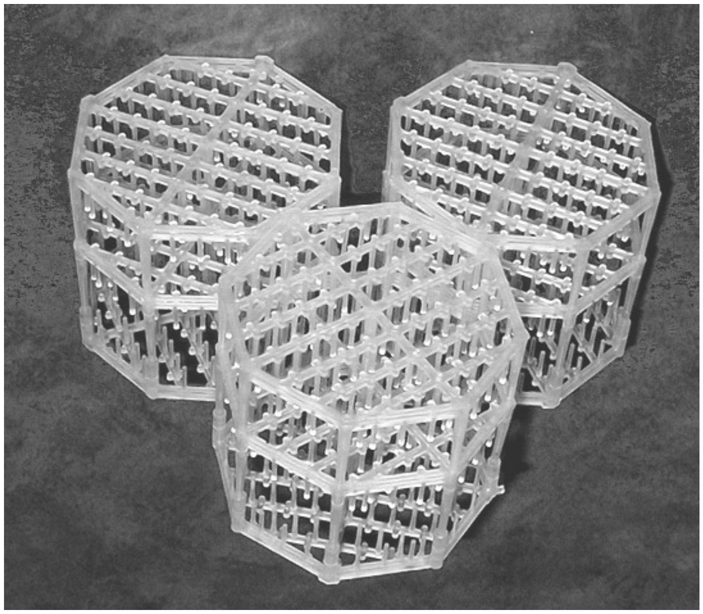
Q-PAC
Comparison Data
Section



QPC/QDTA-0205-A

ADVANTAGES OF USING Q-PAC TOWER PACKING

1. **Smaller Tower Diameters**
   Reduced capital & fabrication costs, smaller system footprint
2. **Lower Pressure Drop**
   Smaller blower motors, lower electrical energy costs, less noise
3. **Smaller Recirculation Pumps**
   Save on equipment and operation costs
4. **Increases Flow Rates of Existing Towers**
   Increase capacity by 30-50%
5. **Smaller Mist Eliminator Diameters**
6. **Less Total Packing Volume**
7. **Q-PAC is a Lower Cost Packing**
8. **Fouling and Plugging Resistant**
   Reduced maintenance costs

Acid Gas Scrubber Packing Test

Q-PAC® vs. Conventional Random Plastic Packings

by Oscar Reynoso
Chemical Engineer

Introduction

Plastic Q-PAC®, from Lantec Products, has been developed as a high-capacity random packing for large scrubbers, gas absorbers, and cooling towers. With a nominal size of 4 inches, a geometric surface area of 30 ft^2/ft^3, and a packing factor of just 7 ft^{-1}, Q-PAC® provides a combination of air-water contacting efficiency and low pressure drop which is unmatched by any other random dumped packing in the world.

In order to assess the suitability of Q-PAC® for scrubber applications, we compared its contacting efficiency and pressure drop to those of widely used polypropylene packings under identical, controlled conditions.

Test Procedure

Q-PAC®, 3.5-inch Tri-Packs®, and 2K Tellerettes® were tested in a counter-current packed scrubber for removal of sulfur dioxide from air. The SO_2 system has long been used by Lantec for comparison of packings, because it allows precise, reproducible measurement of operating parameters and mass-transfer rates, which are not affected by changes in weather conditions. The efficiency of mass transfer depends on the ability of the packing to create more gas-liquid contacting surface, so the results of this scrubbing test are a good predictor of the relative performance of these packings in any acid gas scrubber.

The test apparatus consists of a vertical counter-current scrubber with a cross-sectional area of 6.0 ft^2, packed with one or the other media to a depth of 3.0 ft. The scrubber is equipped with variable-speed fan and pump drives, allowing us to adjust both the gas flow and the liquid loading on the media. The air was spiked with SO_2, fed from a cylinder under its own vapor pressure. The injection point was 15 duct diameters upstream from the scrubber inlet, to allow for adequate mixing. The regulator on the SO_2 cylinder was adjusted manually to give an inlet concentration in the range of 80~120 ppm_v at each air flow rate. Inlet and outlet SO_2 concentrations were measured simultaneously using Interscan electrochemical analyzers.
The air was scrubbed using a buffered solution of 2% sodium bicarbonate and sodium hydroxide. An automated chemical feed system added NaOH as required to maintain a constant pH of 9.15±0.05 throughout the test.

The air and water flow rates used were in the ranges typically encountered in gas scrubber operation. The gas loading was varied from 500 to 3000 lb/hr-ft^2, corresponding to superficial velocities of 110 to 670 ft/min. The liquid loading ranged from 5 to 8 gpm/ft^2.

Results and Discussion

The test results are summarized in the attached graphs. Gas-liquid contacting efficiency is quantified in terms of the height of a transfer unit, abbreviated HTU. (This is the depth of media required to reduce the SO_2 concentration to approximately 37% of its initial value.) The data show that Q-PAC® is slightly more efficient than 2K Tellerettes®, at less than half the pressure drop per foot. Compared with 3.5-inch Tri-Packs®, Q-PAC® is approximately 40% more efficient, with about half the pressure drop.

The lower pressure drop of Q-PAC® made it possible to continue scrubbing tests at gas velocities all the way up to 900 ft/min without exceeding the fan's capacity. At higher velocities, the liquid holdup on the packing increases, and the more turbulent air flow helps break the water into smaller droplets, resulting in increased gas-liquid contacting surface. As a result, the height of a transfer unit actually begins to decrease as the velocity increases beyond 600 ft/min. (The same behavior is observed with conventional packings, but their high pressure drop makes it impractical to operate a scrubber at much over 500 ft/min.)

Conclusion

The gas-liquid contacting efficiency of Q-PAC® is as good or better than that of conventional random plastic packings, and it provides substantially higher gas handling capacity. The high capacity of Q-PAC® can be utilized in two different ways. When designing new equipment, the cross section of a scrubber can be reduced in order to cut the costs of the vessel, recirc pump, and media, without requiring a larger fan or increasing the operating cost of fan power. Attached is a table comparing the vessel diameters needed for a standard sewage treatment odor-control scrubber (packed depth 10 ft, packing ΔP 2 inches) using each of these packings.

As an alternative, scrubbers can be sized for conventional gas velocities, but packed with Q-PAC® in order to cut the pressure drop for reduced fan power consumption. Retrofitting an existing scrubber with Q-PAC® makes it possible to increase the air flow without changing the fan. One Lantec customer recently installed Q-PAC® in a hydrogen chloride absorber whose throughput had been limited by the fan capacity. Not only did they obtain the desired increase in gas flow, but employees on site reported a welcome reduction in noise levels now that the fan doesn't have to strain so hard.

Q-PAC® should also be considered for scrubbers in which media fouling is a problem. The uniform spacing of plastic elements in Q-PAC® minimizes the tendency of solids to accumulate on it. Hard enough water or high enough particulate loadings will eventually foul any packing, but with Q-PAC®, a scrubber that is prone to plugging can be run longer between shutdowns to clean the media.

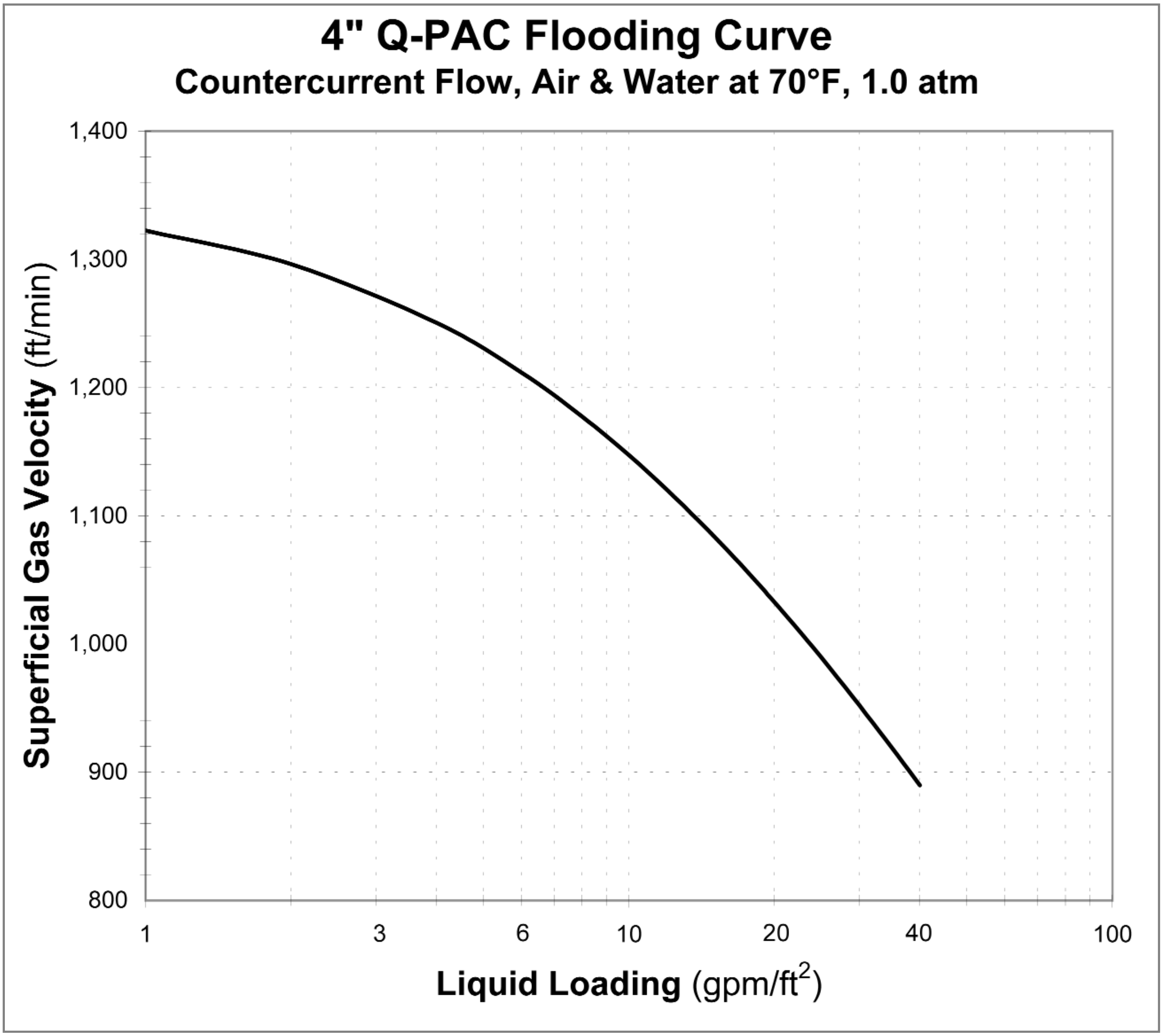
Pilot Test Data (runs MT4, MT7, MTT44, MTT46)			4" Q-PAC		3.5" Tri-Packs		2K Tellerette	
v_G (ft/min)	Recirc. (gpm)	L (gpm/ft^2)	ΔP/z ($in.H_2O/ft$)	HTU (ft)	ΔP/z ($in.H_2O/ft$)	HTU (ft)	ΔP/z ($in.H_2O/ft$)	HTU (ft)
900	30	5.0	0.53	1.10				
800	30	5.0	0.38	1.15				
700	30	5.0	0.27	1.23				
600	30	5.0	0.18	1.29	0.317	1.80	0.364	1.33
500	30	5.0	0.12	1.24	0.215	1.79	0.235	1.28
400	30	5.0	0.08	1.17	0.134	1.71	0.145	1.20
300	30	5.0	0.04	1.05	0.075	1.57	0.078	1.06
200	30	5.0	0.02	0.91	0.036	1.28	0.035	0.86
900	40	6.7	0.63	1.05				
800	40	6.7	0.44	1.10				
700	40	6.7	0.31	1.16				
600	40	6.7	0.21	1.23	0.340	1.59	0.385	1.21
500	40	6.7	0.14	1.18	0.227	1.66	0.248	1.17
400	40	6.7	0.09	1.12	0.139	1.55	0.153	1.10
300	40	6.7	0.05	1.00	0.081	1.40	0.084	0.96
200	40	6.7	0.02	0.88	0.038	1.07	0.038	0.81
900	50	8.3	0.73	1.00				
800	50	8.3	0.50	1.03				
700	50	8.3	0.35	1.11				
600	50	8.3	0.24	1.16	0.356	1.55	0.398	1.07
500	50	8.3	0.16	1.12	0.237	1.42	0.257	1.03
400	50	8.3	0.10	1.03	0.149	1.39	0.156	0.99
300	50	8.3	0.05	0.93	0.083	1.17	0.089	0.86
200	50	8.3	0.02	0.80	0.038	0.96	0.040	0.71
900	60	10.0	0.83	0.95				
800	60	10.0	0.56	0.97				
700	60	10.0	0.39	1.03				
600	60	10.0	0.26	1.09	0.370	1.27	0.429	0.97
500	60	10.0	0.17	1.04	0.246	1.26	0.272	0.94
400	60	10.0	0.11	0.97	0.156	1.18	0.164	0.87
300	60	10.0	0.06	0.87	0.087	1.02	0.091	0.77
200	60	10.0	0.03	0.75	0.042	0.80	0.042	0.62

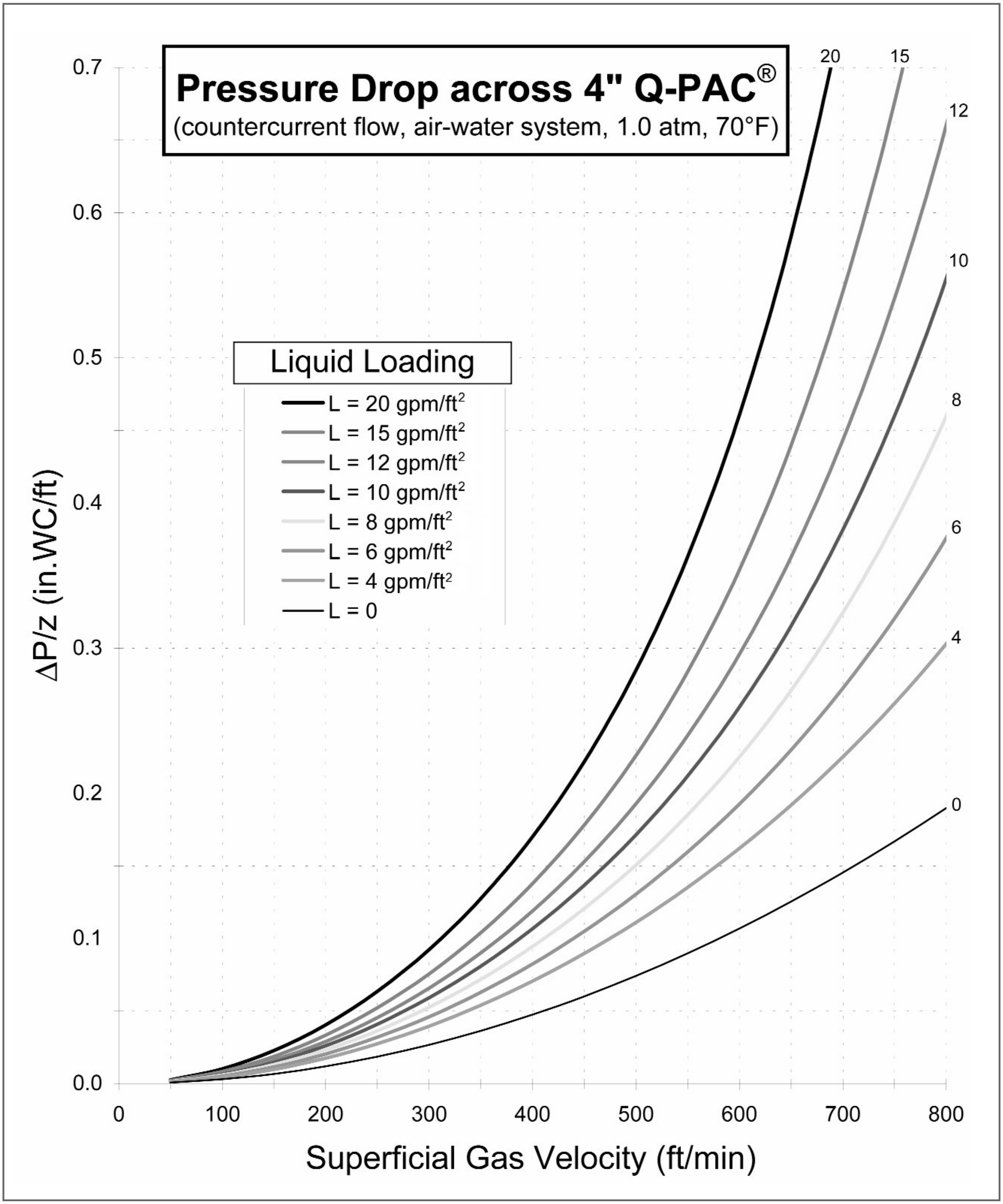
Analysis of Flooding Points in a 10' Diameter Tower

(Vertical, counter current flow, 60,000 acfm air flow, 6 gpm per ft^2 liquid flow, 10 ft packing)

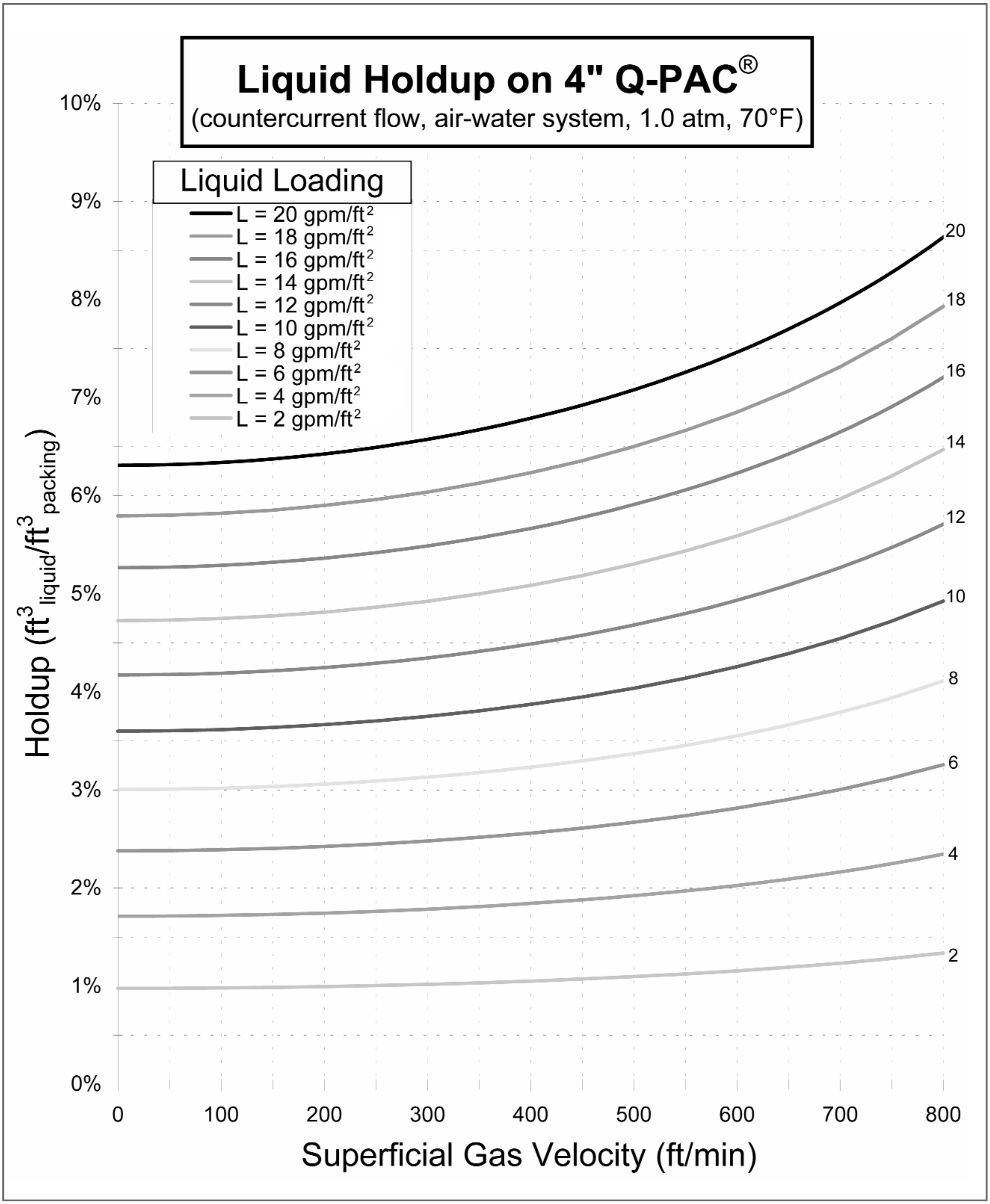
	2" Pall Rings	2" Tri-Packs	2-K Tellerettes	3.5" Tri-Packs	Q-PAC
Gas Velocity:	764 fpm	764 fpm	764 fpm	764 fpm	764 fpm
Pressure Drop*:	15.0" WC	12.0" WC	12.0" WC	5.4" WC	3.3" WC
% Flooding:	115	105	105	89	**62**

Q-PAC has the only practical design!

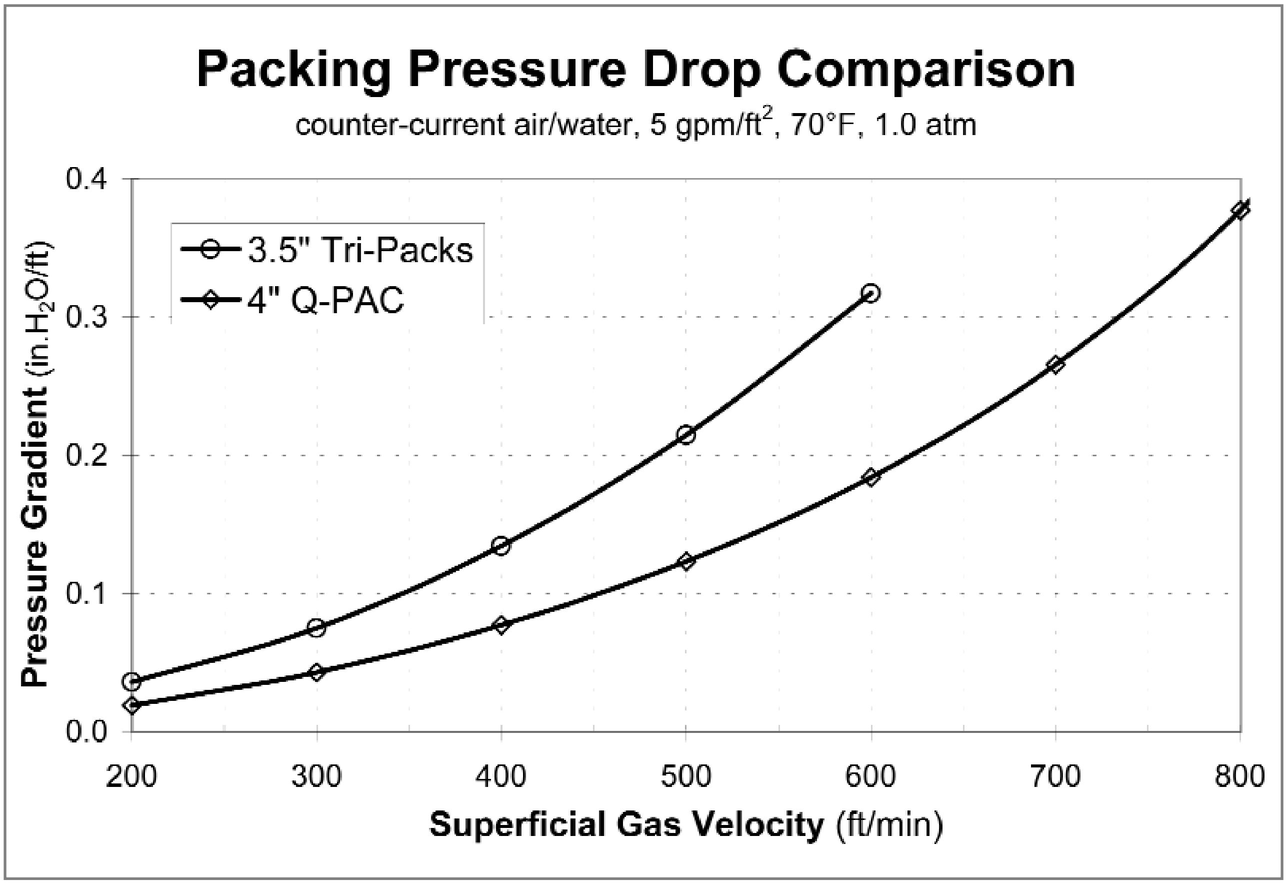


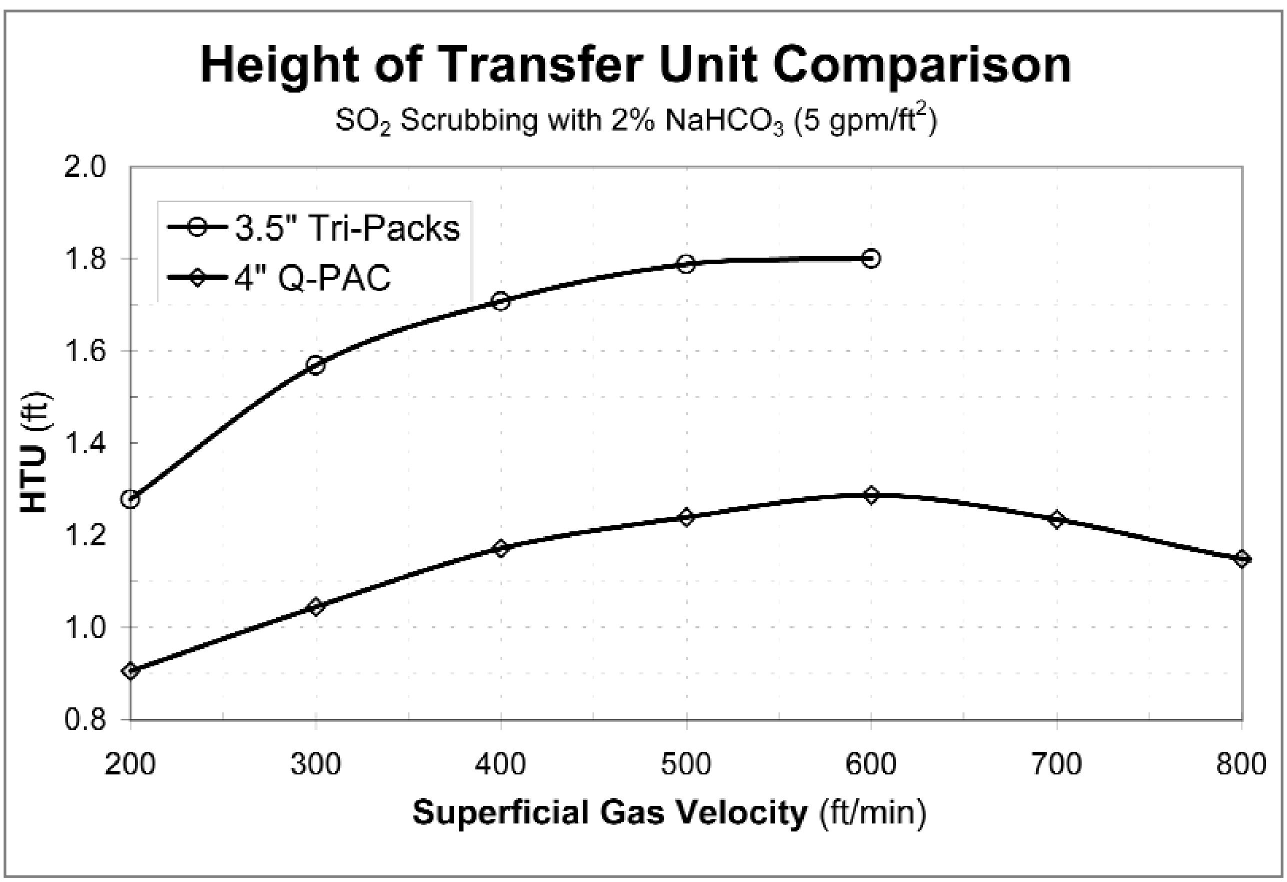


Pressure Drop across 4" Q-PAC®
(countercurrent flow, air-water system, 1.0 atm, 70°F)
Liquid Loading
L = 20 gpm/ft2
L = 15 gpm/ft2
L = 12 gpm/ft2
L = 10 gpm/ft2
L = 8 gpm/ft2
L = 6 gpm/ft2
L = 4 gpm/ft2
L = 0
20
15
12
10
8
6
4
0
ΔP/z (in.WC/ft)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
100
200
300
400
500
600
700
800
Superficial Gas Velocity (ft/min)

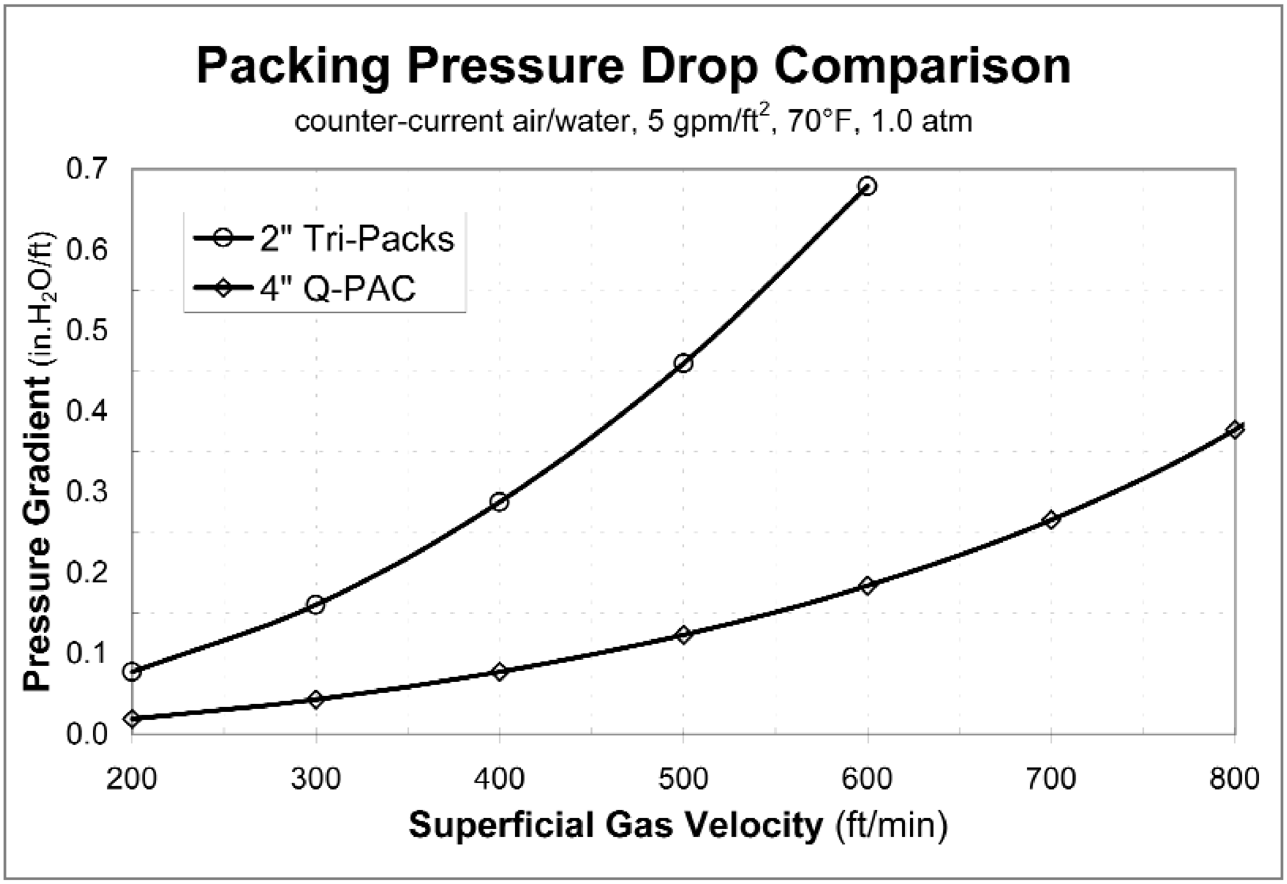

Liquid Holdup on 4" Q-PAC®
(countercurrent flow, air-water system, 1.0 atm, 70°F)
Liquid Loading
L = 20 gpm/ft²
L = 18 gpm/ft²
L = 16 gpm/ft²
L = 14 gpm/ft²
L = 12 gpm/ft²
L = 10 gpm/ft²
L = 8 gpm/ft²
L = 6 gpm/ft²
L = 4 gpm/ft²
L = 2 gpm/ft²
Holdup (ft³liquid/ft³packing)
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
0
100
200
300
400
500
600
700
800
Superficial Gas Velocity (ft/min)
20
18
16
14
12
10
8
6
4
2

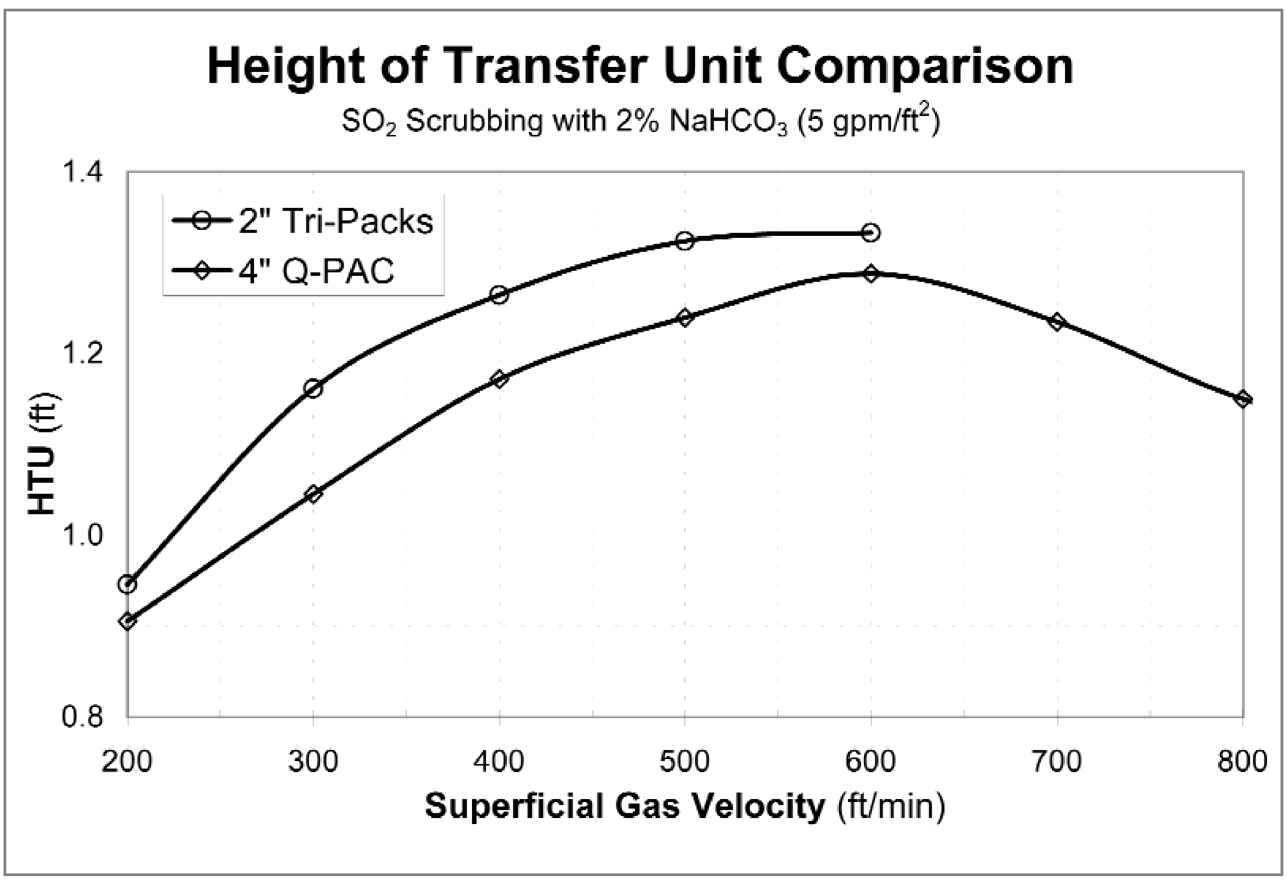
Q-PAC® VS. 3.5" TRI-PACKS



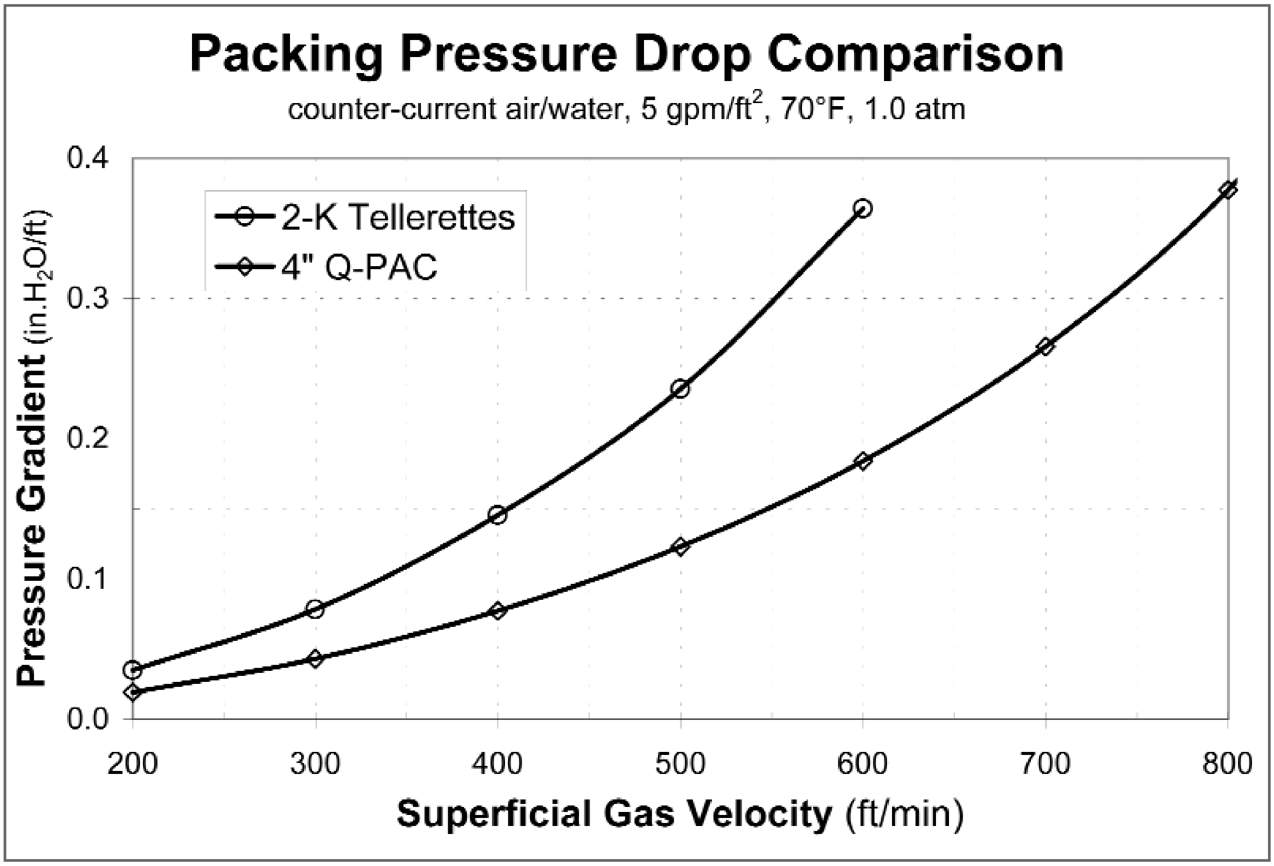


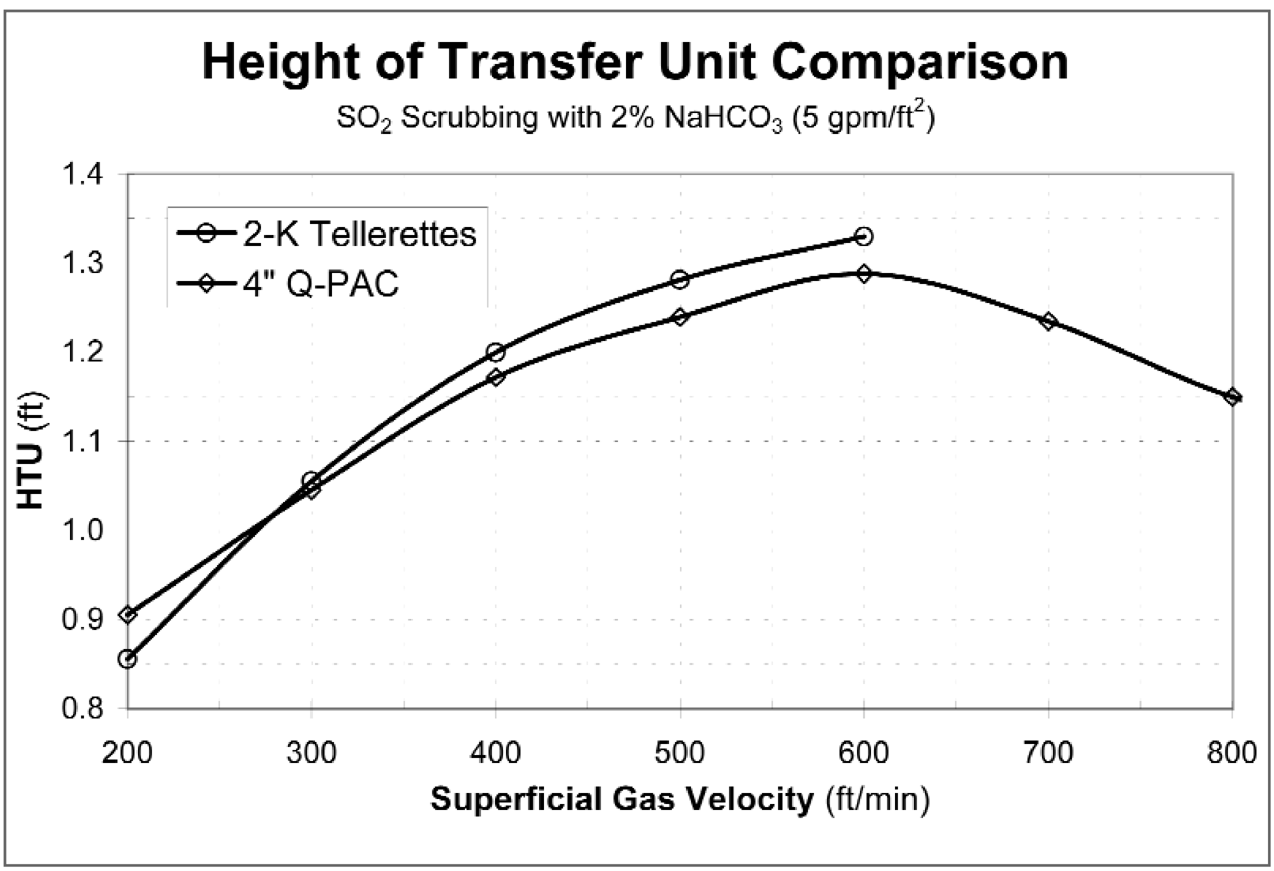
Q-PAC® VS. 2" TRI-PACKS



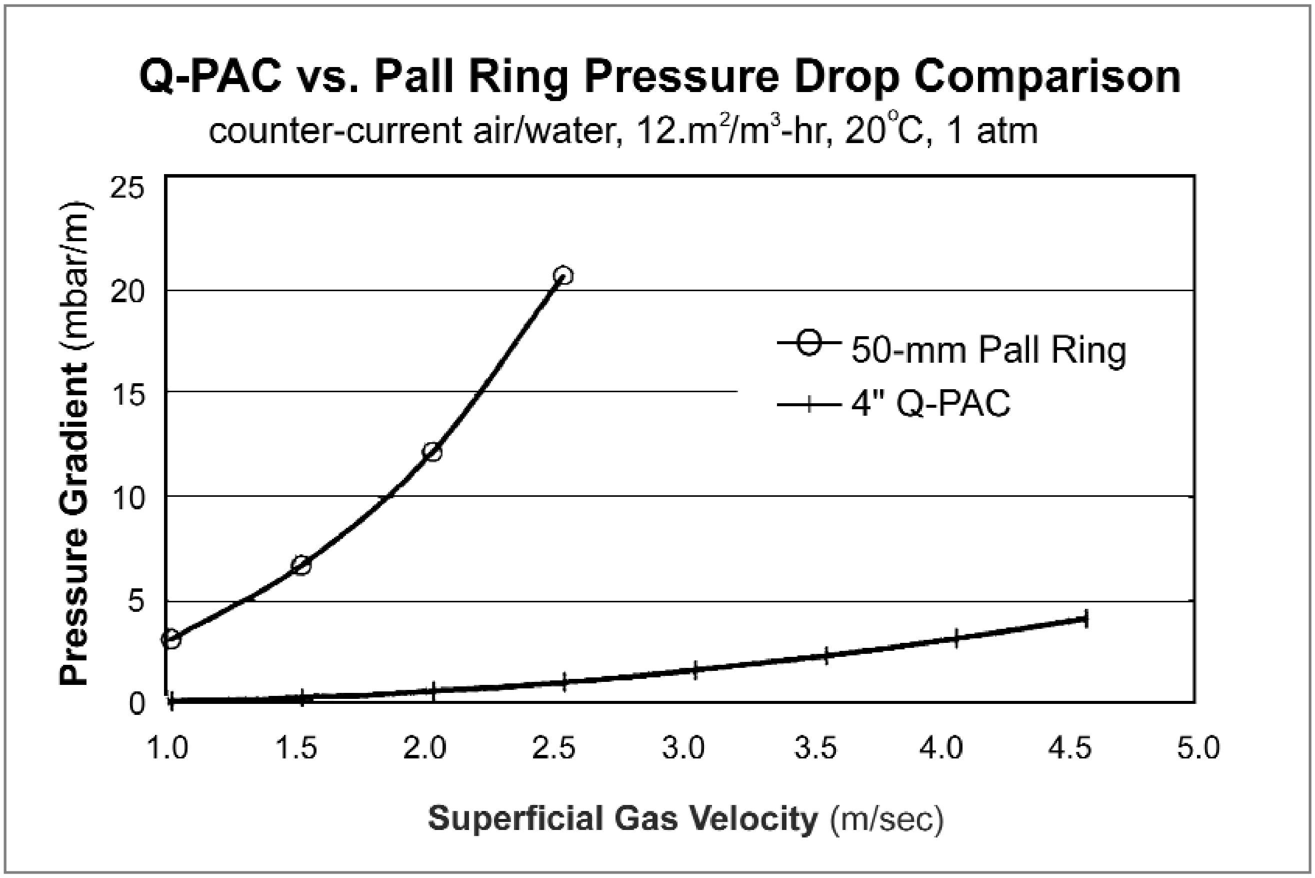


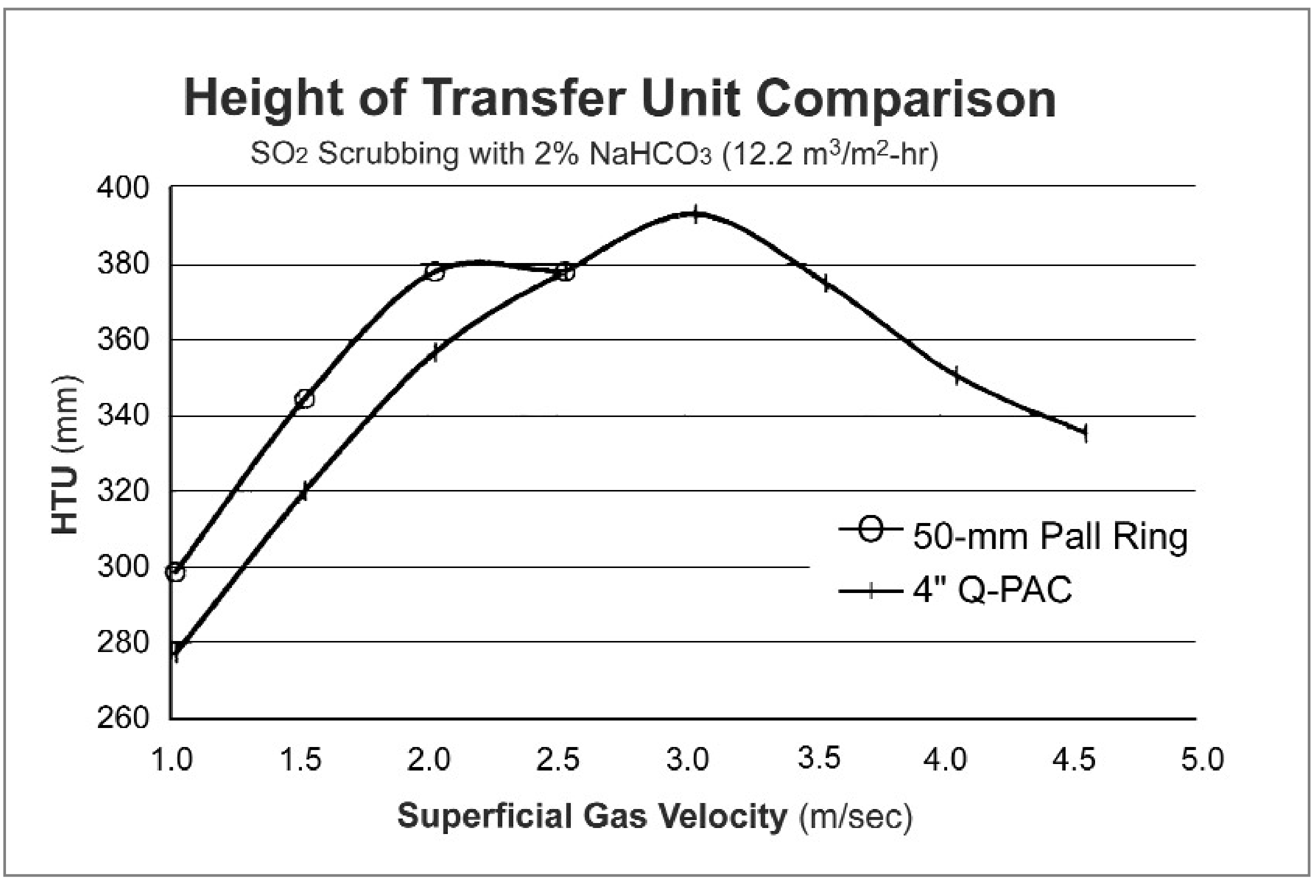
Q-PAC® VS. 2-K TELLERETTES





Q-PAC® VS. PALL RINGS

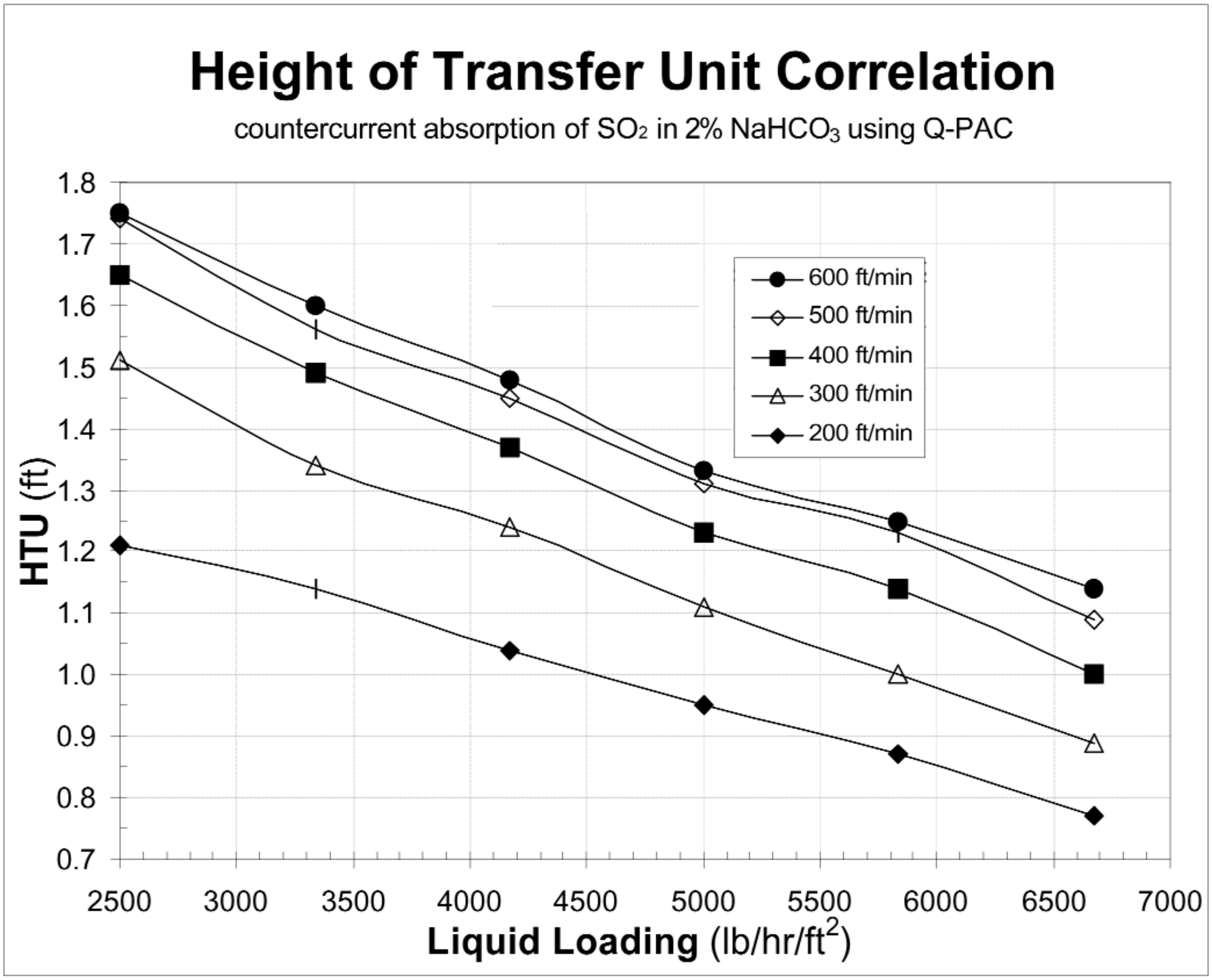




Boost Scrubber Capacity
by Retrofitting with 4" Q-PAC

Example: 12-ft diameter tower removing 99.9% of H_2S using water with NaOCl and NaOH added to maintain pH 9.5~10 and ORP 550~600 mV at 70°F, atmospheric pressure

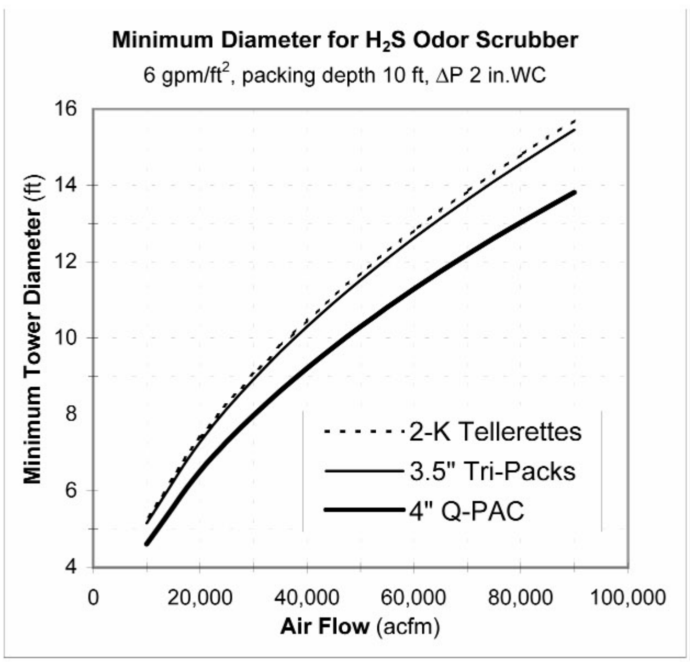
Superficial Gas Velocity v_G (ft/min)	Scrubber Capacity Q (acfm)	Liquid Loading L (gpm/ft^2)	Pressure Gradient $\Delta P/z$ (in.WC/ft)	Packing Height z (ft)	Pressure Drop ΔP (in.WC)
700	79,200	8	0.34	7.5	2.5
700	79,200	6	0.29	8.5	2.5
700	79,200	4	0.24	10.0	2.4
600	67,900	8	0.23	7.5	1.7
600	67,900	6	0.20	8.5	1.7
600	67,900	4	0.17	10.0	1.7
500	56,500	8	0.15	7.5	1.1
500	56,500	6	0.13	8.0	1.1
500	56,500	4	0.11	9.5	1.1
400	45,200	8	0.09	7.0	0.7
400	45,200	6	0.08	7.5	0.6
400	45,200	4	0.07	9.0	0.6
300	33,900	8	0.05	6.0	0.3
300	33,900	6	0.05	7.0	0.3
300	33,900	4	0.04	8.0	0.3
200	22,600	8	0.02	5.0	0.1
200	22,600	6	0.02	5.5	0.1
200	22,600	4	0.02	6.5	0.1

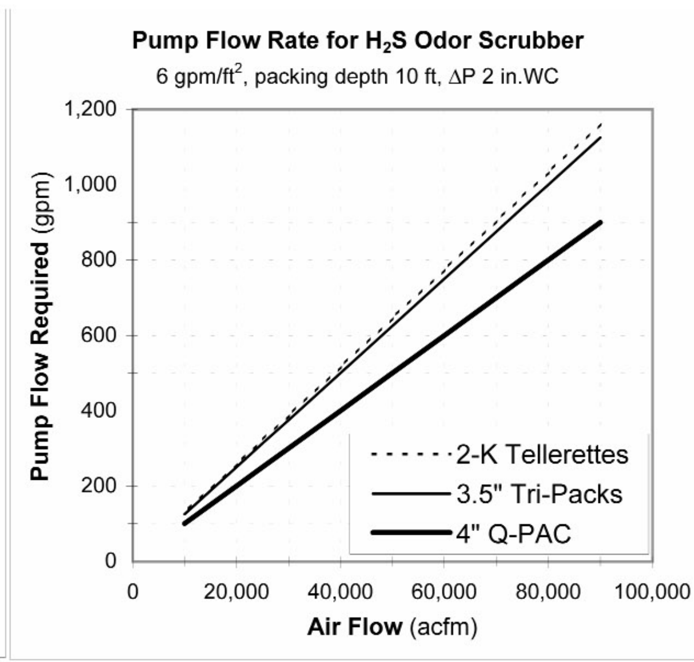

Height of Transfer Unit Correlation
countercurrent absorption of SO2 in 2% NaHCO3 using Q-PAC
600 ft/min
500 ft/min
400 ft/min
300 ft/min
200 ft/min
HTU (ft)
Liquid Loading (lb/hr/ft2)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000

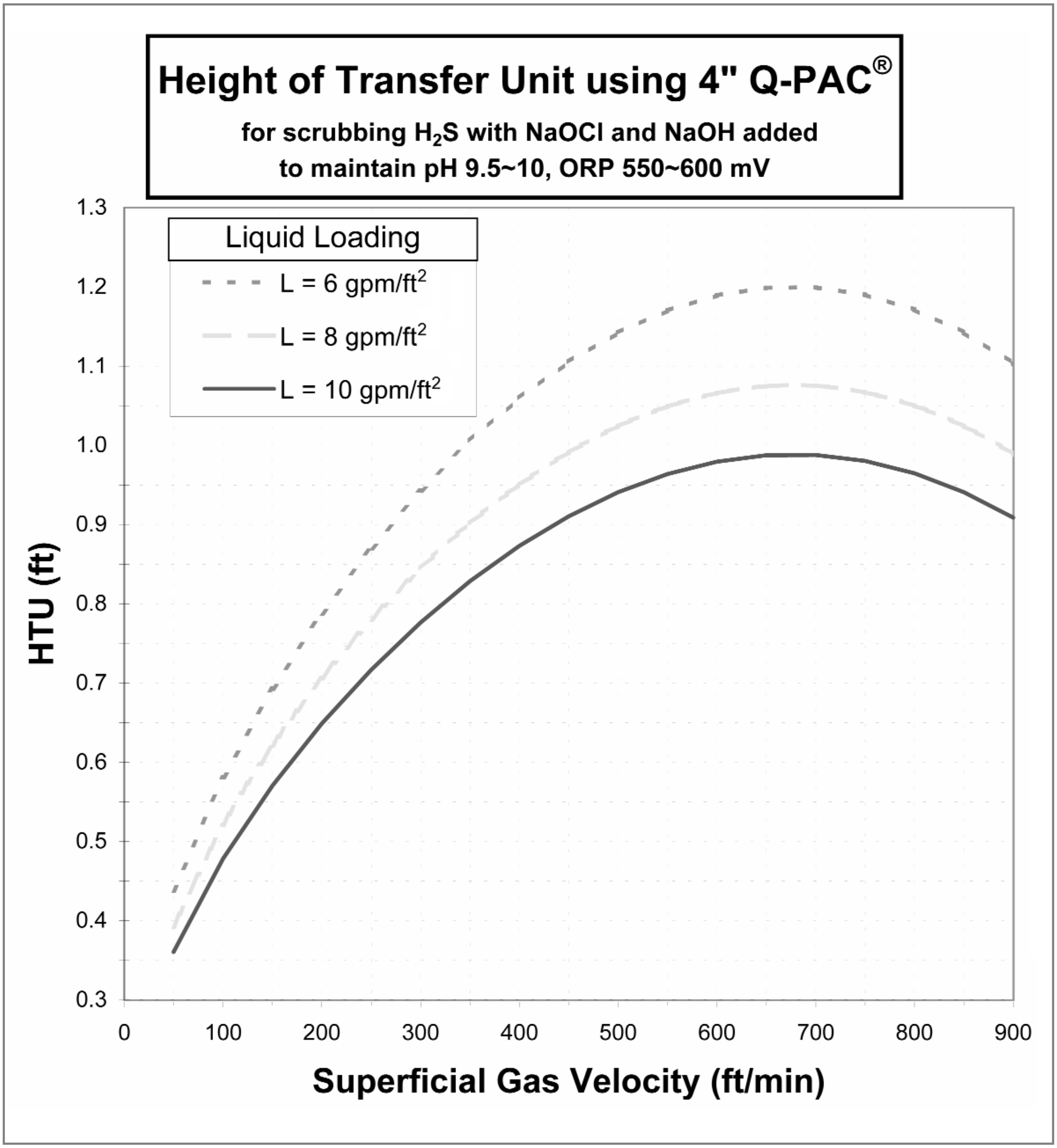
Reduce Scrubber Size without Increasing Fan Power Costs

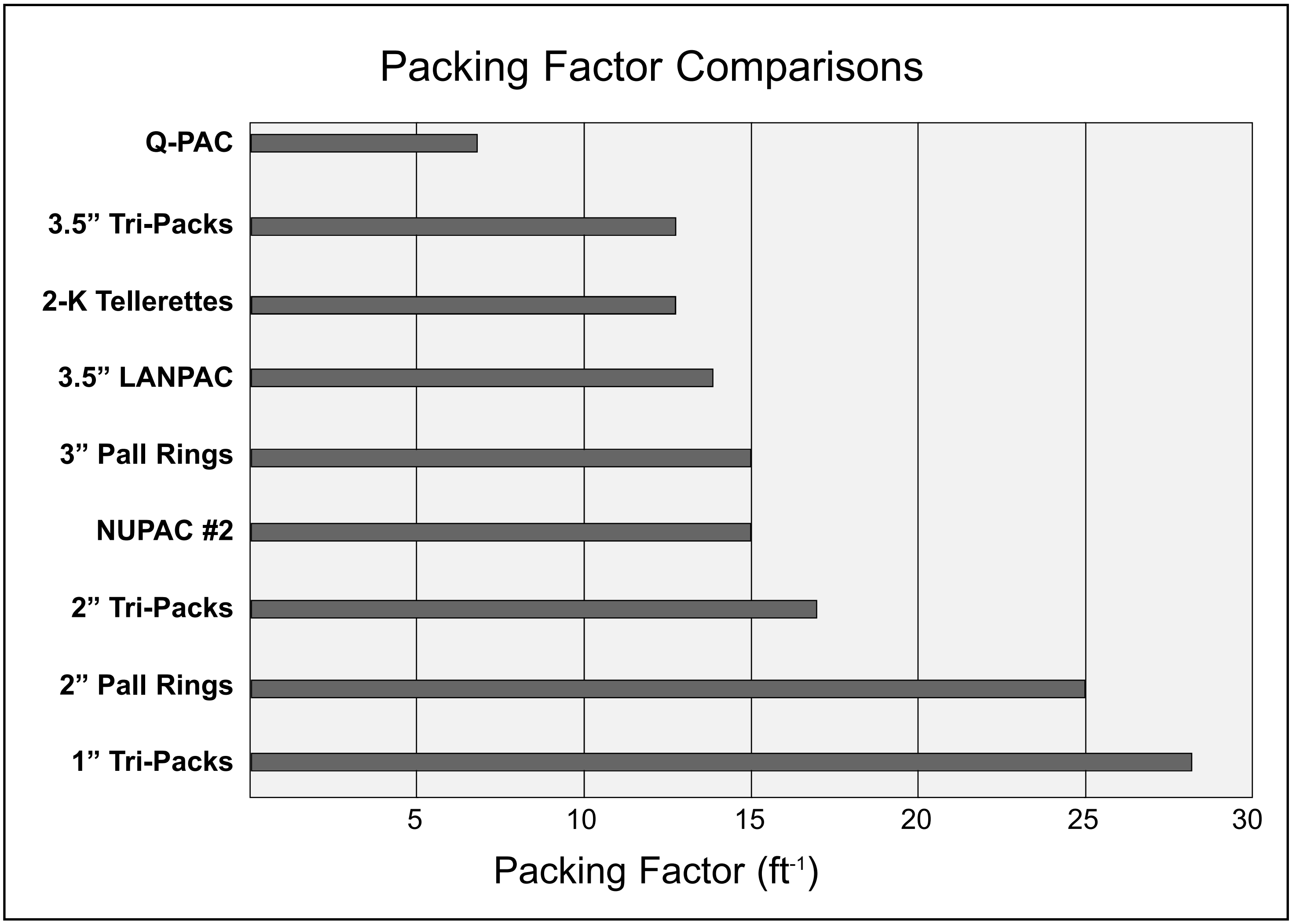
Example: H_2S Odor-Control Scrubber, liquid flux 6 gpm/ft^2, packing depth 10 ft, $\Delta P \leq 2$ in.WC

	Using Q-PAC				Using 3.5" Tri-Packs				Using 2-K Tellerettes			
	Superficial Gas Velocity 600 ft/min				Superficial Gas Velocity 480 ft/min				Superficial Gas Velocity 465 ft/min			
Air Flow Rate (acfm)	Minimum Tower Diameter (ft)	Rounded Tower Diameter (ft)	Min. Pump Flow (gpm)	H_2S Odor Removal	Minimum Tower Diameter (ft)	Rounded Tower Diameter (ft)	Min. Pump Flow (gpm)	H_2S Odor Removal	Minimum Tower Diameter (ft)	Rounded Tower Diameter (ft)	Min. Pump Flow (gpm)	H2S Odor Removal
90,000	13.8	14	900	99.9%	15.5	16	1125	99.8%	15.7	16	1161	99.9%
80,000	13.0	14	800	99.9%	14.6	15	1000	99.8%	14.8	15	1032	99.9%
70,000	12.2	13	700	99.9%	13.6	14	875	99.8%	13.8	14	903	99.9%
60,000	11.3	12	600	99.9%	12.6	13	750	99.8%	12.8	13	774	99.9%
50,000	10.3	11	500	99.9%	11.5	12	625	99.8%	11.7	12	645	99.9%
40,000	9.2	10	400	99.9%	10.3	11	500	99.8%	10.5	11	516	99.9%
30,000	8.0	8	300	99.9%	8.9	9	375	99.8%	9.1	10	387	99.9%
20,000	6.5	7	200	99.9%	7.3	8	250	99.8%	7.4	8	258	99.9%
10,000	4.6	5	100	99.9%	5.2	6	125	99.8%	5.2	6	129	99.9%






Height of Transfer Unit using 4" Q-PAC®
for scrubbing H2S with NaOCl and NaOH added
to maintain pH 9.5~10, ORP 550~600 mV
Liquid Loading
L = 6 gpm/ft2
L = 8 gpm/ft2
L = 10 gpm/ft2
HTU (ft)
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
100
200
300
400
500
600
700
800
900
Superficial Gas Velocity (ft/min)


Packing Factor Comparisons
Q-PAC
3.5” Tri-Packs
2-K Tellerettes
3.5” LANPAC
3” Pall Rings
NUPAC #2
2” Tri-Packs
2” Pall Rings
1” Tri-Packs
5
10
15
20
25
30
Packing Factor (ft-1)

