# Module 2

For each problem, show the details of your calculations (equations, units etc.).

**Problem 1**

Design an air stripping column to remove TCE from water (i.e. determine the stripping factor, the height and number of transfer units, and the height of the packing in the column). The initial concentration of TCE is 1.3 mg/L and this must be reduced to 75 µg/L. Use the following criteria: water flow rate of 350 gal/min; air to water ratio of 70; water temperature of 16°C; air temperature of 23°C; column diameter of 2 ft; 2-in Intalox saddles for packing material; liquid mass transfer coefficient of 20.4 cm/hr; design safety factor of 20%; and tower height(s) between 1-15 m.

**Problem 2**

Use Hartley's method to estimate the rate of volatilization of benzene. Use an estimated diffusion coefficient of 0.087 $cm^2/s$. The following data are provided: benzene saturation in air of 319 $g/m^3$; humidity of 0.3; temperature of 20°C; latent heat of vaporization of 9.53 Kcal/mol; thickness of stagnant boundary layer of 0.3 cm; specific gravity of benzene of 0.8786. In addition, determine the time required for 30,000 gal of benzene to evaporate that contaminated a 2,000 $ft^2$ of soil.

**Problem 3**

An underground storage tank (UST) containing trichloroethane at a chemical plant has ruptured. The plume currently extends west to a distance of 345 ft and is 120 ft wide at this distance. The depth of the plume is 12 ft and the seasonal high groundwater table is at a depth of 7 ft. Assume that the curves shown in Figures 16-32 and 16-33 are applicable to your site and that the minimum vacuum pressure at the extraction well radius of influence will be 0.5 in $H_2O$ gauge. Provide a preliminary design and layout of a soil vapor extraction system. Specifically determine:

(a) The required number of extraction wells and their layout.

(b) The volumetric capacity (in $ft^3$/min) and the operating system pressure of the blower.

(c) If there is anything that you will need to do with the groundwater at the site to be able to treat the plume using SVE.

**Problem 4**

Given the following octanol water partition coefficients ($K_{ow}$), indicate for which compounds is soil vapor extraction (SVE) a candidate process for removing the compound from the vadose zone of a contaminated soil. Assume that low values of $K_{ow}$ are <10. Provide a relative ranking of contaminants in terms of potential efficiency for SVE treatment.

| **Compound** | **Log $K_{ow}$** |
|---|---|
| Trichloroethene | 2.38 |
| Pyrene | 4.88 |
| PCBs | 6.01 |
| Vinyl chloride | 1.38 |
| Ethyl benzene | 3.15 |
| Phenol | 1.46 |
| Lindane | 3.9 |
| DDT | 6.19 |
| 2-Butanone (methyl ethyl ketone) | 0.26 |