Recheck Q2(c) (see underlined answer)

Department of Civil Engineering-I.I.T. Delhi
CVL100: Environmental Science (1st Semester 2016-17)
Minor 1 Exam (60 minutes; 20 points)

14 + 1 = 15

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Note:(closed notes) (50% negative marking)

Q1. Number of moles of oxygen required for reacting one mole of ammonium ions to produce nitrate ions? $NH_4^+ + 2\text{-}5O_2 \rightarrow NO_3^- + 2H_2O$ => 2.5 moles O_2 / mol NH_4^+ [5 points] X 0

Q2. A wastewater treatment plant disposes of its effluent in a surface stream. Characteristics of the stream and effluent are shown below. For 20°C, stream water temperature, equilibrium concentration of oxygen =9.17 mg/L. Answer the following.

Parameter	Wastewater	Stream	Mixture (wastewater-stream)
flow (m^3/s)	0.2	5	
Dissolved oxygen, mg/L	1	8	
Temperature, °C	20	20	20
BOD_5 at 20°C, mg/L	100	2	
Oxygen consumption rate (K1 at 20°C) (1/day)	0.02	0.2	0.2
Oxygen reaeration rate (K2 at 20°C) (1/day)	0	0.3	0.3

(A)Calculate following: (i)Ultimate BOD, (ii) Initial DO deficit, (iii)Time for critical DO deficit (t_c),(iv)Critical DO deficit (D_c), (v) lowest DO value. [10points]
(B)Draw a DO sag curve showing all information. [3points]
(C)Does it violate the CPCB recommended DO value? How much additional removal of BOD is required? [2 points]

Formula:
$(t_c) = 1/(K2-K1) * \ln[(K2/K1)*(1-D_0*(K2-K1)/(K1L_0))]$
$(D_c) = (K1/K2)*L_0 \exp(-K1*t_c)$

All params for mixture =) $\frac{C_{stream} Q_{stream} + C_{waste} Q_{waste}}{Q_{stream} + Q_{waste}}$ C: any param

A) $Q_{mix} = 5 + 0.2 = 5.2\ m^3/s$

$DO_{mix} = \frac{1(0.2) + 5(8)}{5 + 0.2} = 7.73\ mg/L$

$BOD_{5\ mix} = \frac{100(0.2) + 2(5)}{5 + 0.2} = 5.77\ mg/L$

i) Ultimate BOD $= L_0$ $\quad BOD_t = L_0(1 - e^{-k_1 t})$

$\Rightarrow L_0 = \frac{BOD_{5\ (mix)}}{1 - e^{-k_1(5)}} = \frac{5.77}{1 - e^{-5(0.2)}} = 9.13\ mg/L$ (2)

ii) Initial deficit $D_0 = C_{saturation} - DO_{mix} = 9.17 - 7.73$
$= 1.44\ mg/L$ (2)

iii) $t_c = \frac{1}{k_2 - k_1} \ln\left(\frac{k_2}{k_1}\left(1 - D_0 \frac{k_2 - k_1}{k_1 L_0}\right)\right) = \frac{1}{0.1} \ln\left(\frac{0.3}{0.2}\left(1 - 1.44\left(\frac{0.1}{0.2(9.13)}\right)\right)\right)$

$= 10 \ln\left(1.5\left(1 - \frac{1.44}{18.26}\right)\right) =$ 3.23 days (2)