Introduction to I1DISP

- River Examples
- Lake Examples

River Examples

Examples 3.1 – 3.3

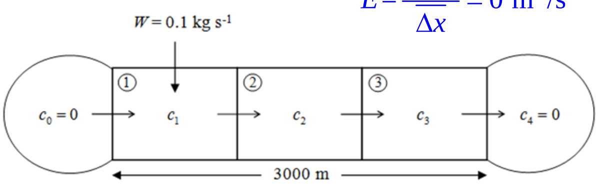
Example 3.1 - Summary

A = 20 m^2 L = 3000 m u = 0.1 m/s

E = 0.0 m^2/s Δx = 1000 m W = 0.1 kg/s

k = 10^{-4} s^{-1} $Q = uA = 2\ \mathrm{m}^3/\mathrm{s}$

$$\bar{E} = \frac{E \cdot A}{\Delta x} = 0\ \mathrm{m}^3/\mathrm{s}$$



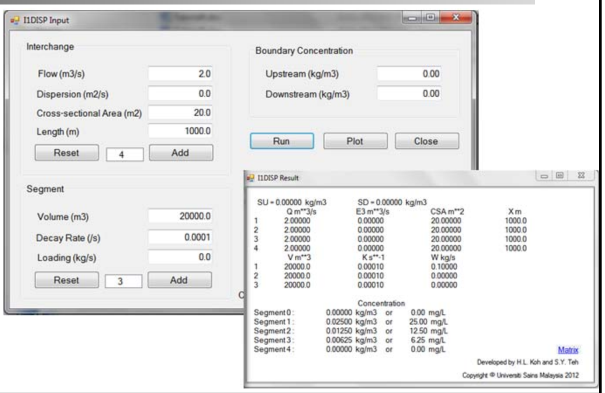
Example 3.1 – Analytical Solution

$c_1 = 0.025\ \mathrm{kg/m^3} = 25\ \mathrm{mg/L}$

$c_2 = 0.0125\ \mathrm{kg/m^3} = 12.5\ \mathrm{mg/L}$

$c_3 = 0.00625\ \mathrm{kg/m^3} = 6.25\ \mathrm{mg/L}$

Example 3.1 – I1DISP Solution



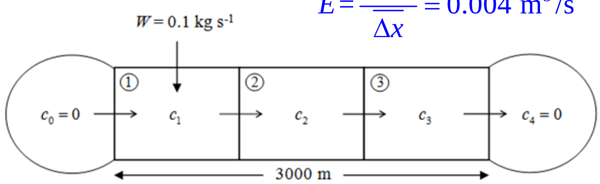
Example 3.2 - Summary

A = 20 m^2 L = 3000 m u = 0.1 m/s

E **= 0.2 m^2/s** Δx = 1000 m W = 0.1 kg/s

k = 10^{-4} s^{-1} $Q = uA = 2\ \mathrm{m}^3/\mathrm{s}$

$$\bar{E} = \frac{E \cdot A}{\Delta x} = 0.004\ \mathrm{m}^3/\mathrm{s}$$



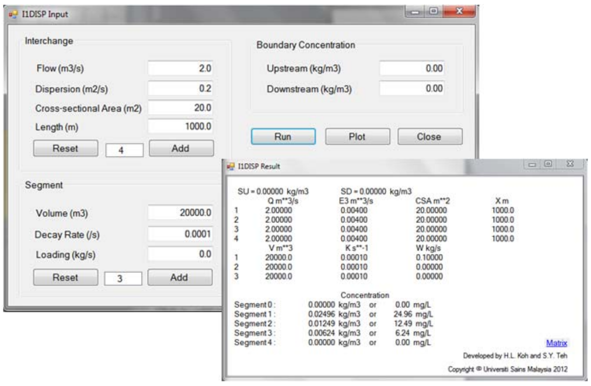
Example 3.2 – Analytical Solution

$c_1 = 0.02496\ \text{kg/m}^3$ or $c_1 = 24.96\ \text{mg/L}$

$c_2 = 0.01249\ \text{kg/m}^3$ or $c_2 = 12.49\ \text{mg/L}$

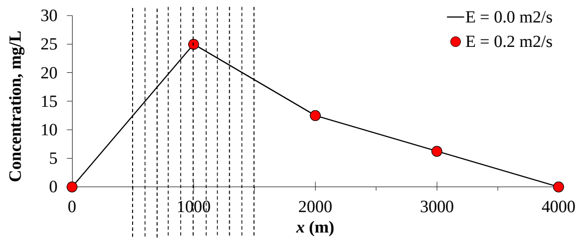
$c_3 = 0.00624\ \text{kg/m}^3$ or $c_3 = 6.24\ \text{mg/L}$

Example 3.2 – I1DISP Solution



Examples 3.1 & 3.2: Comparison

c (mg/L)	x (m)				
	0	1000	2000	3000	4000
Example 3.1	0	25	12.5	6.25	0
Example 3.2	0	24.96	12.49	6.24	0



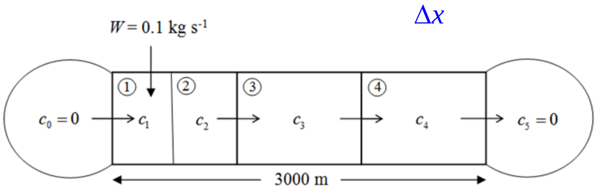
Example 3.3 - Summary

$A = 20\ \text{m}^2$ L = 3000 m $u = 0.1$ m/s

$E = 0.0\ \text{m}^2/\text{s}$ $\Delta x = 1000$ m $W = 0.1$ kg/s

$k = 10^{-4}\ \text{s}^{-1}$ $Q = uA = 2\ \text{m}^3/\text{s}$

$$\bar{E} = \frac{E \cdot A}{\Delta x} = 0\ \text{m}^3/\text{s}$$



Example 3.3 – Analytical Solution

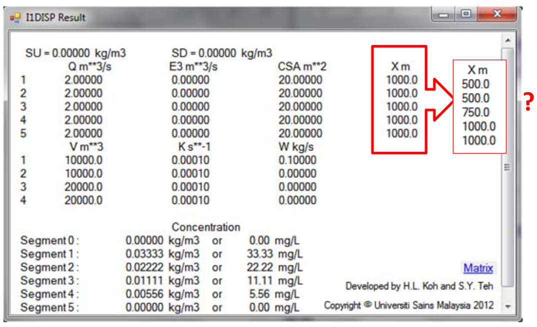
$c_1 = 0.033\ \text{kg/m}^3$ or $c_1 = 33\ \text{mg/L}$

$c_2 = 0.022\ \text{kg/m}^3$ or $c_2 = 22\ \text{mg/L}$

$c_3 = 0.011\ \text{kg/m}^3$ or $c_3 = 11\ \text{mg/L}$

$c_4 = 0.0056\ \text{kg/m}^3$ or $c_3 = 5.6\ \text{mg/L}$

Example 3.3 – I1DISP Solution



Lake Examples

Example 1

A lake has the following characteristics:

Volume = 50,000 m^3

Mean depth = 2 m

Inflow = outflow = 7500 $m^3\ d^{-1}$

The lake receives the input of a pollutant from three sources: a factory discharge of 50 kg d^{-1}, a flux from atmosphere of 0.6 g $m^{-2}\ d^{-1}$, and the inflow stream that has a concentration of 10 mg L^{-1}. If the pollutant decays at the rate of 0.25 d^{-1}, determine the steady-state concentration.

Example 1 – Analytical Solution

Factory discharge, $W_1 = 50$ kg/d

Atmospheric flux, $W_2 = 0.6 \text{ g m}^{-2}\text{ d}^{-1} \times \frac{50000}{2} \text{m}^2 = 15000 \text{ g/d} = 15 \text{ kg/d}$

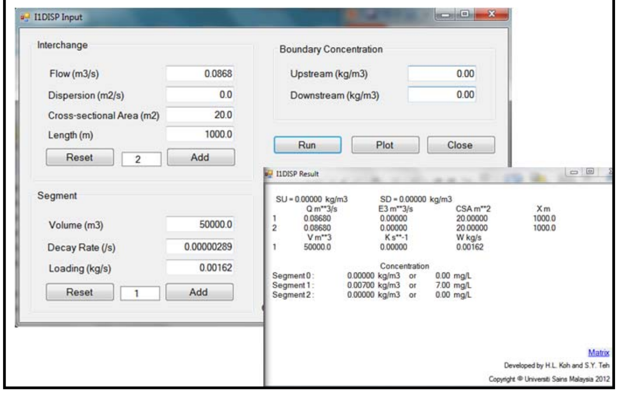
Inflow input $W_3 = 10 \text{ mg/L} \times 7500 \text{ m}^3\text{/d} = 0.01 \text{ kg/m}^3 \times 7500 \text{ m}^3\text{/d} = 75 \text{ kg/d}$

Loading, $W = 50 + 15 + 75 = 140$ kg/d

Assimilation factor, $a = Q + \gamma V = \left(7500 + 0.25 \times 5 \times 10^4\right) \text{m}^3\text{d}^{-1} = 2 \times 10^4 \text{ m}^3\text{d}^{-1}$

Steady-state concentration, $C = \frac{W}{a} = \frac{140}{2\times 10^4}\left(\frac{\text{kg}}{\text{d}} \times \frac{\text{d}}{\text{m}^3}\right) = 0.007 \text{ kg/m}^3 = 7 \text{ mg/L}$

Example 1 – I1DISP Solution



Example 2

A pond with a single inflow stream has the following characteristics:

Mean depth = 3 m ; Surface area = 2 × 10^5 m^2 ; Residence time = 2 weeks ; Inflow BOD = 4 mg L^{-1}

A subdivision housing 1000 people will discharge raw sewage into this system. Each individual contributes about 150 gal $capita^{-1}\ d^{-1}$ of wastewater and 0.25 lb $capita^{-1}\ d^{-1}$ of BOD. If the BOD decays at a rate of 0.1 d^{-1} and settles at a rate of 0.1 m d^{-1}, Determine the steady-state concentration for the lake with and without the subdivision.

Example 2

Determine the steady-state concentration for the lake with and without the subdivision.

Steady-state concentration for the lake without subdivision,

$$C = \frac{Q_{in} C_{in}}{a}$$

Steady-state concentration for the lake with subdivision,

$$C = \frac{Q_{in} C_{in} + \mu}{a}$$

Example 2 – Without Subdivision

Steady-state concentration for the lake without subdivision,

$$C = \frac{Q_{in}C_{in}}{a}$$

Inflow BOD = 4 mg L^{-1} $\Rightarrow C_{in} = 0.004$ kg/m^3

Pond residence time, $\tau_w = V/Q$

$$Q_{in} = 0.429\times10^5 \text{ m}^3/\text{d}$$

$$\Rightarrow 2 \text{ week} = \frac{2\times10^5\times3 \text{ m}^3}{Q} \Rightarrow Q = 3\times10^5 \text{ m}^3/\text{week} = 0.429\times10^5 \text{ m}^3/\text{d}$$

Decay, $k = 0.1 \text{ d}^{-1}$ Settling velocity, $v = 0.1 \text{ m}^{-1}\text{d}^{-1}$

Surface area, $A_s = 2\times10^5 \text{ m}^2$

Assimilation factor, $a = Q + kV + vA_s$

$$= 0.429\times10^5 + 0.1\times(6\times10^5) + 0.1\times(2\times10^5) \text{ m}^3/\text{d}$$

$$= (0.429 + 0.6 + 0.2)\times10^5$$

$$a = 1.229\times10^5 \text{ m}^3/\text{d}$$

Example 2 – Without Subdivision

Steady-state concentration for the lake without subdivision,

$$C = \frac{Q_{in}C_{in}}{a}$$

$$Q_{in} = 0.429\times10^5 \text{ m}^3/\text{d}$$

$$C_{in} = 0.004 \text{ kg/m}^3$$

$$a = 1.229\times10^5 \text{ m}^3/\text{d}$$

$$\therefore C = \frac{Q_{in}C_{in}}{a} = 1.4\times10^{-3} \text{ kg/m}^3 = 1.4 \text{ mg/L}$$

Example 2 – With Subdivision

Steady-state concentration for the lake with subdivision,

$$C = \frac{Q_{in}C_{in} + \mu}{a}$$

$$Q_{in} = 0.429\times10^5 \text{ m}^3/\text{d}$$

$$C_{in} = 0.004 \text{ kg/m}^3$$

$$a = 1.229\times10^5 \text{ m}^3/\text{d}$$

Wastewater BOD loading

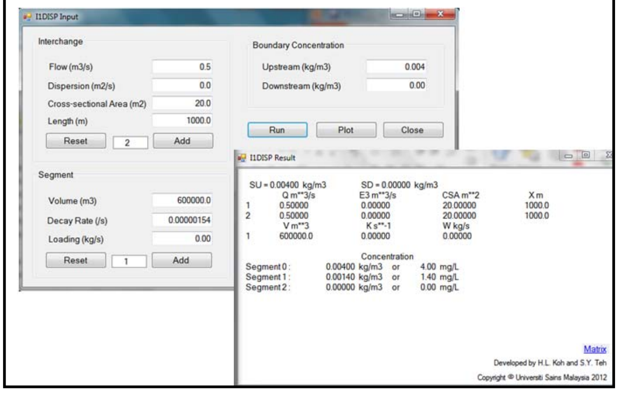
$$= 0.25\left(\frac{\text{lb}}{\text{capita d}}\right)\times1000 \text{ capita}$$

$$= 2.5\times10^2 \text{ lb/d}$$

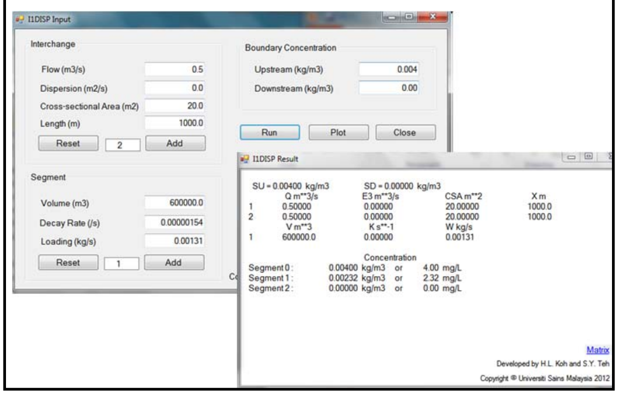
$$\approx 113.6 \text{ kg/d}$$

$$\therefore C = \frac{Q_{in}C_{in}}{a} = 2.32\times10^{-3} \text{ kg/m}^3 = 2.32 \text{ mg/L}$$

Example 2 – I1DISP Without Sub



Example 2 – I1DISP With Sub



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Thank you

Presented by
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