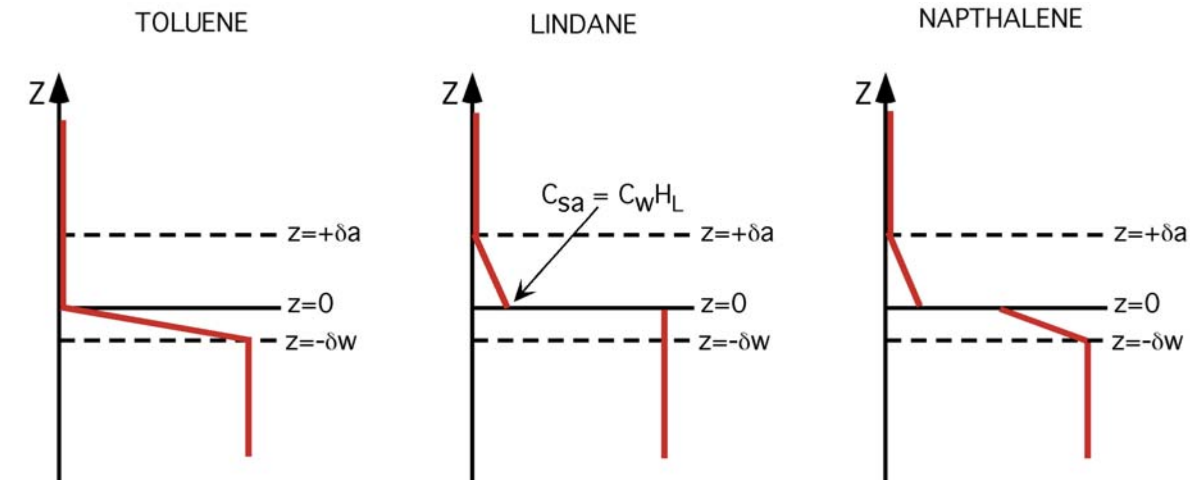
Answer 9.5

Toluene [$H_T = 0.28 >> 0.01$] is waterside controlled

Lindane [$H_L = 2.2 \times 10^{-5} << 0.01$] is airside controlled

Napthalene [$H_N = 0.04 \approx 0.01$] is controlled by both air and water side conditions.

(a) Sketch the profile of C (z) for each chemical



b) Write an equation for the mass flux at the air-water interface for each chemical.

c) For each chemical determine the time at which only 5% of the original mass remains.

TOLUENE	LINDANE	NAPTHALENE
$\dot{m} = D_w A \dfrac{C_w}{\delta_w}$	$\dot{m} = D_a A \dfrac{C_w H_L}{\delta_a}$	$\dot{m} = A \dfrac{C_w}{\left[(\delta_w / D_w) + \delta_a / (H_N D_a)\right]}$
$\dfrac{\partial C_w}{\partial t} = -\left[\dfrac{D_w}{\delta_w h}\right] C_w$	$\dfrac{\partial C_w}{\partial t} = -\left[\dfrac{D_a H_L}{\delta_a h}\right] C_w$	$\dfrac{\partial C_w}{\partial t} = -\dfrac{C_w / h}{(\delta_w / D_w) + \delta_a / (H_N D_a)}$
$C_w(t) = C_o \exp\left(-\dfrac{D_w}{\delta_w h} t\right)$	$C_w(t) = C_o \exp\left(-\dfrac{D_a H_L}{\delta_a h} t\right)$	$C_w = C_o \exp\left(-\dfrac{t}{\left[\dfrac{\delta_w}{D_w} + \dfrac{\delta_a}{H_N D_a}\right] h}\right)$
$T_{5\%} = \dfrac{3\delta_w h}{D_w} = 3 \times 10^5 \text{ s}$	$T_{5\%} = 3\dfrac{\delta_a h}{D_a H_L} = 1.4 \times 10^8 \text{ s}$	$T_{5\%} = 3h\left[\dfrac{\delta_w}{D_w} + \dfrac{\delta_a}{H_N D_a}\right] = 3.8 \times 10^5 \text{ s}$

d) For which chemicals is the assumption of a uniform concentration within the bulk fluid appropriate?

The mixing time is, $T_D = h^2/(4D_t) = (1\text{m})^2/(4 \times 0.001 \text{ m}^2\text{s}^{-1}) = 250$ s. For every chemical $T_D << T_{5\%}$, so the assumption of well-mixed conditions in the lake are appropriate for each chemical.