 2S. A.

Note: other information submitted with 2S.A is duplicated in the DEP Regional File.

AIR STRIPPING TOWER DESIGN METHODOLOGY

Design requirements for the Vanport Township TCE removal system are as follows:

Average flow - 1.4 MGD

Design flow - 2.7 MGD

Average influent TCE concentration - 100 ppb

Design influent TCE concentration - 1000 ppb

Required effluent TCE concentration $\leq$ 2.6 ppb

The proposed TCE Removal System is to be a two-stage air stripping process. The first tower of the system is designed to process existing average criteria, namely, 1.4 MGD with an influent and effluent TCE concentration of 100 ppb and 2.6 ppb, respectively. The second tower has a two-fold purpose. Under present and normal operating conditions, the second tower will be used during periods of maintenance for the first tower allowing non-interrupted flow. However, should influent concentrations or flow demand increase, the two towers would be operated in series to achieve the required reduction.

The proposed system consists of two identical stripping towers. Each tower is to be 9.5 feet in diameter and contain 14.5 feet of No. 1 Jaeger Tri-Pack packing media. Each tower will be outfitted with a backwardly inclined Fan type blower capable of delivering 7500 scfm at 3" of static water pressure with 4.8 BHP. The blower size is governed by the design requirements of 2.7 MGD and an air-to-water ratio of 30:1. The packed height of the two towers is governed by the average flow and concentration data such that a single tower meets discharge criteria.

Table one (1) presents design performance data for the air stripping system based on computer modeling. For the five (5) cases described, tower diameter, packed height, water temperature, and air flowrate are held constant. Case 1 represents tower performance for the design required by the consent order. Case 2 represents performance for a flow of 2.7 MGD and the highest influent TCE concentration presently observed of 275 ppb. Case 3 represents performance for average flow and influent TCE concentrations. Case 4 represents the highest influent TCE concentration that can be treated to meet discharge criteria under average flow conditions of 1.4 MGD with a single tower. Case 5 represents performance of a single tower operation at the lowest hydraulic loading possible, the highest influent TCE concentration and still meet discharge criteria.

Also listed in Table 1 is total pressure drop through each tower for the five (5) cases described. The proposed blowers for each tower are capable of 7500 scfm at 3" of static water pressure. Therefore, for Case 1, a safety factor of 4.6 against packing fouling is realized. Safety factor against fouling for the other four cases are given in Table 1.

Table X two (2) presents actual performance data for the air stripping system under non-fouling conditions. Since the proposed blowers for the system are capable of 7500 scfm at 3" static water pressure, and under non-fouling conditions, the resulting air-to-water ratios are increased. Therefore, in Table 2, the same parameters are held constant with the exception of air flowrate. In this case, air-to-water ratios are allowed to increase to levels corresponding to pressure drop due to the packing material only. As shown in Table 2, safety factors with respect to reduction for cases 1, 2, and 3 are 1.6, 1.3, 1.2, respectively.

Computer printouts of the stripping tower design analysis for the five cases and calculations of theoretical pressure drop are given in the appendix. In addition, complete documentation of the computer program used to model the air stripping process are given in the appendix. The pilot study currently underway at the site will be used to determine actual pressure drop for the packing media proposed as well as the potential for fouling.

TABLE 1

Design Temperature = 55^{o} F Airflow = 7500 scfm	TOWER NO. 1 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks		TOWER NO. 2 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks	
Case No. 1 Flow 2.7 MGD S.F. = 4.6 Against fouling Total Pressure Drop = 0.653 "H_2O A/W = 30	Influent Concentration C_{in}= 1000 ppb TCE	Discharge Concentration C_{out}= 39.7 ppb TCE	Influent Concentration C_{in}= 39.7 ppb TCE	Discharge Concentration C_{out}= 1.6 ppb TCE
Case No. 2 Flow 2.7 MGD S.F. = 4.6 Against fouling Total Pressure Drop = 0.653 "H_2O A/W = 30	Influent Concentration C_{in}= 275 ppb TCE	Discharge Concentration C_{out}= 10.9 ppb TCE	Influent Concentration C_{in}= 10.9 ppb TCE	Discharge Concentration C_{out}= 0.4 ppb TCE

TABLE 1
Cont'd

Design Temperature = 55^{o} F Airflow = 7500 scfm	TOWER NO. 1 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks		TOWER NO. 2 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks	
Case No. 3 Flow 1.4 MGD S.F. = 13.7 Against Fouling Total Pressure Drop ≤ 0.218 "H_2O A/W = 58	Influent Concentration C_{in}= 100 ppb TCE	Discharge Concentration C_{out}= 1.6 ppb TCE	Influent Concentration By-Passed	Discharge Concentration By-Passed
Case No. 4 Flow 1.4 MGD S.F. = 13.7 Against Fouling Total Pressure Drop = ≤ 0.218 "H_2O A/W = 58	Influent Concentration C_{in}= 160 ppb TCE	Discharge Concentration C_{out}= 2.6 ppb TCE	Influent Concentration By-Passed	Discharge Concentration By-Passed

TABLE 1
Cont'd

Design Temperature = 55° F Airflow = 7500 scfm	TOWER NO. 1 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks		TOWER NO. 2 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks	
Case No. 5 Flow 0.76 MGD S.F. = 20.1 Against Fouling Total Pressure Drop = $\leq$ 0.145 "H_2O A/W = 106	Influent Concentration C_{in}= 380 ppb TCE	Discharge Concentration C_{out}= 2.6 ppb TCE	Influent Concentration By-Passed	Discharge Concentration By-Passed

TABLE 2

Design Temperature = 55°F A/W Ratio = Variable	TOWER NO. 1 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks	TOWER NO. 2 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks
Case No. 1A Flow = 2.7 MGD Air Flowrate = 11000 scfm A/W Ratio = 44 Total Pressure Drop = 1.131 "H_2O	C_{in}= 1000 ppb C_{out}= 31.9 ppb	C_{in}= 31.9 ppb C_{out}= 1.0 ppb
Case No. 2A Flow = 2.7 MGD Air Flowrate = 11000 scfm A/W Ratio = 44 Total Pressure Drop = 1.131 "H_2O	C_{in}= 275 ppb C_{out}= 8.8 ppb	C_{in}= 8.8 ppb C_{out}= 0.3 ppb

TABLE 2
Cont'd

Design Temperature = 55^oF A/W Ratio = Variable	TOWER NO. 1 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks	TOWER NO. 2 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks
Case No. 3A Flow = 1.4 MGD Air Flowrate = 11250 scfm A/W Ratio = 87 Total Pressure Drop ≤ .218 "H_2O	C_{in}= 100 ppb C_{out}= 1.3 ppb	BY - PASSED
Case No. 4A Flow = 1.4 MGD Air Flowrate = 11250 scfm A/W Ratio = 87 Total Pressure Drop ≤ .218 "H_2O	C_{in}= 195 ppb Max C_{out}= 2.6 ppb	BY - PASSED

TABLE 2
Cont'd

Design Temperature = $55^{O}F$ A/W Ratio = Variable	TOWER NO. 1 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks	TOWER NO. 2 Diameter = 9.5', Packing Depth = 14.5' 2" Jaeger Tri-Paks
Case No. 5A Flow = 0.76 MGD Air Flowrate = 11500 scfm A/W Ratio = 163 Total Pressure Drop $\leq$ 0.10 "H_2O	C_{in}= 450 ppb C_{out}= 2.6 ppb	BY - PASSED

CALCULATION OF ACTUAL
PRESSURE DROP FOR 2"DIAMETER
JAEGER TRI-PACKS

Case No. 1 & 2

Flow = 2.7 MGD & A/W = 30

Determine liquid loading, L in unit of $\frac{lbs}{hr\text{-}ft^2}$:

$$L = \frac{(2{,}700{,}000\ gal/day)(day/24\ hrs)(0.1337\ ft^3/gal)(62.43\ lbs/ft^3)}{Pi\ \frac{(9.5)^2}{4}}$$

$$L = 13250\ \frac{lbs}{hr\text{-}ft^2}$$

Determine gas loading, G in units of $\frac{lbs}{hr\text{-}ft^2}$:

$$G = \frac{(1875\ gal/min)(0.1337\ ft^3/gal)(A/W{=}30)(60\ min/hr)(1.2472\ g/l)(2.205 \times 10^{-3}\ lbs/g)(28.32\ l/ft^3)}{Pi\ \frac{(9.5)^2}{4}}$$

$$G = 500\ \frac{lbs}{hr\text{-}ft^2}$$

Now, with L & G, enter manufactures literature for pressure drop to determine P/ L in inches H_2O:

$$\Delta P/\Delta L = 0.045\ "H^2O/ft \quad \text{of packing.}$$

Therefore, for Case 1 & 2 having Z = 14.5' packing:

Total Pressure Drop, $\Delta P_T = 0.653$ "H_2O

Case No. 3 & 4

Flow = 1.4 MGD & A/W = 58

Determine liquid loading, L in unit of $\frac{lbs}{hr\text{-}ft^2}$:

$$L = \frac{(1,400,000\ gal/day)(day/24\ hrs)(0.1337\ ft^3/gal)(62.43\ lbs/ft^3)}{Pi\ \frac{(9.5)^2}{4}}$$

$L = 6870\ \frac{lbs}{hr\text{-}ft^2}$

Determine gas loading, G in units of $\frac{lbs}{hr\text{-}ft^2}$:

$$G = \frac{(972\ gal/min)(.1337\ ft^3/gal)(A/W=58)(60\ min/hr)(1.2472\ g/l)(2.205 \times 10^{-3}\ lbs/g)(28.32\ l/ft^3)}{Pi\ \frac{(9.5)^2}{4}}$$

$G = 497\ \frac{lbs}{hr\text{-}ft^2}$

Now, with L & G, enter manufactures literature for pressure drop to determine P/ L in inches of H_2O:

$\Delta P/\Delta L = 0.030\ in\ H_2O/ft$ or less (falls of plot)

Therefore, for Case 3, having Z = 14.5′ packing:

Total Pressure Drop, $\Delta P_T = 0.435\ "H_2O$

Case No. 5

Flow = 0.76 MGD @ A/W = 106

$L = 3730 \frac{lbs}{hr\text{-}ft^2}$ & $G = 493 \frac{lbs}{hr\text{-}ft^2}$

Enter manufacture's plot:

$$\Delta P/\Delta L \leq 0.025 \text{ in "}H_2/ft$$

Therefore, for Z = 14.5' packing:

Total pressure drop, $\Delta P_T \leq 0.373$ "H_2O