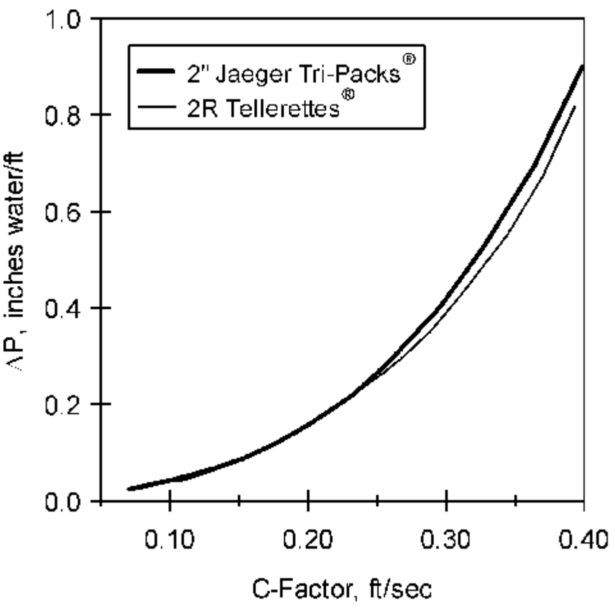
2R Tellerettes® vs 2” Tri-Packs®

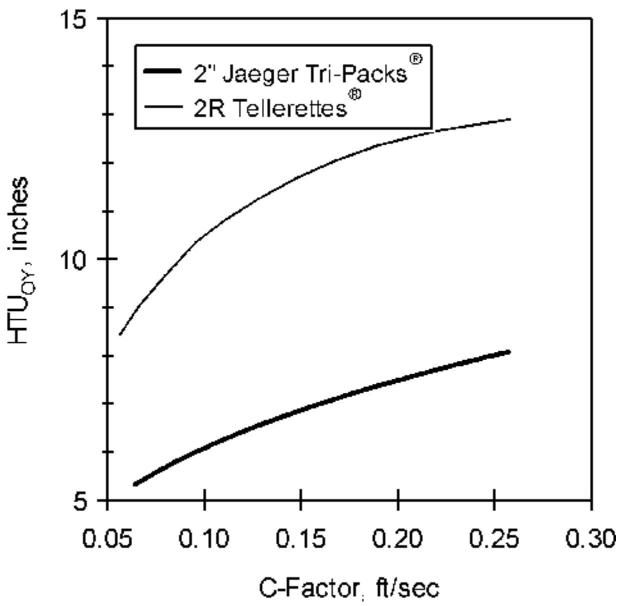
HCl/Caustic Scrubbing @ 70oF, 1 atm, 100 ppmV Inlet



ppm_V Out	Removal Effcy. %	Δp/H “H_2O/ft	
17.5	82.5	0.11	2” Pall Rings
3.8	96.2	0.065	2R Tellerettes®
3.8	96.2	0.042	3 1/2” Tri-Packs®
0.5	99.5	0.086	2” Tri-Packs®

- 2” Tri-Packs® give a 97% improvement in outlet HCl concentration compared to 2” Pall Rings -2” Tri-Packs® outperform 2R Tellerettes® by 87%
- 3 1/2" Tri-Packs® give a 78% improvement when compared to 2” Pall Rings
- **3 1/2" Tri-Packs® equal 2R Tellerettes® performance with 35% lower pressure drop**





Tellerettes® HTU data from Ceilcote catalog 12-1 0.60; Δp data from 12-10.11
Tri-Packs® HTU curves are simulations based on available HTU data from other systems.

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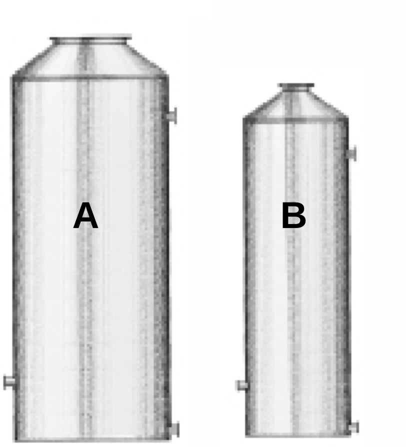
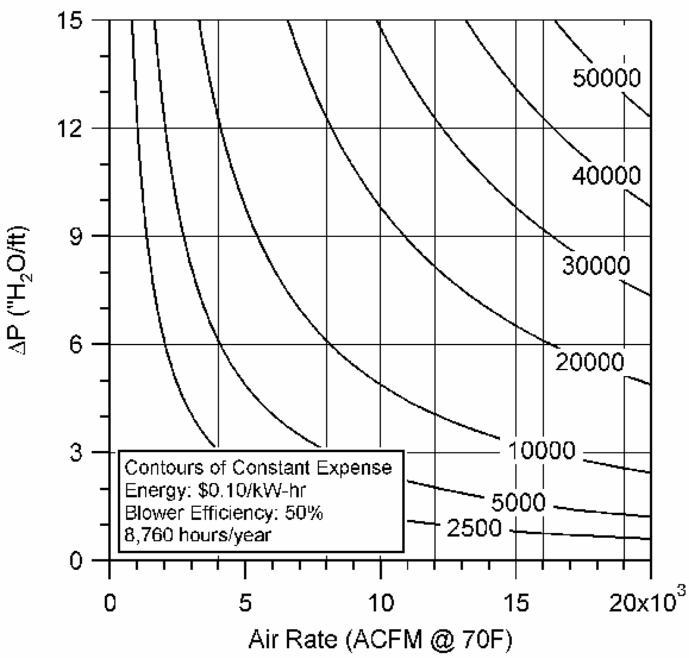


<u>Question:</u> Which column design is less expensive?

<u>Answer:</u> Column A

Which design is less expensive? If you chose column **B**, then you might be in for a surprise.

The price you pay for pollution abatement is composed of two parts. First, there's the direct capital cost for the scrubber or stripper. This includes the up-front money you are charged for the column, the packing and the internals. But there's also an ongoing energy expense that you must pay for gas compression and for liquid pumping. The capital cost is usually carefully monitored and controlled because it is oftentimes a large lump sum payment charged before abatement even begins.



By contrast, energy is paid for on an ongoing basis. It is a cost not often considered in the evaluation of designs submitted by different vendors because it is presumed that this cost should be about the same for all designs. It then follows that the cost for abatement is minimized by minimizing the capital expense. But this reasoning can be seriously flawed. Energy costs are extremely sensitive to design choices like column diameter, packed depth, gas loading per square foot of column cross sec-tion, and materials of construction. The only proper way to choose a design is to balance capital expenses against operating expenses. The annual abatement cost is the sum of the depreciated capital cost and the annual energy cost. The proper choices of column diameter, packed depth, and gas loading per unit cross section are those that minimize this annual abatement cost. When the capital depreciation time is relatively long, the column diameter increases in order to bring the pressure drop down and thus lower energy costs. Conversely, when capital is depreciated more quickly, the column size shrinks (at the expense of higher pressure drop) in order to lower the up front expense. In short, then, a smaller column can be more expensive to operate than a larger one when all cost factors are taken into account

Jaeger can work closely with your organization to develop cost models for your project and we can optimize a design based on these models to meet your financial objectives. Contact us about your design needs.

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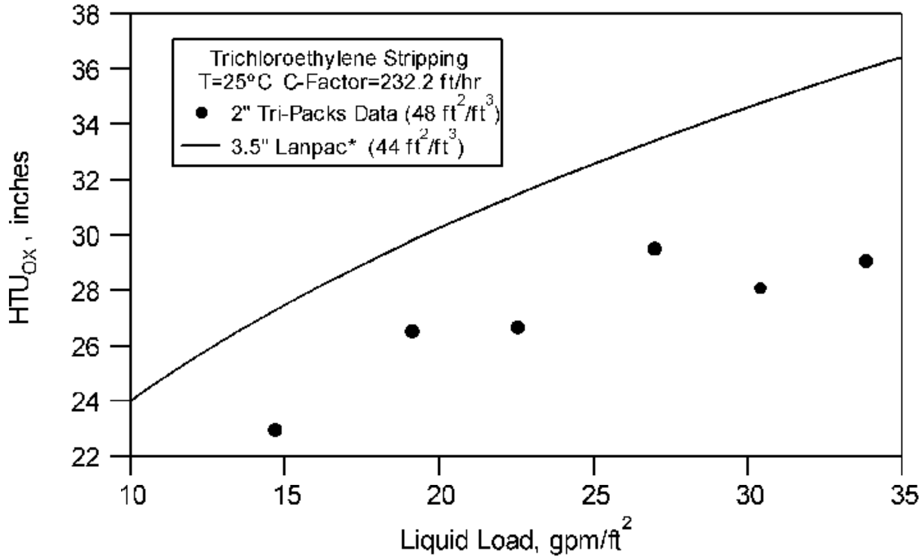
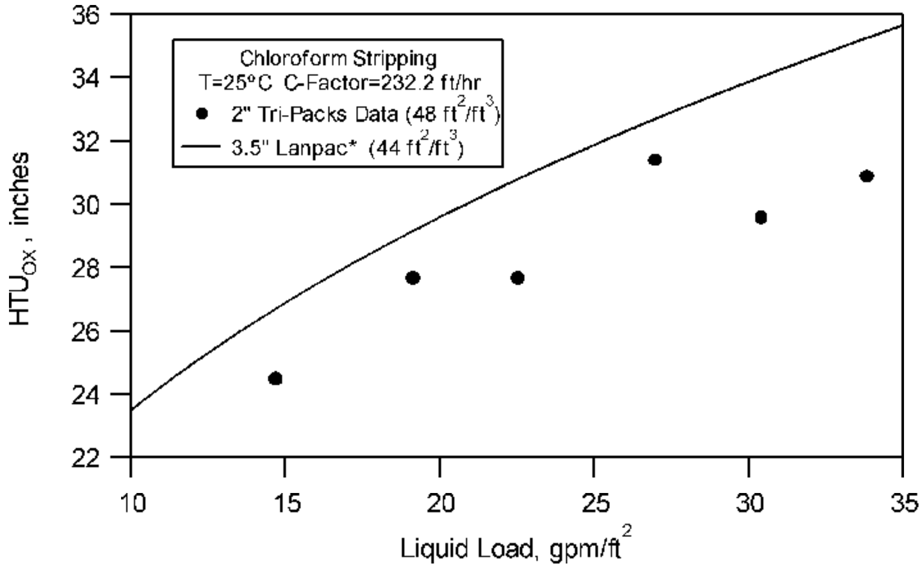
Jaeger Tri-Packs® Outperform Lanpac®

Verified by Independent Test





*HTU values for 3.5" Lanpac® calculated from Lanpac HTU correlation reported in Lantec Technical Bulletin TL-901.
2" Jaeger Tri-Packs® performance data taken from U.S. Department of Commerce document AD-A158 811 June 1985

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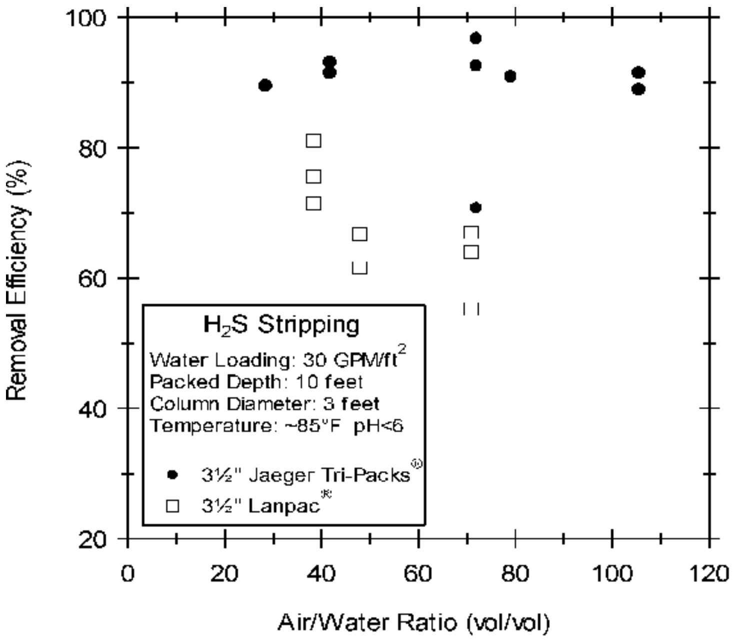
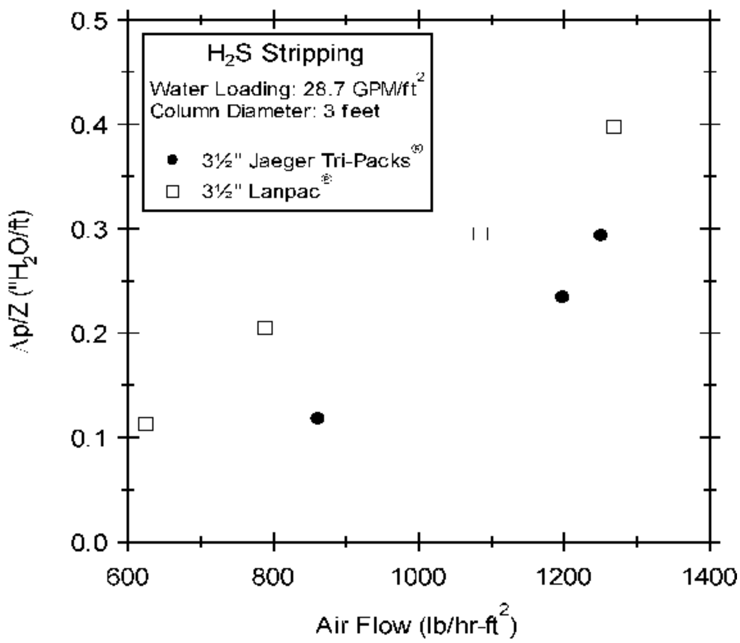
Again & Again!!

Jaeger Tri-Packs® Out Distance Lanpac® in Stripping and Pressure Drop Tests





When Manatee County, Florida required H_2S stripping towers for water treatment in 1992, they were concerned about long-term energy cost. The OEM Manufacturer retained by the county conducted tests on different packings to assure that their client received the most efficient packing and system. The partial results shown in the two graphs at the left show why they picked $3^{1/2}$" Jaeger Tri-Packs® over $3^{1/2}$" Lanpac® as the most efficient and affordable packing available.

When these two products - of comparable size - are used for identical purposes with identical conditions, the $3^{1/2}$" Jaeger Tri-Packs® overwhelmingly outperform the $3^{1/2}$" Lanpac®. Stripping efficiencies for $3^{1/2}$" Jaeger Tri-Packs® averaged 36.5% better than those for $3^{1/2}$" Lanpac®. These results are illustrated by the graph at the top left.

The same trend is evident in the pressure drop, as illustrated by the graph on the lower left. The data shows the advantage in energy savings that $3^{1/2}$" Jaeger Tri-Packs® offers over the $3^{1/2}$" Lanpac®.

$3^{1/2}$" Jaeger Tri-Packs® were recommended and installed because they outperformed $3^{1/2}$" Lanpac® in both mass transfer efficiency and pressure drop. The $3^{1/2}$" Jaeger Tri-Packs® are still in service and will con-tinue to provide the energy savings and value originally desired by Manatee County

Give us a call. Jaeger can provide the products and services to get you the most out of your packing or mass transfer device.

Data from test performed in 1992 by Duall Division, Metpro Corporation, Owosso, Michigan.

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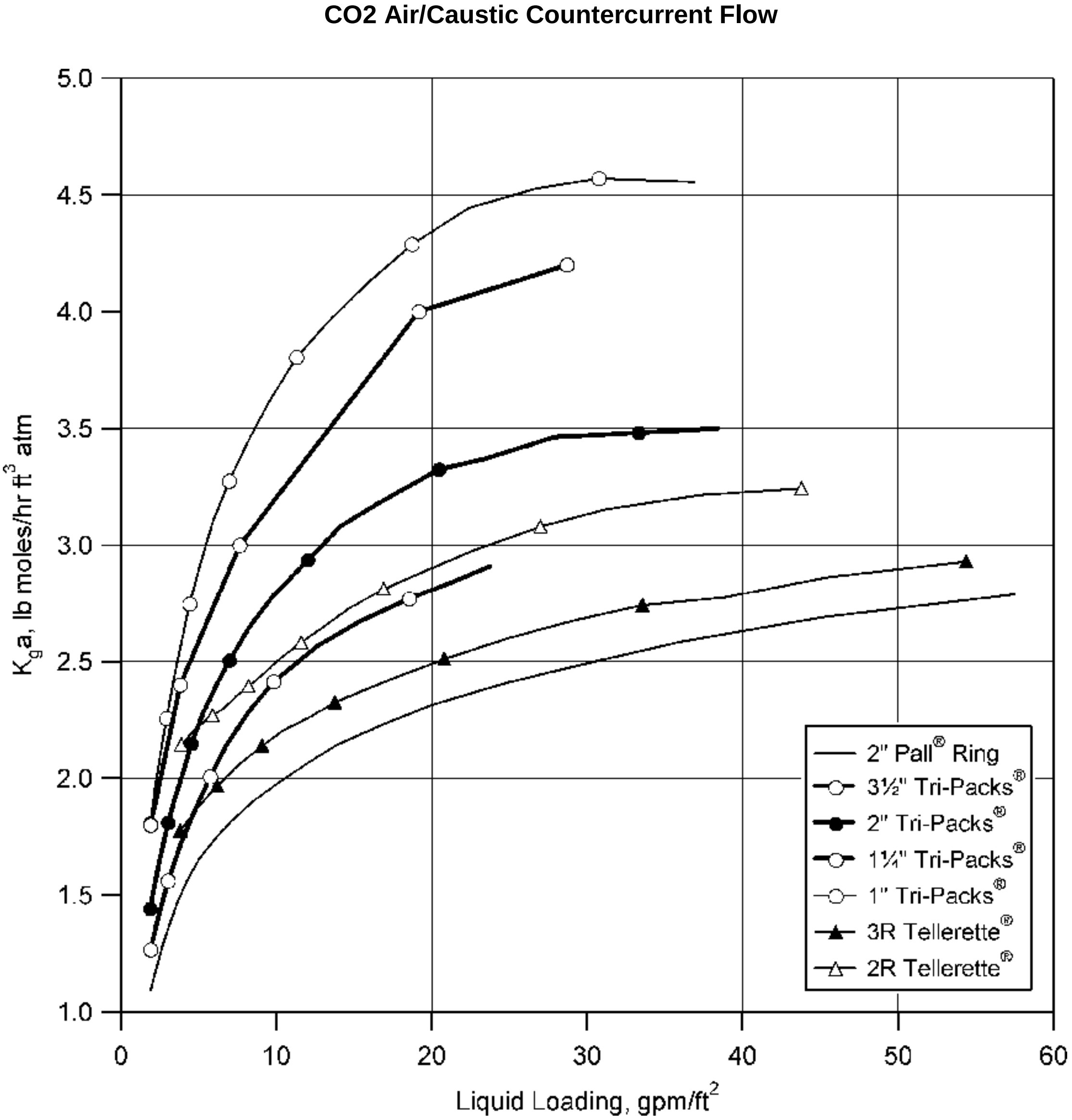
Packing Comparison

K_Ga vs. Liquid Loading



Tellerettes® data from Ceilcote Technical Bulletin 12-10.60
Column diameters and packed depths varied among the tests reported here

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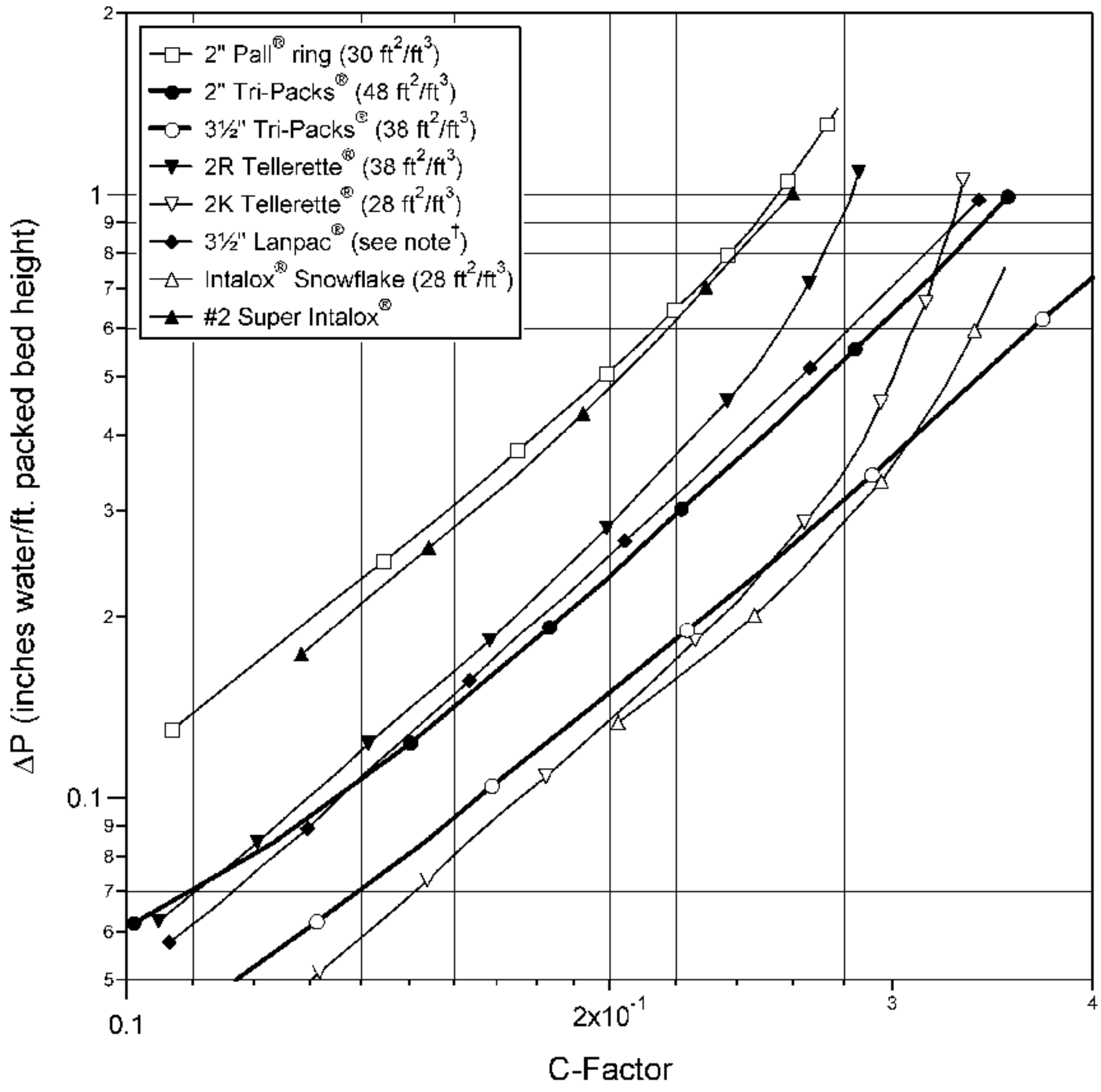
Pressure Drop Comparison

Plastic Packing

Ambient Air/Water (70oF, 1 atm) at 20 gpm/ft2



C-Factor = $V_s[(\rho_V)/(\rho_L - \rho_V)]^{1/2}$ where
V_s = Superficial Vapor Velocity in ft/sec
ρ_L and ρ_V = Density of Liquid and Vapor in lb/ft^3

+44, 45, 48, 68 ft2/ft3 reported in Lantec Literature.
Lanpac data from Lantec Technical Bulletin TL-905.
2K & 2R Tellerettes data from Ceilcote Catalog 12-10.11 and 12-10.13.
Pall ring data from Jaeger Catalog 700-pd705.
Snowflake data from Norton Bulletin ISPP-1.
Super Intalox saddle data from Norton Bulletin DC-11.

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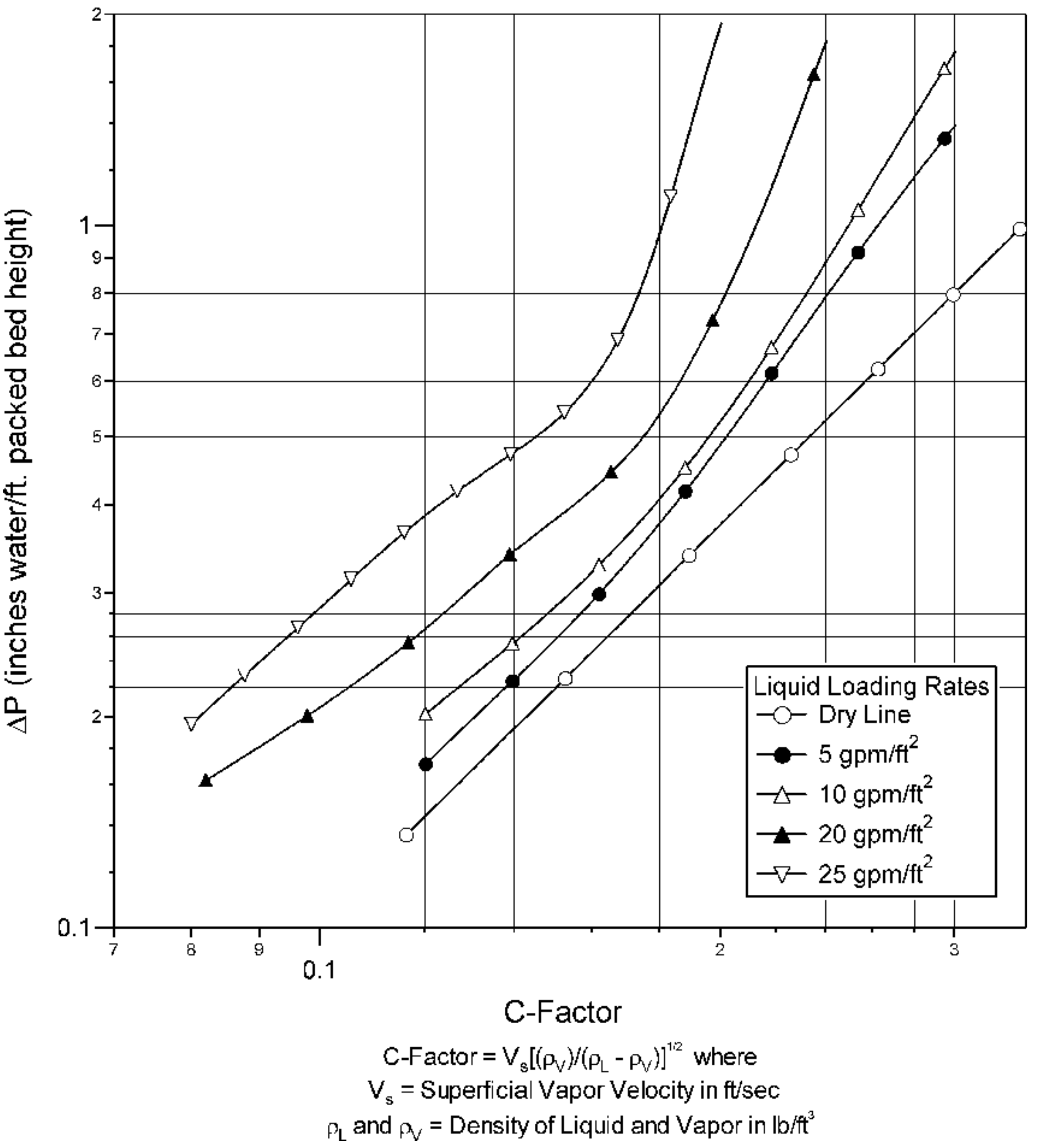
Pressure Drop vs. C-Factor

1" Plastic Jaeger Tri-Packs®

Ambient Air-Water Systems for Various Liquid Loadings



For Air/Water systems at 70oF & 1 atm: C-Factor x 7776.2 = lb/hr-ft2; gpm/ft2 x 499.7 = lb/hr-ft2

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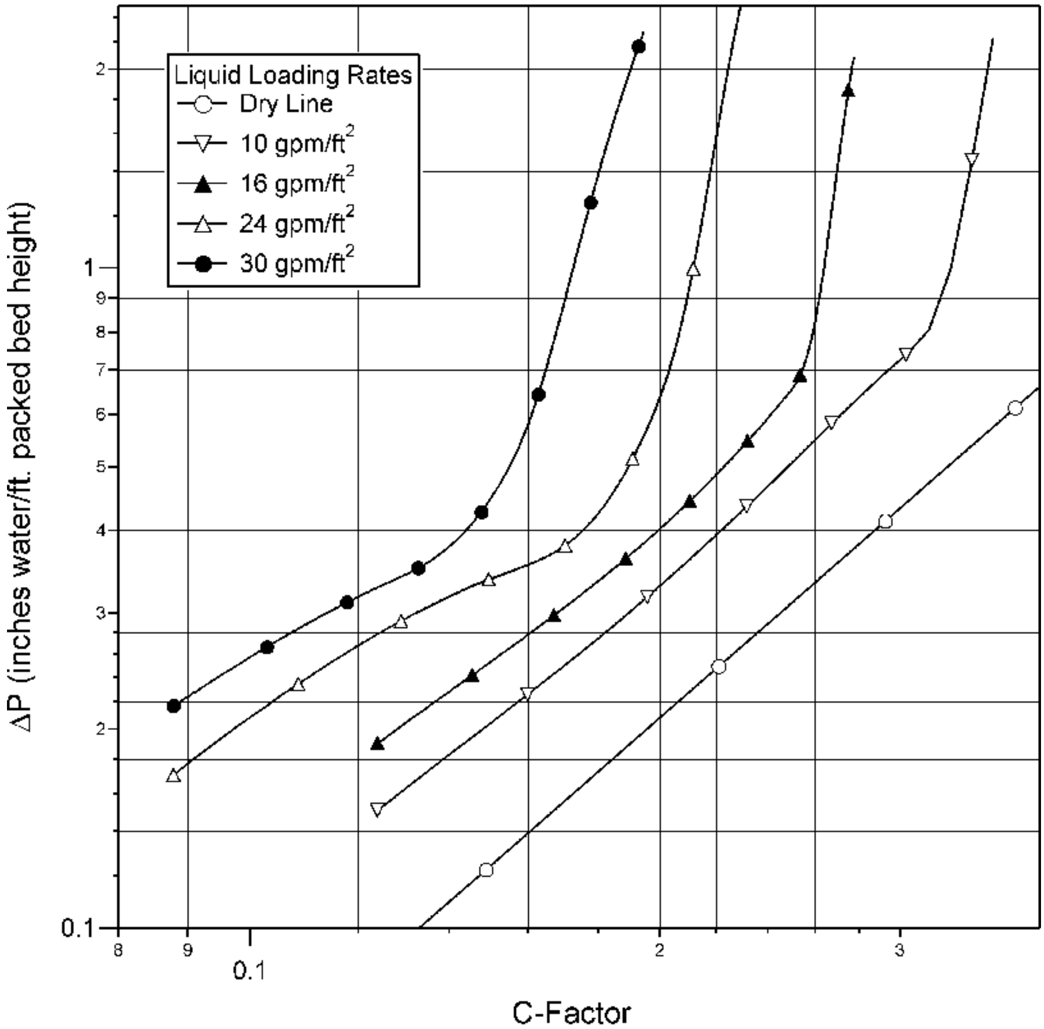
Pressure Drop vs. C-Factor

1.25” Plastic Jaeger Tri-Packs®

Ambient Air-Water Systems for Various Liquid Loadings



C-Factor = $V_s[(\rho_V)/(\rho_L - \rho_V)]^{1/2}$ where

V_s = Superficial Vapor Velocity in ft/sec

ρ_L and ρ_V = Density of Liquid and Vapor in lb/ft^3

For Air/Water systems at 70oF & 1 atm: C-Factor x 7776.2 = lb/hr-ft2; gpm/ft2 x 499.7 = lb/hr-ft2

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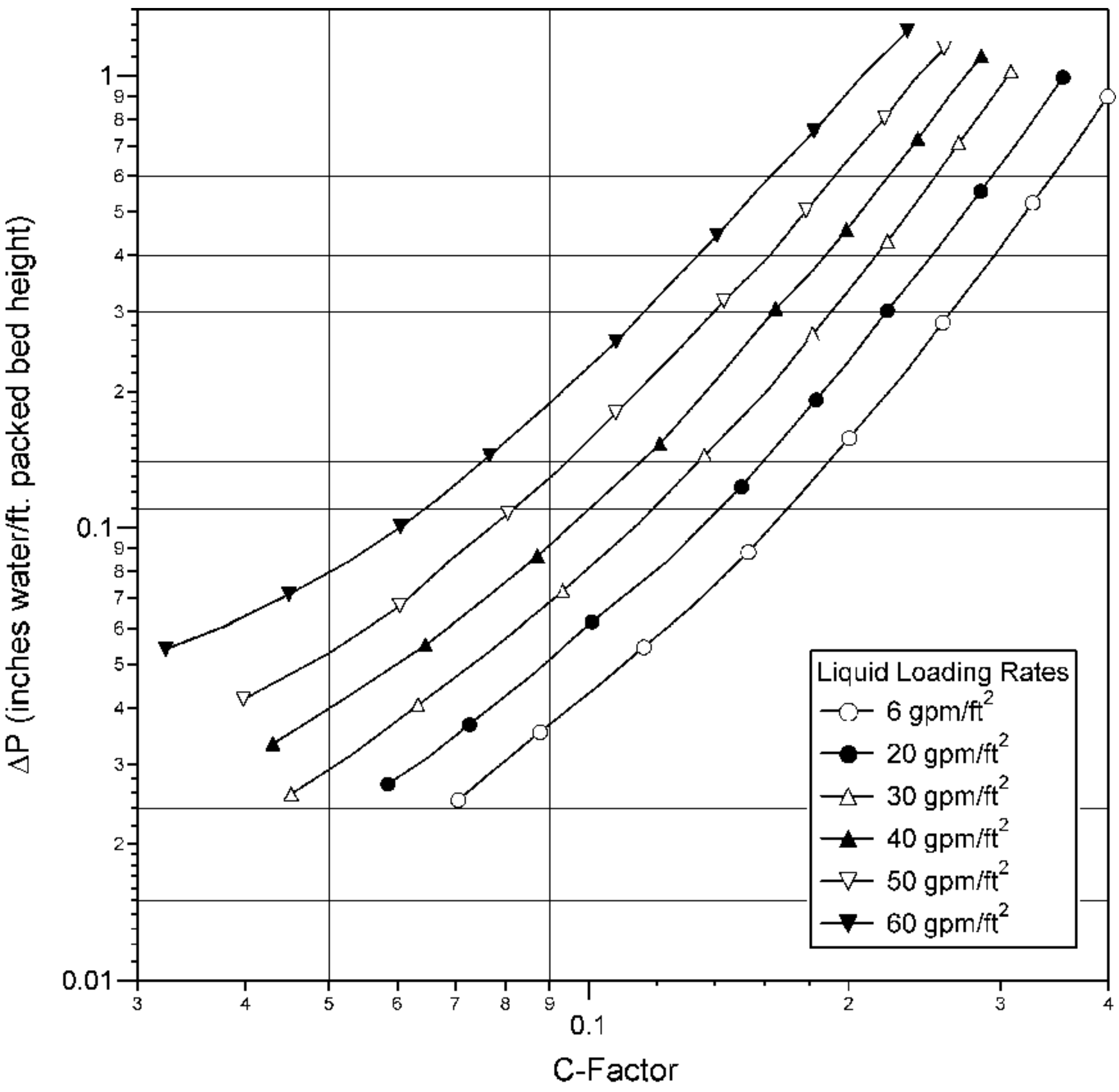
Pressure Drop vs. C-Factor

2” Plastic Jaeger Tri-Packs®

Ambient Air-Water Systems for Various Liquid Loadings



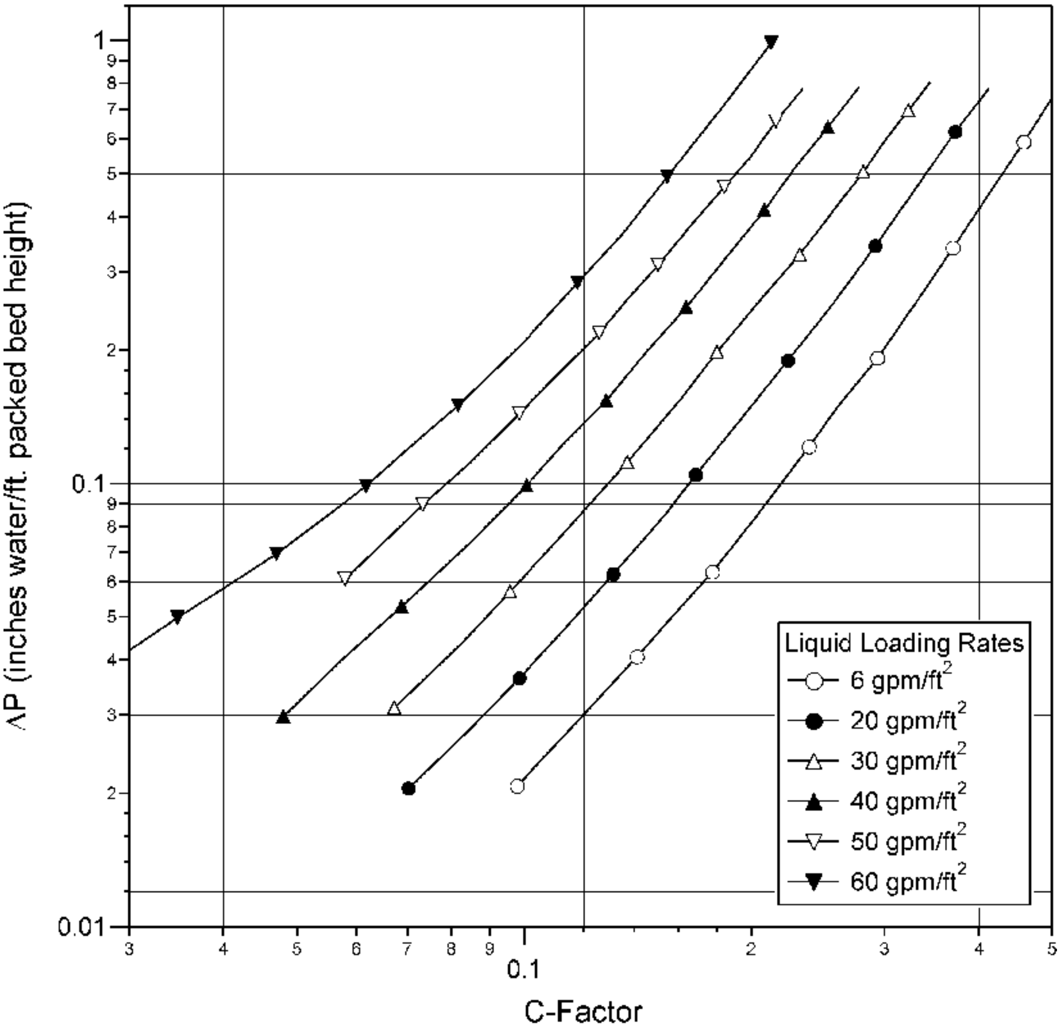
C-Factor = $V_s[(\rho_V)/(\rho_L - \rho_V)]^{1/2}$ where
V_s = Superficial Vapor Velocity in ft/sec
ρ_L and ρ_V = Density of Liquid and Vapor in lb/ft^3

For Air/Water systems at 70oF & 1 atm: C-Factor x 7776.2 = lb/hr-ft2; gpm/ft2 x 499.7 = lb/hr-ft2

Pressure Drop vs. C-Factor

3.5” Plastic Jaeger Tri-Packs®

Ambient Air-Water Systems for Various Liquid Loadings



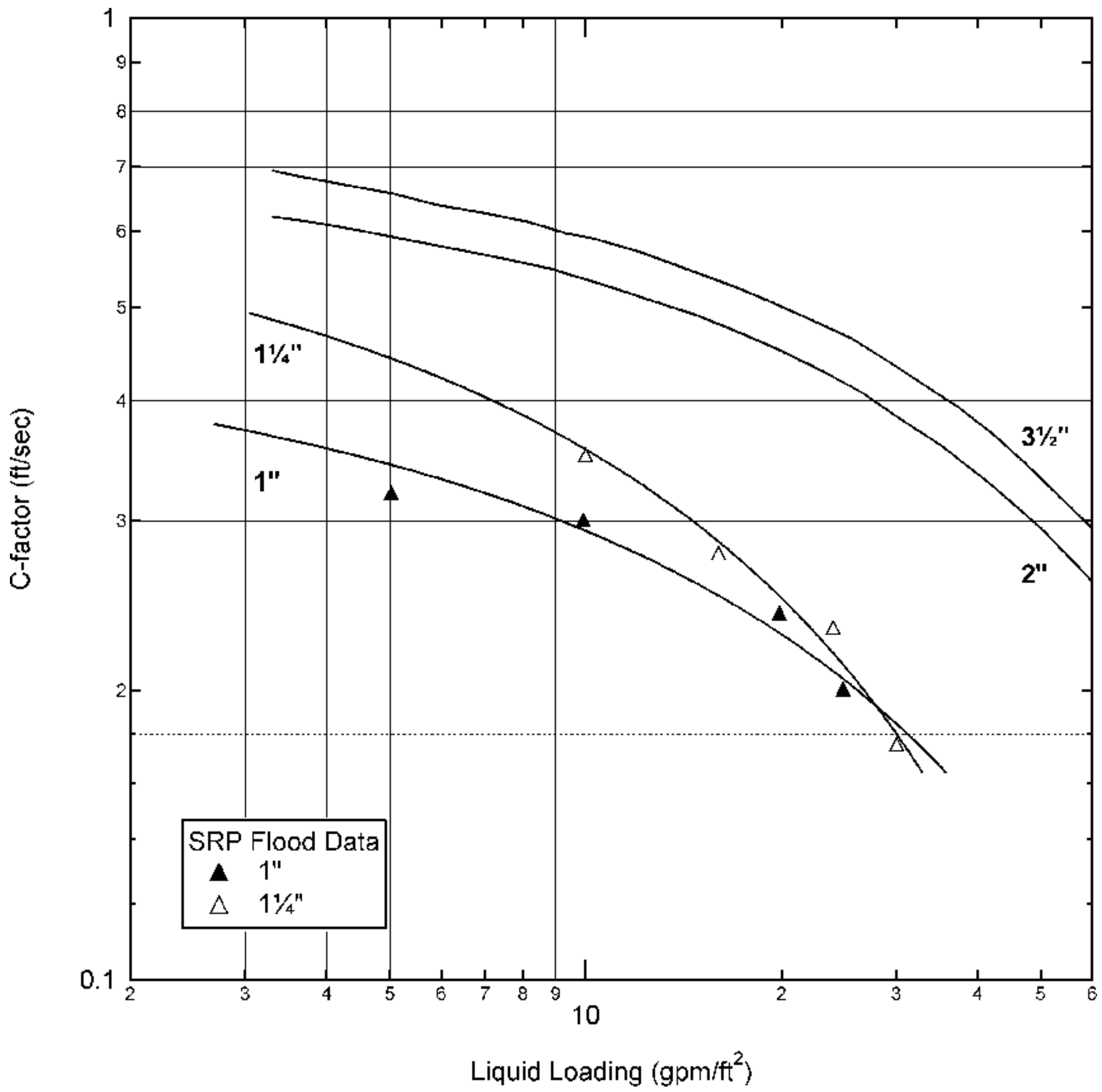
C-Factor = $V_s[(\rho_V)/(\rho_L - \rho_V)]^{1/2}$ where
V_s = Superficial Vapor Velocity in ft/sec
ρ_L and ρ_V = Density of Liquid and Vapor in lb/ft³

For Air/Water systems at 70oF & 1 atm: C-Factor x 7776.2 = lb/hr-ft2; gpm/ft2 x 499.7 = lb/hr-ft2

Generalized Flooding Curves

Plastic Jaeger Tri-Packs®

Ambient Air-Water Systems at 1 atm, 70^0F



C-Factor = $V_s[(\rho_V)/(\rho_L - \rho_V)]^{1/2}$ where

V_s = Superficial Vapor Velocity in ft/sec

ρ_L and ρ_V = Density of Liquid and Vapor in lb/ft^3

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SRP – Separations Research Program, University of Texas at Austin

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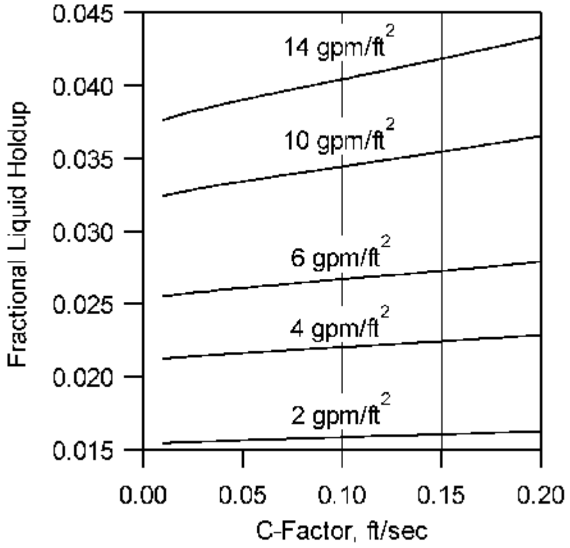
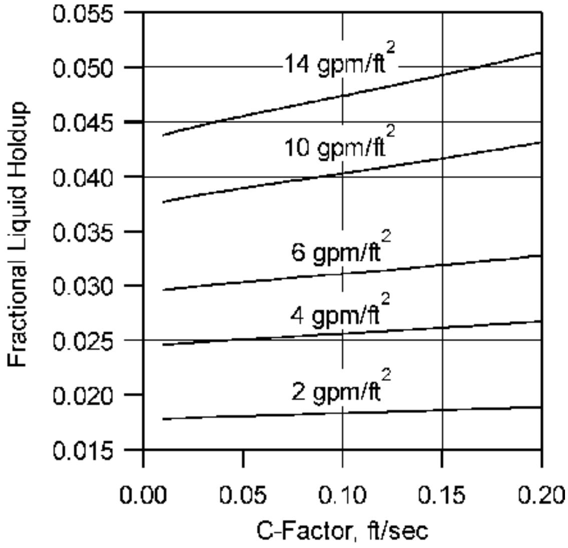
Liquid Holdups

Jaeger Tri-Packs®

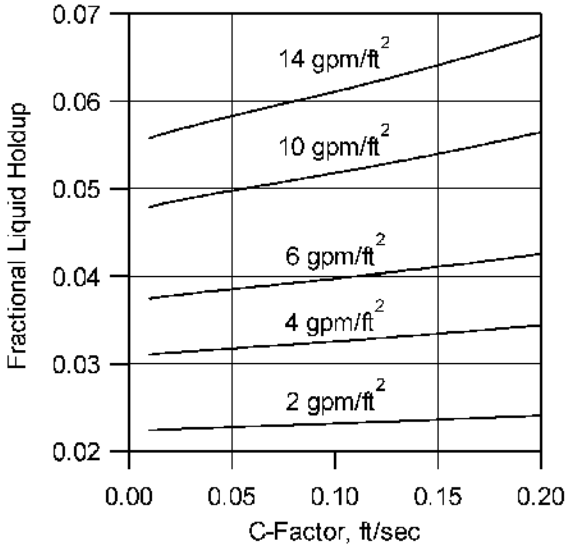
$3^{1/2}$" Jaeger Tri-Packs®



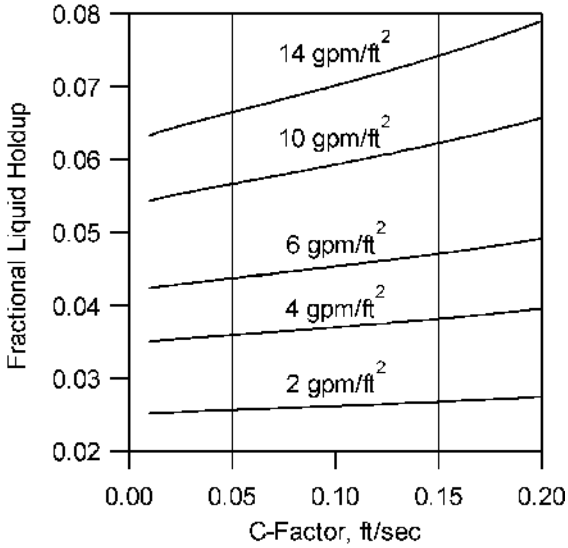
2" Jaeger Tri-Packs®



$1^{1/4}$"Jaeger Tri-Packs®



1"Jaeger Tri-Packs®



Fractional holdups estimated from formula presented in I&EC Research, 5(33), 1222 (1994).

For Air/Water systems at 70oF & 1 atm: C-Factor x 7776.2 = lb/hr-ft2; gpm/ft2 x 499.7 = lb/hr-ft2

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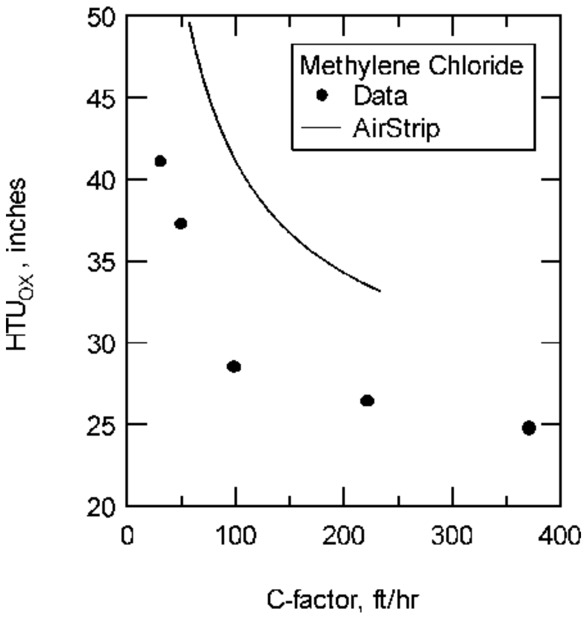
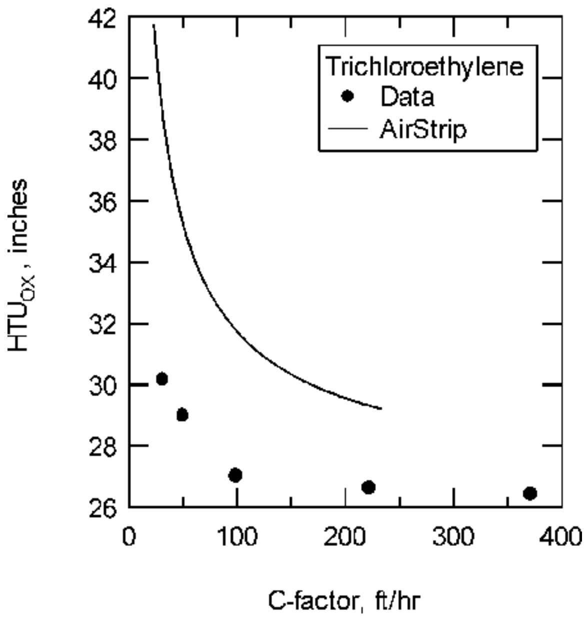
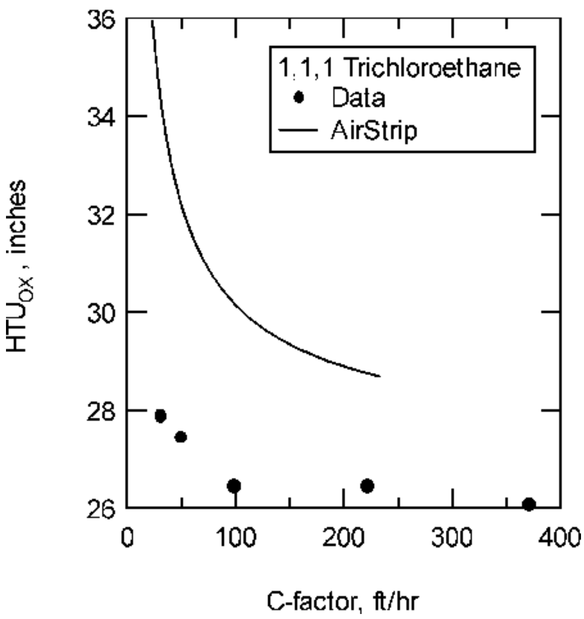
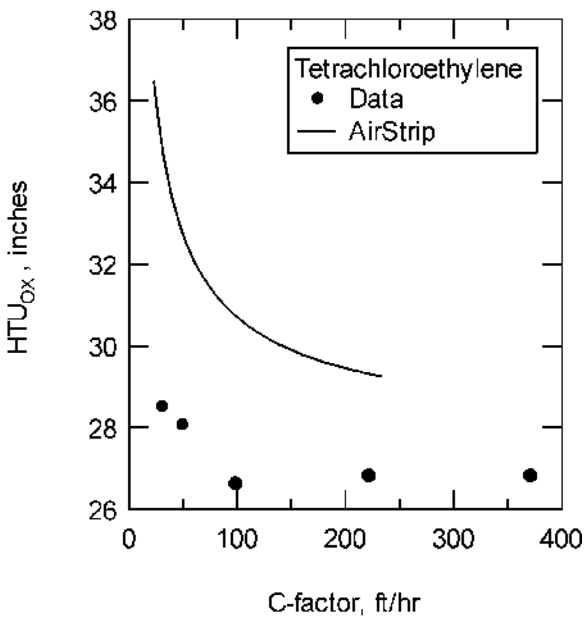
Independent Tests Prove…

Jaeger Tri-Packs® Outperform



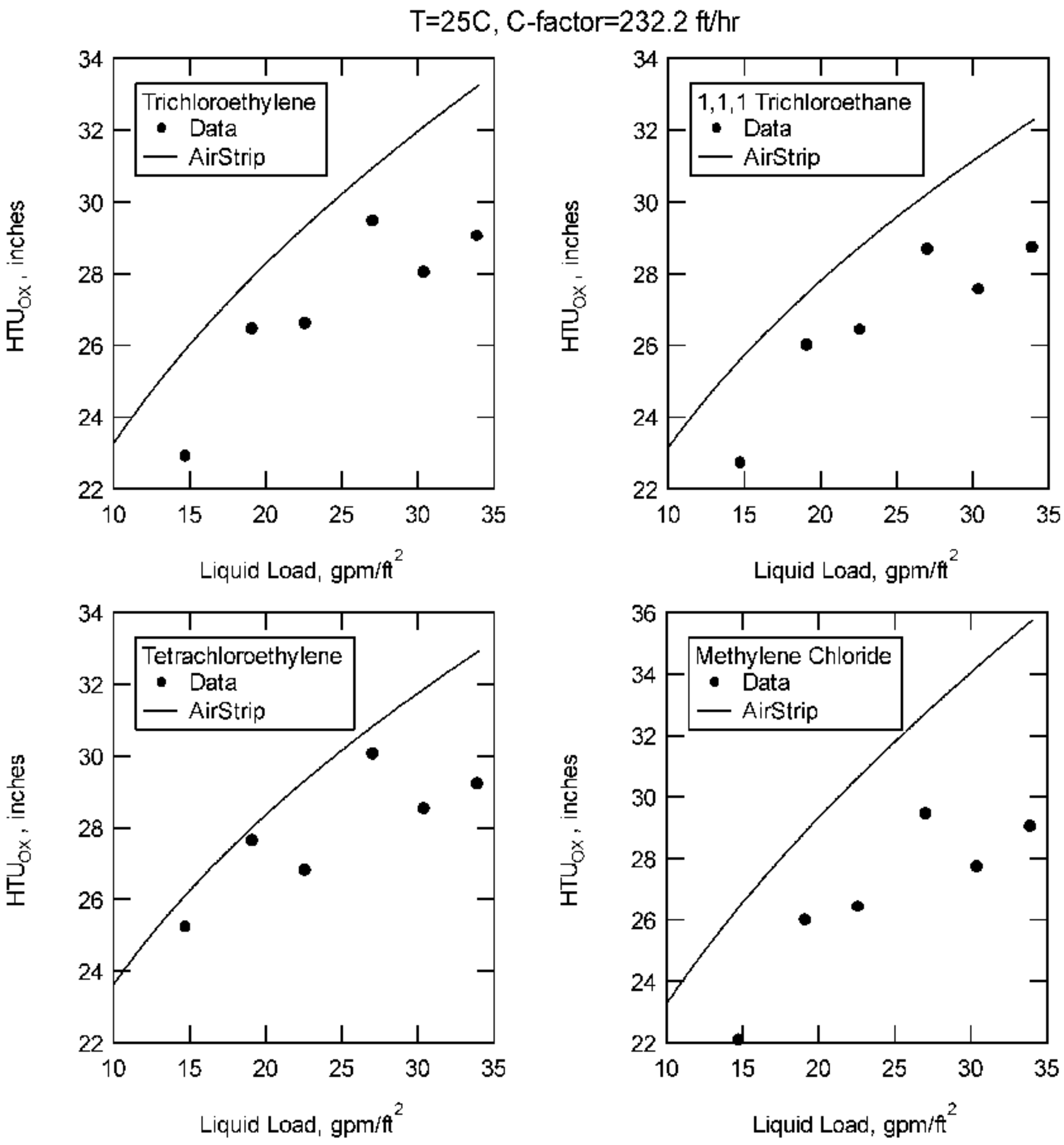






…Jaeger Tri-Packs® Exceed Expectations

AirStrip® Predictions



2” Jaeger Tri-Packs® performance data taken from U.S. Department of Commerce document AD-A 158 811, June 1985.
AirStrip v.1.2 is a computer program which uses the mass transfer correlations of Onda et al., to design and rate air strippers.

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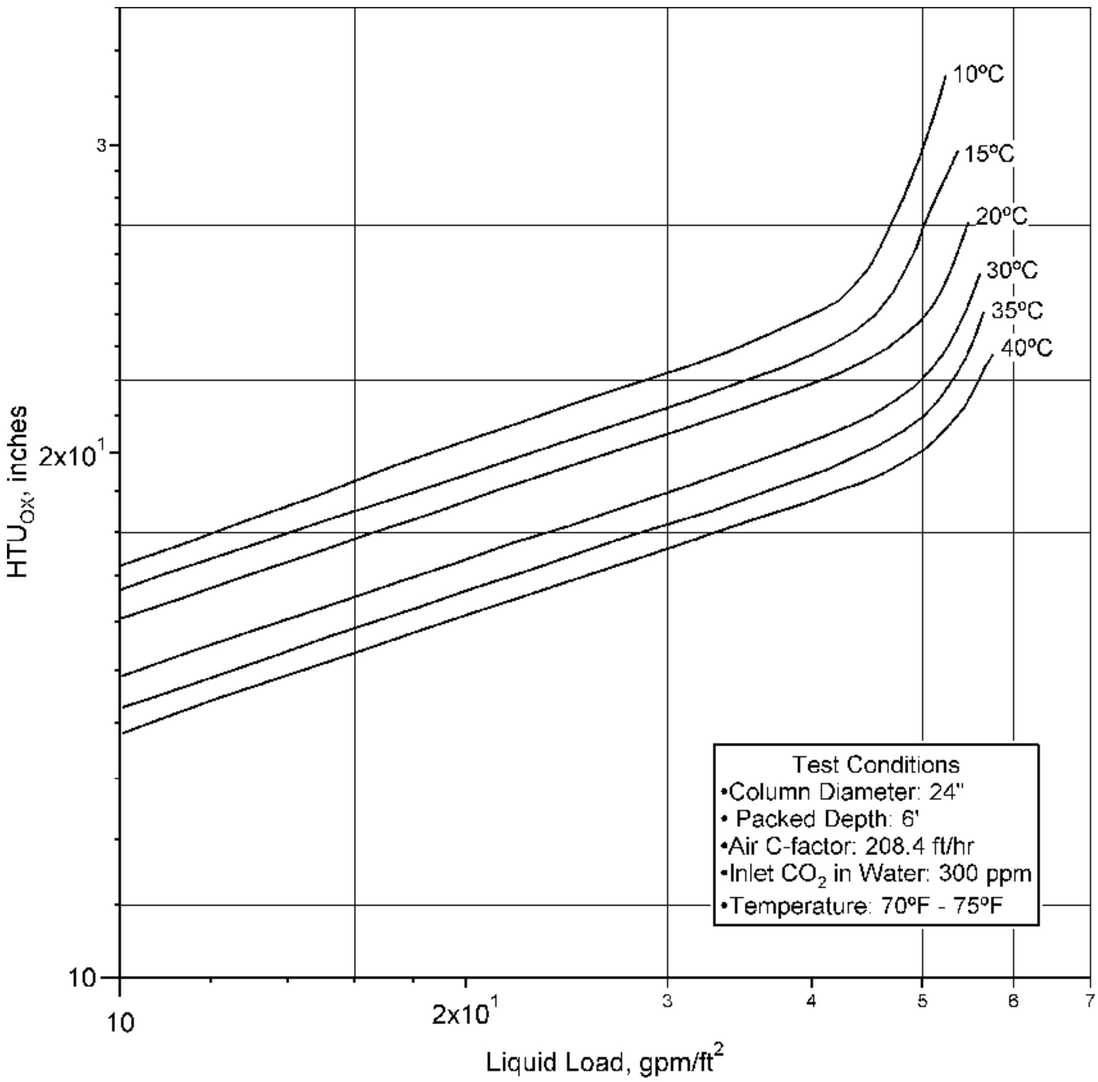
HTU_{OX} for CO_2 Desorption from Water

2” Plastic Jaeger Tri-Packs®



For Air/Water systems at 70oF & 1 atm: C-Factor x 7776.2 = lb/hr-ft2; gpm/ft2 x 499.7 = lb/hr-ft2

Absorption / Scrubbing

MASS TRANSFER DATA

Absorption System	G (lb/hr-ft^2)	L	Temp. (°F)	HTU-Inches		
				1	2	32
HCl-H_2O	1792	2048	77	7.0	10.6	12.0
HCl-NaOH	1567	2048	68	6.1	8.8	10.0
Cl_2-NaOH	1229	2202	122	9.9	14.5	16.0
NO_2-Na_2S+NaOH	717	1127	68	32.0	49.2	54.0
$NH_3H_2SO_4$	492	1024	68	4.1	6.0	7.0
NH_3-H_2O	512	1024	68	5.6	8.4	10.0
NH_3-H_2O	512	4096	68	3.6	5.4	6.2
SO_2-NaOH	1946	4096	140	8.1	12.0	14.0
HF-H_2O	1844	3072	77	4.6	6.9	8.1
H_2S-NaOH	1229	1331	68	13.0	19.4	22.0

Typical Design Parameters

Gas Velocity 100-500 ft/min.
These loadings are based on the cross-sectional area of the scrubber as seen by the gas. In counter-current scrubbers this area corresponds to the cross-section of the tower. In cross-flow scrubbers, it corresponds to the cross-section on a vertical plane of the packed bed.

Liquid Loading 2-10 gpm/ft2
These loadings are based on the cross-sectional area of the scrubber as seen by the liquid. In counter-current scrubbers, this area corresponds to the cross-section of the tower. In cross-flow scrubbers, it corresponds to the cross-section on a vertical plane of the packed bed.

Packing Size For random packings, optimum size scrubber diameter/packing size ratio is 12:1.

pH pH needs to be specified and controlled for any absorption involving contaminants which can dissociate in aqueous solution. Contact Jaeger for your specific application.

Pressure Drop Packed bed pressure drop in new scrubbers should be between 0.02” and 0.2” water/ft. of packed bed depth for optimum design.

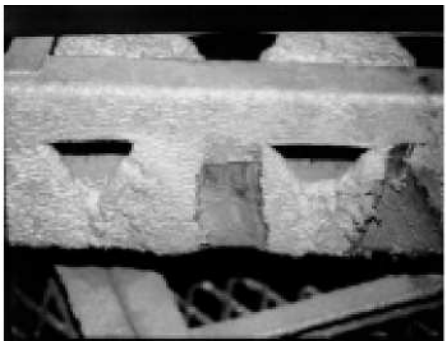
Blowdown and Makeup Rates These two variables need to be determined by process design and material balance considerations within the constraints shown above. Consult Jaeger for the proper values for your application

Jaeger Understand Your Water Treatment Needs

Among the biggest long term maintenance problems facing personnel charged with operating scrubbers and strippers are *scaling, fouling, and disinfection*. *Scaling* is the precipitation and deposition of water-insoluble salts onto column internals and packing. Scaling is distinct from *fouling*, which involves the formation of deposits other than salts and which may be due to corrosion or biological growth. Finally, operators must consider *disinfection* if the water being treated is ultimately destined for human or animal consumption.

Scaling is especially troublesome when the contaminant being dealt with can dissociate or needs to dissociate in water to effect its efficient removal. For these contaminants, water pH is adjusted by adding strong acids or bases to prevent or enhance dissociation. Generally speaking, dissociation needs to be prevented when the contaminant is to be stripped from water; it needs to be enhanced when the contaminant is to be scrubbed from air. Unfortunately, when these pH adjustments are performed on “hard” water, one is often forced to cross the solubility envelopes for sparingly soluble salts of calcium, iron, or magnesium (among others). If these solubility phase boundaries are crossed, precipitation is a thermodynamic inevitability. Contrary to popular belief, **packing geometry plays little or no role in the scaling process**. The rate at which a packing scales, therefore, depends primarily upon the initial water “hardness” and the “pH driving force”, i.e. the difference between the operating pH and the pH at the solubility limit for the salt in question, with secondary effects caused by liquid and gas loading

The pictures shown are of actual packings and internals taken from different air stripping towers in the field. The picture on the top right is of $3^{1/2}$" Lanpac®, claimed by its manufacturer to be “scaling and fouling resistant”. It came from an air stripper located in an area where the groundwater is high in iron. The middle picture is of a conventional Pall® ring that also fouled severely in an air stripping application. Finally, the bottom right picture is of the distributor removed from the same tower which held the Pall® rings of the center photo.



Two very common contaminants - ammonia and hydrogen sulfide - require that water pH be adjusted for effective stripping or scrubbing to take place. Ammonia is a weak base while hydrogen sulfide is a weak acid. Vapor/liquid equilibrium considerations make ammonia normally amenable only to scrubbing while hydrogen sulfide can be scrubbed or stripped. The top graph on the opposite page illustrates the effect of pH on the dissociation of these two compounds. The bottom graph is a solubility phase diagram for three of the more common cations found in “hard” water. Comparison of these two graphs illustrates that there can be significant overlap of the regions of best “operational” pH into regions of high scaling potential for these two example compounds. Similar analyses could be done for other compounds and/or other cations

Clearly, the best way to avoid costly shutdowns from scaling is to prevent them. Addition of sequestering agents or other appropriate chemicals can drastically minimize column down time. In situations where chemical addition is inappropriate, or perhaps even prohibited, a proper maintenance and cleaning program should be implemented, which might include *in situ* acid or caustic washing of the packing and internals. These measures will also help to reduce fouling.

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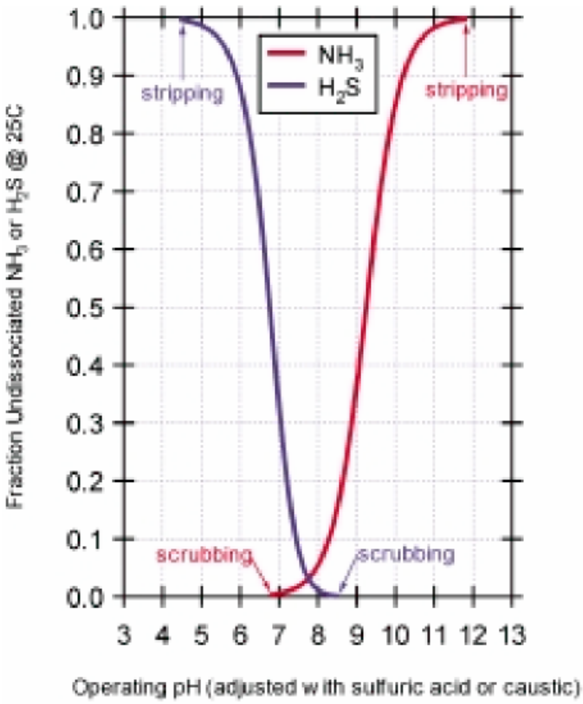
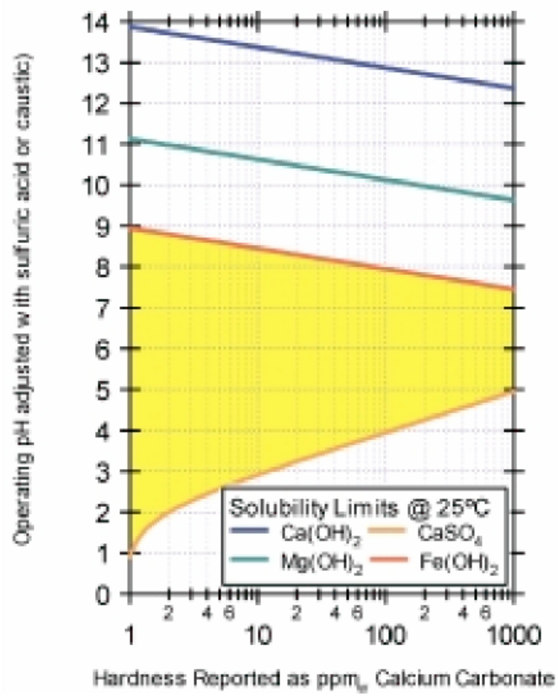
Disinfection refers to the killing of microorganisms. Most forms of disinfection, including chlorination and ozonation, kill organisms by oxidation. The exception is UV disinfection, which kills organisms with ultraviolet radiation. Chlorination is by far the most common disinfectant in use in the United States. One concern associated with chlorine use is its potential to react with suspended or soluble organic matter to produce *trihalomethanes* (*THMs*). These compounds appear to be potent carcinogens. The *trihalomethane formation potential* (*THMFP*) is a measure of the tendency of a water source to produce THMs. Unfortunately, the effectiveness of chlorine is decreased by high pH and low temperature. For these reasons, ozone is becoming a more common disinfectant. Ozone is a much more powerful oxidant than chlorine. It is also naturally unstable, with half-life of approximately 20 minutes. It, therefore, must be generated at its point of use. Ozonation is very common in Europe. It has received increased attention recently because it is the only disinfectant that appears to be effective against *cryptosporidium.*



Today, Jaeger is the only packing supplier offering you more than just rhetoric on the subjects of scaling, fouling, and disinfection. For example, our non-toxic pretreatment product, JP-7, is a proven technology based on polyphosphate chemistry. Polyphosphates sequester “hard” cations in solution by complexing with them to form large, soluble clusters. In addition, JP-7 has been approved by the EPA, the Department of Agriculture, and several state health agencies for use in potable water systems. Where water comes in contact with metals JP-7 has the added benefit of acting as a corrosion inhibitor. Contact Jaeger for additional information about scaling, fouling, and disinfection and how we might help you to overcome these difficulties.



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Conversion Factors

FROM	TO	MULTIPLY BY	ADD OFFSET
µg/ml	ppm_W	1.0	
1/ft	1/m	3.2808	
atm	psia	14.696	
atm	psig	14.696	-14.696
atm	torr	760	
C	F	1.8	32
C	K	1	273.15
C-factor (air/water @70ºF) ft/se	lb/hr ft^2	7776.2	
F	K	.5556	255.3722
ft	cm	30.48	
ft	m	.3048	
ft^2/ft^3	m^2/m^3	3.2808	
ft^3	gal (US)	7.4805	
ft3	m^3	.0283	
g/cm^3	lb/ft^3	62.428	
gm/cm^3	kg/m^3	1000	
gpm/ft^2	lb/hr ft^2(water @ 70ºF)	499.7	
hr	sec	3600	
in	m	.0254	
in wc/ft	$dyne/cm^3$	81.5617	
in wc/ft	Pa/m	815.6168	
kg	gm	1000	
kg	lb	2.2046	
kg/m^2*sec	lb/ft^2*hr	737.3402	
kg/sec	lb/hr	7936.6829	
kg mole/m^2*sec	lbmole/ft^2*hr	737.3402	
kW	hp	1.341	
lb	gm	453.59	
m2	cm^2	10000	
m2	ft^2	10.7639	
m^2/m^3	cm^2/cm^3	.01	
m3	liters	1000	
mg/l	ppm W	1.0	
Millions of Gallons/Day	gpm	694.46	
min	sec	60	
ppm_W	ppb_W	1000	

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Physical Properties of Jaeger Packings

	Size (nominal)	Packing Factor [1/ft]	Weight [lb/ft³]	Surface Area [ft²/ft³]	Void Space [%]
Plastic Packing					
Jaeger Tri-Packs®	1"	28	6.2	85	90
	1 1/4"	25	5.6	70	92
	2"	16	4.2	48	93.5
	3 1/2"	12	3.3	38	95
Raschig Super-Ring	Nr. 0.6		3.9	63	93
	Nr. 2		3.5	30.5	96
Cascade Mini-Rings®	1"	26	4.0	85	92
	2"	16	3.5	50	93
	3 1/2"	12	3.2	40	94
Jaeger Rings	5/8"	97	7.8	108	86
	1"	52	5.9	64	80
	1 1/4"	32	4.8	44	91
	2"	25	4.3	33	92
	3 1/2"	16	3.8	26	93
Jaeger Saddles	1"	33	4.7	60	91
	2"	21	3.3	30	94
	3"	16	2.8	20	95
Bio-Ring™	3 1/2"	NA	2.8	32	95
Cascade Bio-Rings™	7"	NA	2.2	30	95
Random Metal Packing					
Raschig Super-Ring	Nr. 0.3		21.2	96	96
	Nr. 0.5		17.2	76.2	97
	Nr. 0.7		11.6	55	98
	Nr. 1		10.3	45.7	98
	Nr. 1.5		10.6	36.5	98
	Nr. 2		10.6	30.5	98
	Nr. 3		9.4	24.4	98
Metal Structured Packing					
Raschig Super-Pak	100Y			30.5	98
	150Y			45.7	98
	200Y			61	98
	250Y			76.2	98
	300Y			91.5	98
	350Y			106.7	97
	400Y			122	97
	500Y			152.4	96
	750Y			228.6	96
Max-Pak™	1/2"	19-22	12.8	77	97
Ceramic Packing					
Novalox® Saddles	1/2"	201	43.0	190	73
	3/4"	131	41.0	102	74
	1"	97	40.3	78	74
	1 1/2"	52	40.3	61	75
	2"	40	36.8	37	77
	3"	22	35.9	28	77

Weights of plastic based on polypropylene
Weights of metal based on 300 series stainless steel
All weights are dry weights

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Locations / Production Sites

Ludwigshafen and Espenhain,
Germany

Houston, Texas
El Dorado, Kansas
And Monterrey, Mexico.

Furthermore we co-operate with reliable partners all over the world

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