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Problem 1.-

As the intervals are regular (2h):

$$\text{Average Q} = \frac{\sum Q_i}{\text{numer of samples}} = 800 \text{ L/s}$$

As flow rates are not regular:

$$\text{Average SS} = \frac{\sum Q_i \cdot SS_i}{\sum Q_i} = 190.5 \text{ mg SS/L}$$

Problem 2.-

- 300 mg/L CH_2O simple carbohydrate:

$$CH_2O + O_2 \rightarrow CO_2 + H_2O$$

$$300 \frac{\text{mg } CH_2O}{L} \cdot \frac{1 \text{ g}}{10^3 \text{mg}} \cdot \frac{1 \text{ mol } CH_2O}{30 \text{ g}} \cdot \frac{1 \text{ mol } O_2}{1 \text{ mol } CH_2O} \cdot \frac{32 \text{ g } O_2}{1 \text{ mol } O_2} \cdot \frac{10^3 \text{mg}}{1 \text{ g}} = 320 \text{ mg} \frac{O_2}{L}$$

- 50 mg/L N as NH_3 simple carbohydrate:

$$NH_3 + 2O_2 \rightarrow NO_3^- + H^+ + H_2O$$

$$50 \frac{\text{mg N}}{L} \cdot \frac{1 \text{ g}}{10^3 \text{mg}} \cdot \frac{17 \text{g } NH_3}{14 \text{ g N}} \cdot \frac{1 \text{ mol } NH_3}{2 \text{ mol } O_2} \cdot \frac{32 \text{ g } O_2}{1 \text{ mol } O_2} \cdot \frac{10^3 \text{mg}}{1 \text{ g}} = 228.6 \text{ mg} \frac{O_2}{L}$$

Sum of both demands:

$$320 \text{ mg} \frac{O_2}{L} + 228.6 \text{ mg} \frac{O_2}{L} = 548.6 \text{ mg} \frac{O_2}{L}$$

ThOD (if ΔT= 5ºC) = 548.6 mg O_2/L

It does not depend on the temperature.

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Problem 3.-

40 mg/L phenol; MW (C_6H_5OH) = 94 g/mol

350 mg/L glucose; MW ($C_6H_{12}O_6$) = 180 g/mol

3 mg/L sulphur; MW (S^{2-}) = 32 g/mol

50 mg/L methanol; MW (CH_3OH) = 32 g/mol

100 mg/L non-bio compound; MW ($C_9H_{14}O$) = 138 g/mol

a) Chemical Oxygen Demand (COD)

Phenol:

$C_6H_5OH + 7O_2 \rightarrow 6CO_2 + 3H_2O$

COD = 95.319 mg O_2/L

Glucose:

$C_6H_{12}O_6 + +6O_2 \rightarrow 6CO_2 + 6H_2O$

COD = 373.33 mg O2/L

Sulhpur:

$S^{2-} + 2O_2 \rightarrow SO_4{}^{2-}$

COD = 6 mg O2/L

Methanol:

$$CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O$$

COD = 75 mg O_2/L

Non-biodegradable compound

$C_9H_{14}O + 12O_2 \rightarrow 9CO_2 + 7H_2O$

COD = 278.26 mg O_2/L

Total COD = 827.91 mg O_2/L

b) Biological Oxygen Demand (BOD_5)

$$BOD_{max} = 827.91 - 278.26\ (non - biodegradable) = 549.65\ mg\frac{O_2}{L}$$

$$BOD_5 = 549.65\ mg\frac{O_2}{L}\left(1 - e^{-0.23\ days^{-1}\cdot 5\ days}\right) = 375.612\ \frac{mg\ O_2}{L}$$

Problem 4.-

River mass balance:

1: River parameters before discharge

2: River parameters after discharge

$$Q_1 \cdot BOD_{5_1} + Q_{discharge} \cdot BOD_{5_{discharge}} = Q_2 \cdot BOD_{5_2}$$

$$\frac{100\ L}{s} \cdot \frac{0\ mg\ O_2}{L} + Q_{discharge} \cdot \frac{20\ mg\ O_2}{L} = (\frac{100\ L}{s} + Q_{discharge}) \cdot \frac{4\ mg\ O_2}{L}$$

$$Q_{discharge} = 25\frac{L}{s}$$

$$\frac{400\ L}{hab \cdot day} \cdot \frac{1\ day}{24\ h} \cdot \frac{1\ h}{3600\ s} = 2.16 \cdot 10^{6}\frac{L}{s\ \cdot hab}$$

$$25\frac{L}{s} \div 2.16 \cdot 10^{6}\frac{L}{s\ \cdot hab} = 5400\ inhabitants$$