Lsn 28 In Class—BOD Test and BOD in a CMFR

CEEG 340–Introduction to Environmental Engineering
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ThOD and BOD

A waste of composition $C_{10}H_{20}O_3N$ has been evaluated in a BOD test. 15 mL of full-strength waste (conc. = 100 mg/L of $C_{10}H_{20}O_3N$) with a dissolved oxygen concentration of 2 mg/L is diluted to a total volume of 300 mL with dilution water. After dilution, at time = 0, the dissolved oxygen concentration in the BOD bottle is 8.7 mg/L. After 5 days the dissolved oxygen concentration is 3 mg/L. The waste is 80% biodegradable. What is the rate constant, k, for the BOD use by the test bacteria.

GIVEN: $[C_{10}H_{20}O_3N] = 100 \, mg/L$
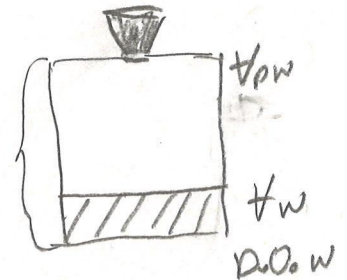
$DO_w = 2 \, mg/L$

$BIODEGRAD. = 0.8$

$DO^0_{BOTTLE} = 8.7 \, mg/L$

$DO(5)^{BOTTLE} = 3 \, mg/L$

$\forall_{TEST} = 300 \, mL$

$D.O._0^{BOTTLE}(0)$

$p.O.(5)^{BOTTLE}$

$\forall_{DW}$

$\forall_w$

$D.O. \, w$

FWP: k

STEP 1: CALCULATE CThOD

$\underset{202 \, g}{C_{10}H_{20}O_3N} + \underset{400 \, g}{125O_2} \rightarrow 10CO_2 + 8H_2O + \underset{14 \, g \, NH_4-N}{NH_4}$
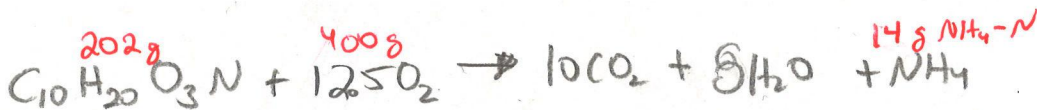
$CThOD = 100 \, mg/L \, WASTE \times \dfrac{400 \, g \, OXY.}{202 \, g \, WASTE}$

$CThOD = 198 \, mg/L$

STEP 2: CALCULATE L_0

$L_0 = BIODEGRAD. \times CThOD = 0.8 \times 198$

$L_0 = 158 \, mg/L$ (NO NTHOD CONSIDERED)

STEP 3: CALCULATE $BOD_5 = Y_5$ (FROM TEST)

$Y_5 = BOD_5 = [DO(0) - DO(5)] \times DF$

$DF = \dfrac{\forall_{TOT}}{\forall_w}$

$Y_5 = [8.7 - 3] \times \dfrac{300}{15}$

$Y_5 = 114 \, mg/L$

STEP 4: CALCULATE k

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

$\dfrac{Y}{L_0} = 1 - e^{-kt}$

$e^{-kt} = 1 - \dfrac{Y}{L_0}$

$-kt = \ln\left[1 - \dfrac{Y}{L_0}\right]$

$k = -\dfrac{1}{t} \times \ln\left[1 - \dfrac{Y}{L_0}\right]$

$k = -\dfrac{1}{5} \ln\left[1 - \dfrac{114}{158}\right]$

$k = 0.26 \, \dfrac{1}{DAY}$

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Calculate NThOD and NBOD

$$NThOD = 100 \text{ mg}/L \text{ WASTE} \times \frac{14 \text{ g } NH_4-N}{2O_2, \text{ WASTE}} \times \boxed{\frac{64, \text{ OXY.}}{14 \text{ } NH_4-N}}$$

ALWAYS FOR NThOD

$$\boxed{NThOD = 32 \text{ mg}/L}$$

$$NBOD \stackrel{\sim}{=} NThOD$$

$$\boxed{NBOD = 32 \text{ mg}/L}$$