HW#3 SO_2 Concentration Downwind of Two Emission Sources

Name _____

Due Oct. 20, 2009 in Class

Given: Two electrical generating power power plants located adacent to each other (similar to the two 700 Megawatt coal fueled boilers at the Centralia Power Plant).
Effective Stack Height = 500 ft = H for both power plants
Boiler A stack emission of SO_2 = 5 gm/sec = Q_A
Boiler B stack emission of SO_2 = 3 gm/sec = Q_B
Wind speed = 5 miles/hour = u Atm Stability Class = B
Distance between Stack A and Stack B = 500 ft Downwind distance = 900m = 2,952.8 ft = x

Find: Use the Gaussian distribution plume dispersion equation with plume reflection from the ground surface (eq 4.13 pp 110 W&W 2nd Ed) to calculate the 10 minute average concentrations of SO_2 at 3 downwind locations.

a) Boiler A SO_2 Plume Centerline (y_A = 0) Ground Level (z = 0)Conc at x = 900 m = _____ $\mu g/m^3$

b) Boiler B SO_2 Plume Centerline (y_B = 0) Ground Level (z = 0) Conc at x = 900m = _____ $\mu g/m^3$

c) SO_2 Concentration of emissions from *both* Boilers A & B at location C
which is at x = 900 m and y_A = - 250 ft and y_B = + 250 ft = _____ $\mu g/m^3$
Attach your calculations; write your "final answers" above

$H := 500 \cdot ft$ $H = 152.4\,m$

Atm Stability Class B

$u := 5 \cdot \frac{mi}{hr}$ $\mu g := \left(10^{-6}\right) \cdot gm$

$Q_A := 5 \cdot \frac{gm}{sec}$ $Q_B := 3 \cdot \frac{gm}{sec}$ $y_A := -250 \cdot ft$ $y_B := 250 \cdot ft$

$x := 900 \cdot m$ $x = 2952.8\,ft$

These σ_{yB} & σ_{zB} approximation equations for atm stability class B are for downwind distances x less than 1 kilometer or 1000 meters; (W&W 2nd Ed pp 115)

$y_B = 76.2\,m$

$\sigma_{yB} := (156 \cdot m) \cdot \left(\frac{x}{km}\right)^{0.894}$ $\sigma_{zB} := (106.6 \cdot m) \cdot \left(\frac{x}{km}\right)^{1.149} + 3.3 \cdot m$

In Mathcad, you can write the variable σ_{yB} and the = sign to get answer

$\sigma_{yB} = 141.977\,m$ $\sigma_{zB} = 97.746\,m$

The equation to the right for SO_{2a} gives the SO_2 conc. at location a (from emissions from plant A) This location a has y_A = 0 and z = 0.

$$SO_{2a} := \left(\frac{Q_A}{\pi \cdot u \cdot \sigma_{yB} \cdot \sigma_{zB}}\right) \cdot \exp\left[-\frac{(H)^2}{2 \cdot (\sigma_{zB})^2}\right]$$

Equation for SO_{2B} gives the SO_{2BC} conc at location C from emissions from plant B. C location has y_B = 250 ft & z = 0 for B emissions

$$SO_{2BC} := \frac{Q_B}{\pi \cdot u \cdot \sigma_{yB} \cdot \sigma_{zB}} \cdot \exp\left[\left[\frac{-(H)^2}{2 \cdot (\sigma_{zB})^2}\right]\right] \cdot \exp\left[-\left[\frac{(y_B)^2}{2 \cdot (\sigma_{yB})^2}\right]\right]$$

Stack A _____ x = 900 m = 2,952.8 ft _____ → (a)

500 ft between stacks A & B → u = 5 miles/hr →

Distance from (a) to (c) = 250 ft = 76.2 m

(c)

Distance from (b) to (c) = 250 ft = 76.2 m

Stack B _____ x = 900 m = 2,952.8 ft _____ → (b)