

Given:

- a) 0.01 gm/sec emission rate of H₂S odorous gases from ground level vent (H = 0)
- b) Wind speed of 2 meters/sec
- c) Atm Stability classes of A and E
- d) Wash State & Puget Sound Clean Air Agency "Acceptable Source Impact Level" or ASIL of 0.9 μg/m³ 24 hr average H₂S concentration.

$$\mu\text{g} := (10^{-6}) \cdot \text{gm}$$

$$i := 0..3$$

$$u_{\text{wind}} := 2 \cdot \frac{\text{m}}{\text{sec}}$$

Find:

- a) Ground level H₂S 10 minute average and 24 hr average concentrations at centerline ground level (y=0, H=0, z=0) at 100, 200, 300, & 400 meters. Plot graph.
- b) Maximum H₂S concentration is with Atm Stab Class E @100m 10 min average
- c) Location (downwind distance) and atm stability class of maximum H₂S = 100 meters
- d) Explain why the 24 hr average concentrations downwind of a point emission source are less than the 10 minute averages.
- e) What % reduction in the .01 gm/sec H₂S emission rate is needed to meet the downwind ASIL ?

$$x := \begin{pmatrix} 100 \\ 200 \\ 300 \\ 400 \end{pmatrix} \cdot \text{m}$$

Relationships between the 10 minute & 24 hr average concentrations have been established by EPA & are given in TSCREEN software. 10min conc = 1 hr conc. 24 hr av conc = 0.4(1 hr conc). Annual average conc. = 0.08 (10 min conc)

$$Q_{\text{H2S}} := .01 \cdot \frac{\text{gm}}{\text{sec}}$$

$$\sigma y_{A_i} := (213 \cdot \text{m}) \cdot \left(\frac{x_i}{\text{km}}\right)^{0.894} \quad \sigma y_{E_i} := (50.5 \cdot \text{m}) \cdot \left(\frac{x_i}{\text{km}}\right)^{0.894}$$

$$\sigma z_{A_i} := (440.8 \cdot \text{m}) \cdot \left(\frac{x_i}{\text{km}}\right)^{1.941} + 9.27 \cdot \text{m} \quad \sigma z_{E_i} := (22.8 \cdot \text{m}) \cdot \left(\frac{x_i}{\text{km}}\right)^{0.678} - 1.3 \cdot \text{m}$$

$$\sigma y_A = \begin{pmatrix} 27.188 \\ 50.524 \\ 72.598 \\ 93.89 \end{pmatrix} \text{m} \quad \sigma y_E = \begin{pmatrix} 6.446 \\ 11.979 \\ 17.212 \\ 22.26 \end{pmatrix} \text{m} \quad \sigma z_A = \begin{pmatrix} 14.319 \\ 28.658 \\ 51.863 \\ 83.716 \end{pmatrix} \text{m} \quad \sigma z_E = \begin{pmatrix} 3.486 \\ 6.357 \\ 8.779 \\ 10.95 \end{pmatrix} \text{m}$$

$$C_{A_i} := \frac{Q_{\text{H2S}}}{\pi \cdot u_{\text{wind}} \cdot \sigma y_{A_i} \cdot \sigma z_{A_i}}$$

$$C_{E_i} := \frac{Q_{\text{H2S}}}{\pi \cdot u_{\text{wind}} \cdot \sigma y_{E_i} \cdot \sigma z_{E_i}}$$

Maximum H₂S Conc is at x = 100 meters and Atm Stability Class E

$$C_{E_0} = 70.836 \mu\text{g} \cdot \text{m}^{-3}$$

$$C_A = \begin{pmatrix} 4.088 \times 10^{-9} \\ 1.099 \times 10^{-9} \\ 4.227 \times 10^{-10} \\ 2.025 \times 10^{-10} \end{pmatrix} \frac{\text{kg}}{\text{m}^3} \quad C_E = \begin{pmatrix} 7.084 \times 10^{-8} \\ 2.09 \times 10^{-8} \\ 1.053 \times 10^{-8} \\ 6.529 \times 10^{-9} \end{pmatrix} \frac{\text{kg}}{\text{m}^3}$$

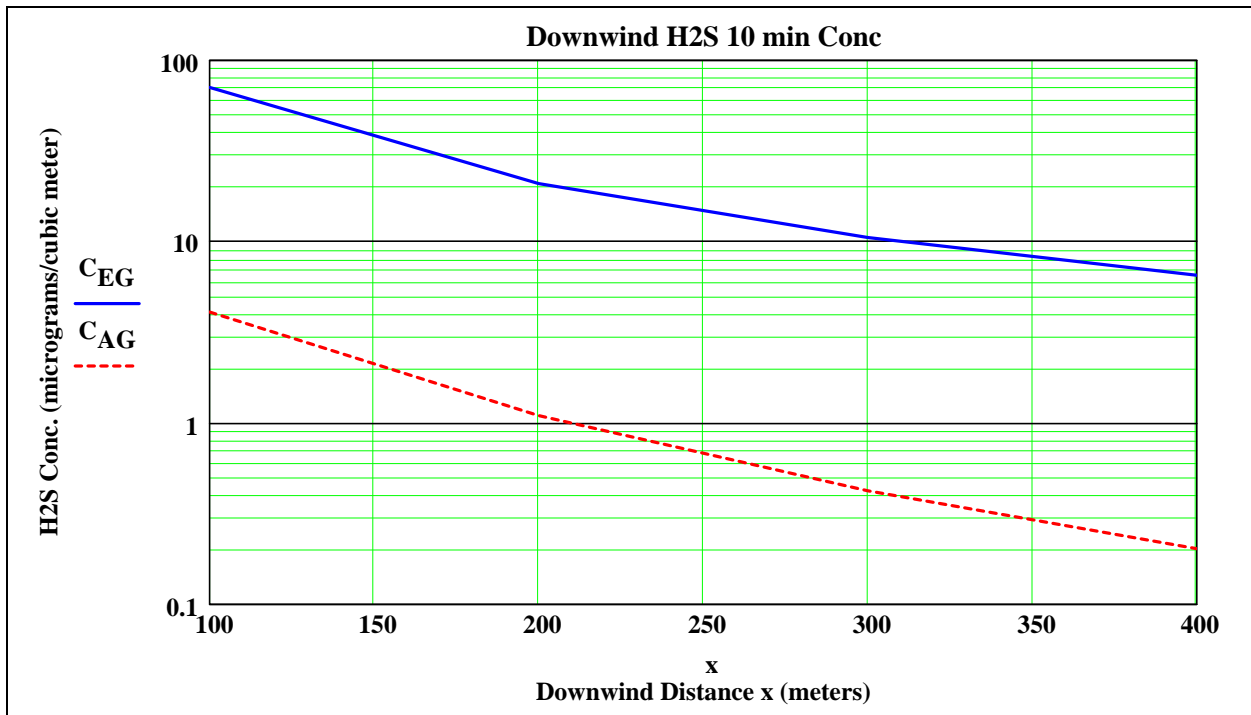
$$C_A = \begin{pmatrix} 4.088 \\ 1.099 \\ 0.423 \\ 0.202 \end{pmatrix} \frac{\mu\text{g}}{\text{m}^3}$$

$$C_E = \begin{pmatrix} 70.836 \\ 20.902 \\ 10.532 \\ 6.529 \end{pmatrix} \frac{\mu\text{g}}{\text{m}^3}$$

$$C_{AG_i} := 10^9 \cdot C_{A_i}$$

$$C_{EG_i} := 10^9 \cdot C_{E_i}$$

$$C_{E_0} = 70.84 \frac{\mu\text{g}}{\text{m}^3}$$



Wash State & Puget Sound Clean Air Agency "Acceptable Source Impact Level" or ASIL of $0.9 \mu\text{g}/\text{m}^3$ 24 hr average H_2S concentration.

$$\text{TwentyFourHourConc} := (0.4) \cdot 70.836 \cdot (\mu\text{g} \cdot \text{m}^{-3})$$

$$\text{TwentyFourHourConc} = 28.334 \mu\text{g} \cdot \text{m}^{-3}$$

$$\text{PercentReductionNeeded} := \frac{(28.334 - 0.9) \cdot (100)}{28.334}$$

96.824% Reduction in H_2S Emission Rate

$$\text{PercentReductionNeeded} = 96.824$$

The 24 hr concentrations downwind of a point source are less than the 10 minute average concentrations because of variations in the wind direction and atmospheric stability class.