Modeling DO along a river

Slide #13 solution)

i) L_a and DO_a

$$L_a = \frac{28.0\ mg/L \times 1.05\ m^3/s + 3.6\ mg/L \times 7.08\ m^3/s}{(1.05+7.08)\ m^3/s} = \mathbf{6.8\ mg/L}$$

$$DO_a = \frac{1.8\ mg/L \times 1.05\ m^3/s + 7.6\ mg/L \times 7.08\ m^3/s}{(1.05+7.08)\ m^3/s} = \mathbf{6.9\ mg/L}$$

ii) DO 16 km downstream

Initial deficit, $D_a = DO_s - DO_a$ = 8.5 mg/L – 6.9 mg/L = 1.6 mg/L

$$t = \frac{16000\ m}{0.37\ m/s \times 86400\ s/day} = 0.50\ days$$

$$D_t = \frac{k_d L_a}{k_r - k_d}\left(e^{-k_d t} - e^{-k_r t}\right) + D_a\left(e^{-k_r t}\right)$$

$$= \frac{0.61\ day^{-1} \times 6.8\ mg/L}{(0.76-0.61)\ day^{-1}}\left(e^{-0.61\ day^{-1} \times 0.50\ days} - e^{-0.76\ day^{-1} \times 0.50\ days}\right)$$

$$+1.6\ mg/L \times \left(e^{-0.76\ day^{-1} \times 0.50\ days}\right)$$

Modeling DO along a river

$= 2.6\, mg/L$

$DO_t = DO_s - D_t$ = 8.5 mg/L – 2.6 mg/L = **5.9 mg/L**

iii) t_c, L_c & DO_c

$$t_c = \frac{1}{k_r - k_d} ln\left[\frac{k_r}{k_d}\left(1 - D_a \frac{k_r - k_d}{k_d L_a}\right)\right]$$

$$= \frac{1}{(0.76 - 0.61)\ day^{-1}} ln\left[\frac{0.76\ day^{-1}}{0.61\ day^{-1}}\left(1 - 1.6\ mg/L \frac{(0.76 - 0.61)\ day^{-1}}{0.61\ day^{-1} \times 6.8\ mg/L}\right)\right]$$

$$= \mathbf{1.07\ days}$$

$$L_c = 1.07\ days\ \times 0.37\ m/s\ \times 86400\ s/day = 34200\ m = \mathbf{34.2\ km}$$

$$D_c = \frac{k_d L_a}{k_r - k_d}\left(e^{-k_d t_c} - e^{-k_r t_c}\right) + D_a\left(e^{-k_r t_c}\right)$$

$$= \frac{0.61\ day^{-1} \times 6.8\ mg/L}{(0.76 - 0.61)\ day^{-1}}\left(e^{-0.61\ day^{-1} \times 1.07\ days} - e^{-0.76\ day^{-1} \times 1.07.days}\right)$$

$$+ 1.6\ mg/L \times \left(e^{-0.76\ day^{-1} \times 1.07\ days}\right)$$

Modeling DO along a river

$= 2.8\ mg/L$

$DO_c = DO_s - D_c = 8.5\ mg/L - 2.8\ mg/L =$ ***5.7 mg/L***

Transport of contaminants in groundwater

Slide #18 solution)

$$R = 1 + \left(\frac{\rho_b}{\eta}\right) K_{oc} \cdot f_{oc} = 1 + \frac{1.5\frac{g}{cm^3}}{0.4} \cdot 27.0\ cm^3/g \cdot 0.02 = 3.03$$

$$v'_{cont} = \frac{v'_{water}}{R} = \frac{4.7\times10^{-6} m/s}{3.03} = 1.55 \times 10^{-6}\ m/s$$

$$t = \frac{10\ m}{1.55 \times 10^{-6}\ m/s \times 86400\ s/d} = 75\ days$$