## Example Problem: Air Pollutant Concentration Downwind of Ground Level Point Source

Given: a. $Q = 1$ gm/sec emission rate of $H_2S$ from ground level vent
- b. wind speed = u = 3 meter/sec
- c. atmospheric stability classes of B and D (or 2 and 4)
- d. "Acceptable source impact level" or ASIL for $H_2S = 0.9\ \mu g/m^3$ for 24 hr average
- e. equation 4-10 page 151 WW&Davis, for conc downwind with Z = 0, Y = 0 where Z is the vertical height above ground level & Y = distance from plume centerline (or in otherwords, equation is for ground level emission & ground level air poll. conc.)

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

$$Q := 1 \cdot \frac{gm}{sec}$$

$$u := 3 \cdot m \cdot sec^{-1}$$

Find: $H_2S$ concentration in x = 100 to 7000 meters downwind.

$$i := 0 .. 7$$

Equation for pollutant conc C, eq 4.10 page 151 Wark, Warner & Davis is shown below:

x is the downwind distance from the ground vent

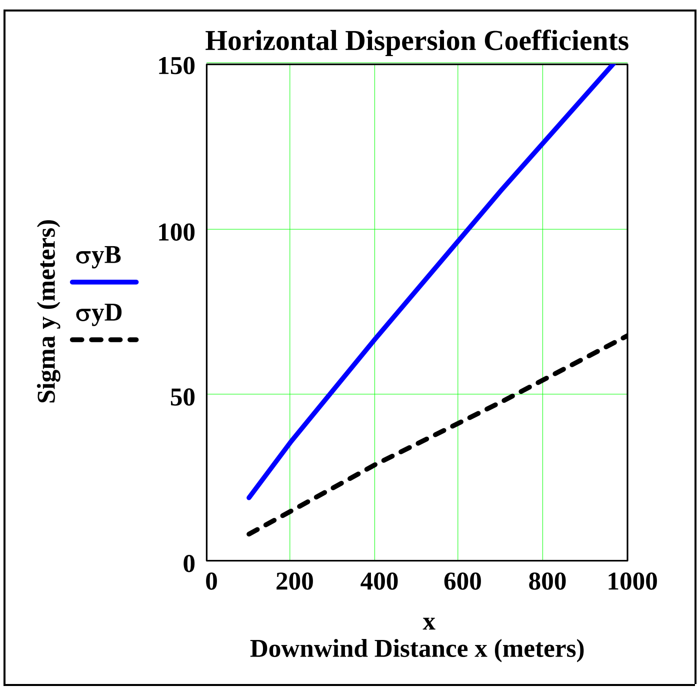
$$C := \frac{Q}{\pi \cdot u \cdot \sigma_y \cdot \sigma_z}$$

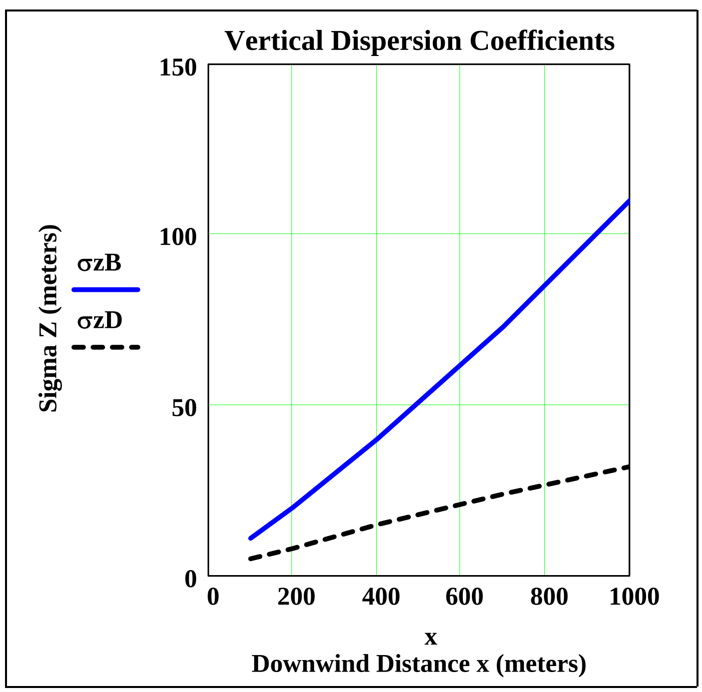
Using 8 downwind distances x in meters

$$x := \begin{pmatrix} 100 \\ 200 \\ 400 \\ 700 \\ 1000 \\ 2000 \\ 4000 \\ 7000 \end{pmatrix} \cdot m$$

The parameters $\sigma_y$ and $\sigma_z$ are the horizontal and vertical dispersion coefficients (sometimes called "standard deviations" as is presented on page 152 WW&D). These dispersion coefficients are for 10 minute average air pollutant concentrations, air pollutant concentrations in flat level open country, and for concentrations in under about 200 meters elevation above ground level. $\sigma_y$ and $\sigma_z$ are a function of the atmospheric stability class and downwind distance x from the emission The $\sigma_y$ and $\sigma_z$ shown below are from a table in Wark & Warner, 2nd edition.

$$\sigma yB := \begin{pmatrix} 19 \\ 36 \\ 67 \\ 112 \\ 155 \\ 295 \\ 550 \\ 880 \end{pmatrix} \cdot m \quad \sigma zB := \begin{pmatrix} 11 \\ 20 \\ 40 \\ 73 \\ 110 \\ 230 \\ 500 \\ 780 \end{pmatrix} \cdot m \quad \sigma yD := \begin{pmatrix} 8 \\ 15 \\ 29 \\ 48 \\ 68 \\ 130 \\ 245 \\ 400 \end{pmatrix} \cdot m \quad \sigma zD := \begin{pmatrix} 5 \\ 8 \\ 15 \\ 24 \\ 32 \\ 50 \\ 77 \\ 109 \end{pmatrix} \cdot m$$



Now we can have Mathcad calculate the downwind $H_2S$ 10 min average concentrations C for the atm stability classes B & D at the varous downwind distances x

$$CB_i := \frac{Q}{\pi \cdot u \cdot \sigma yB_i \cdot \sigma zB_i}$$

$$CD_i := \frac{Q}{\pi \cdot u \cdot \sigma yD_i \cdot \sigma zD_i}$$

$$CB = \begin{pmatrix} 507.671 \\ 147.366 \\ 39.591 \\ 12.977 \\ 6.223 \\ 1.564 \\ 0.386 \\ 0.155 \end{pmatrix} \frac{\mu g}{m^3} \quad x = \begin{pmatrix} 100 \\ 200 \\ 400 \\ 700 \\ 1000 \\ 2000 \\ 4000 \\ 7000 \end{pmatrix} m \quad CD = \begin{pmatrix} 2652.582 \\ 884.194 \\ 243.916 \\ 92.104 \\ 48.761 \\ 16.324 \\ 5.624 \\ 2.434 \end{pmatrix} \frac{\mu g}{m^3}$$

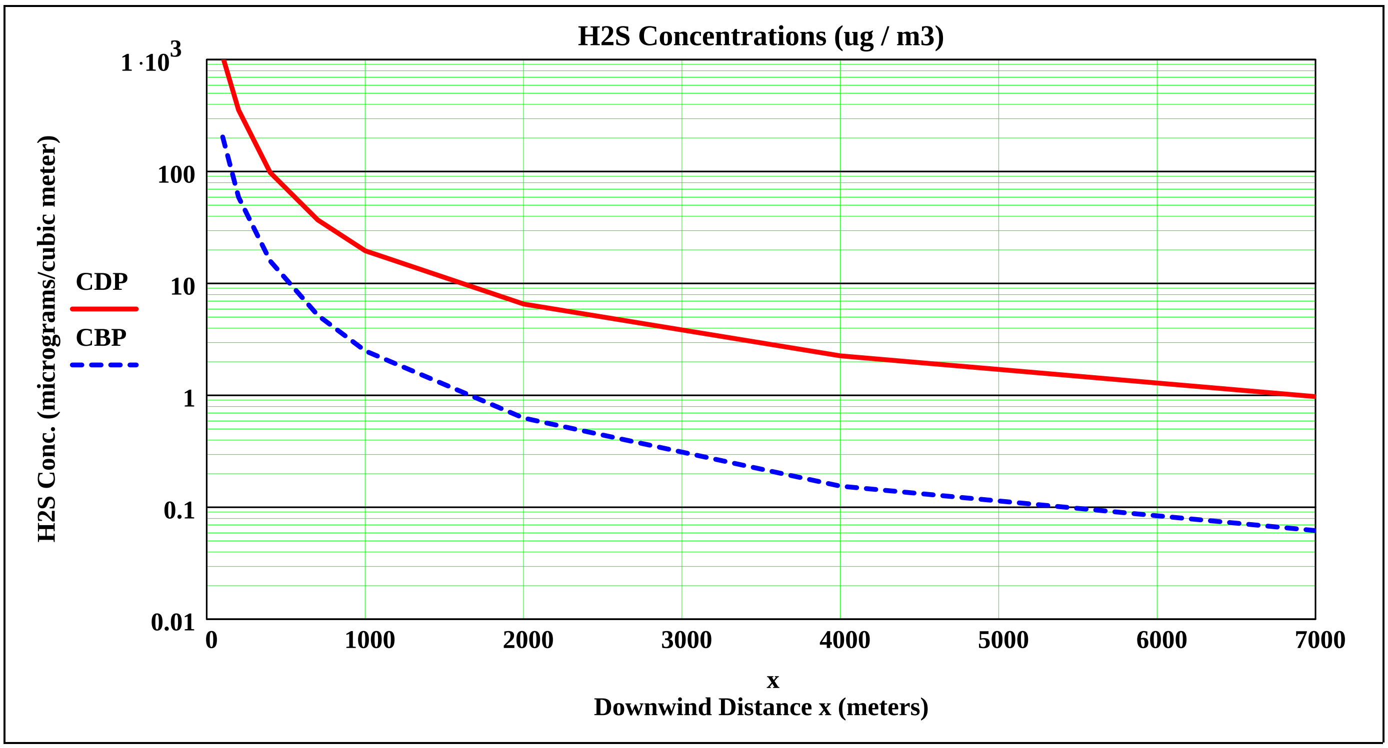
To convert from 10 minute to 24 hr averaging time, note that the EPA assumes the 10 min average conc represents the maximum 1-hr conc. and in the Table on page 169 WW&D it shows the 24 hr average conc. = 0.40 (1 hr average conc)

$$CBP_i := (0.4) \cdot \left(10^9 \cdot CB_i\right)$$

For graphing, convert the conc from $kg/m^3$ to $microgram/m^3$ mulitply by $10^9$ (Mathcad graphs conc. in $kg/m^3$ and not able to change it to $micrograms/m^3$)

$$CDP_i := (0.4) \cdot \left(10^9 \cdot CD_i\right)$$

The graph below shows the 24 hr average $H_2S$ concentrations downwind for Atm Stab Classes B & D. The upper solid red curve is class D, the dashed blue curve is B.




Do any of the $H_2S$ concentrations exceed the Washington State ASIL or Accepted Source Impact Level of 0.9 $\mu g/m^3$ for 24 hr average concentration?

Yes - the 24 hr $H_2S$ concentration exceeds 0.9 $\mu g/m^3$ for downwind distances from x = 0 to about x = 6500 meters for atmospheric stability class D - and from x = 0 to x = 1700 meters for class B.

The ASIL is the "Accepted Source Impact Level" and is used by the State of Washington. Most other states use the AAL or "Acceptable Ambient Level" for the "standard" for toxic and/or hazardous air pollutants (applies to permit to construct applications).