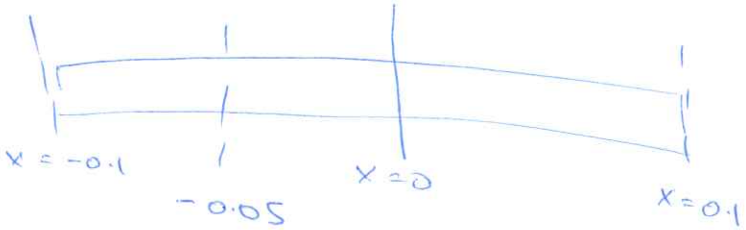
1(ai) Image sources are at $x = -0.2, 0.2, -0.4, 0.4, -0.6, 0.6 \ldots$ (Infinite). #



ii)

$$C = \frac{M}{\sqrt{4\pi D t}} e^{-\frac{x^2}{4Dt}}$$

$$= \frac{10^{-5} \times 10^{-3}}{\sqrt{4\pi (10^{-9})(50\times24\times60\times60)}} \left(e^{-\frac{0.05^2}{4(10^{-9})(50\times24\times60\times60)}} + e^{-\frac{0.15^2}{4(10^{-9})(50\times24\times60\times60)}} + e^{-\frac{0.25^2}{4(10^{-9})(50\times24\times60\times60)}} \right)$$

$= 4.996 \times 10^{-8}$ kg/m^3

(only consider 3 points as remaining mirror images give insignificant values).

iii) By trail and error, (Try $x = 0.1$ and 0. Symmetrical tube). Whole tube have conc of 2 kg/m or larger.

b) $y_t = L_0(1 - e^{-kt})$

$$k = \frac{450 - 210}{5 - 2} = 80$$

$$450 - 210 = L_0(1 - e^{-80(3)})$$

$L_0 = 240$ mg/L

ii) $L_0 = 240$ mg/L

iii) The rate would decrease as less BOD would remain.

2)

a) $C_{12}H_{22}O_{11} + 12\,O_2 \longrightarrow 12\,CO_2 + 11\,H_2O$

b) $5\,C_{12}H_{22}O_{11} + 12\,NH_4^+ \longrightarrow 12\,C_5H_7O_2N + 31\,H_2O + 12\,H^+$

amount of $NH_4^+ = \frac{1}{14+4} = 0.0555$ mmol/L/s

amount of cells = 6.278 mg/L/s.

c) $\frac{a\,(\text{cells})}{b\,(CO_2)} = 1.08$

$\frac{a\,(12\text{ mol})}{b\,(12\text{ mol})} = 1.08$

$\frac{a\,(12 \times (113))}{b\,(12 \times (32))} = 1.08$

$a = 0.305\,b$

$b = 3a$.

d) cell yield will drop as cell synthesis rate drops.

3a)

needs to blow out half to be safe. $\approx 100 m^3$.

time taken to blow $100 m^3 \approx \frac{100}{8} = 12.5$ min

b)

$$\frac{dM}{dt} + \frac{M}{20} = 10$$

$$\frac{dM}{dt} = 10 - \frac{M}{20}$$

$$\int \frac{1}{10 - \frac{M}{20}} dM = \int dt$$

$$\frac{\ln\left(10 - \frac{M}{20}\right)}{-\frac{1}{20}} = t$$

$$\ln\left(10 - \frac{M}{20}\right)(-20) = 10$$

$M = 187.8$ kg/L.

4a) Diethyl Phathalate (a)

Doxycline (B)

(a) has a higher kow which is more hydrophobic and tends to be in the sediments.

(b) has a ~~higher~~ lower kow and tends to be in water and is easily uptaken by fishes and algae.

4b BCF $= 0.61(8200)$

$= 5002$ L/kg. $= \frac{\text{~~water~~ aq.}}{\text{~~solids~~. biomass.}}$

ii) 1kg → 1mg. herbicide.

$\frac{1}{5002} = 2 \times 10^{-4}$ mg/L.

~~$\frac{5002}{1} =$~~

A

iii) $2 \times 10^{-4} + 2 \times 10^{-4} \times 10000 \times 25$

$= 50.0002$ mg/L.

c) because dredging resuspend the pollutants into water.

5)

c) downflow. cheaper using gravity and there is a cross flow to obtain maximum leaching results.

d) High temperature will increase reaction rate and increase the performance.