

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 ft²/ft³, 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 SO₂ 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 ft², 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 SO₂, 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 SO₂ 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 SO₂ 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-ft², corresponding to superficial velocities of 110 to 670 ft/min. The liquid loading ranged from 5 to 8 gpm/ft².

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 SO₂ 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)

Pilot Test Data			4" Q-PAC		3.5" Tri-Packs		2K Tellerette	
V _G (ft/min)	Recirc. (gpm)	L (gpm/ft ²)	ΔP/z (in.H ₂ O/ft)	HTU (ft)	ΔP/z (in.H ₂ O/ft)	HTU (ft)	ΔP/z (in.H ₂ O/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