ENVE FE Review Questions
Fall 2024

Environmental Engineering FE Formatted Review Questions

1. Water Quality Characteristics can be categorized in four different ways. Match the provided characteristics with an appropriate category

Water quality category	Characteristic
Physical - P	Hardness - C
Chemical - C	Odor - P
Microbiological - M	Radon - R
Radiological - R	*Giardia* - M
	Lead - C
	Turbidity - P

Physical: color, taste, odor, temperature, turbidity, solids, electrical conductivity
Chemical: pH, alkalinity, hardness, DO, BOD

Physical: measurable characteristic of water which can be determined without changing the chemical comp. of H_2O

2. A Jar test is used to evaluate the coagulation process and allows the plant operator to optimize which of the following parameters.
   a.) Alum dosage
   b.) Temperature
   c.) Lime dosage
   d.) Dissolved Oxygen

- Temp + DO are measured directly.
- Lime dosage is calculated based on water quality data (hardness, alkalinity).
- Alum dosage must be determined experimentally

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3. Estimate the alkalinity, in mg/L as $CaCO_3$, of water with a carbonate ion concentration of 17.0 mg/L and a bicarbonate ion concentration of 111.0 mg/L.
   a.) 119 mg/L as $CaCO_3$
   b.) 128 mg/L as $CaCO_3$
   c.) 148 mg/L as $CaCO_3$
   d.) 146 mg/L as $CaCO_3$

Solution

$$Alk = 2[CO_3^{2-}] + [HCO_3^-] + [OH^-] - [H^+]$$

OH^-, H^+ are negligible so

$$Alk = 2[CO_3^{2-}] + [HCO_3^-]$$

convert both CO_3^{2-} & HCO_3^- to $\frac{eq}{L}$. add (like units) then convert to mg/L as $CaCO_3$. Eq weights, molar masses given in FE Exam book

$$[HCO_3^-] = \frac{111.0\,mg}{L} \times \frac{1\,mmol}{61\,mg} \times \frac{1\,meq}{1\,mmol} = 1.82\,\frac{meq}{L}$$

$$[CO_3^{2-}] = \frac{17\,mg}{L} \times \frac{1\,mmol}{60\,mg} \times \frac{2\,meq}{1\,mmol} = 0.5\bar{6}\,\frac{meq}{L}$$

$$Alk \text{ in } \frac{meq}{L} = 1.82 + 0.5\bar{6} = 2.37\,\frac{meq}{L}$$

$$2.37\,\frac{meq}{L} \times \frac{100.\,mg\,CaCO_3}{2\,meq} = 119.4\,\frac{mg}{L}\,CaCO_3 = a$$

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4. If the BOD_5 and ultimate BOD of a municipal wastewater are 200 mg/L and 457 mg/L respectively, what is the reaction rate constant?

   a.) 0.265 d^{-1}
   b.) 0.050 d^{-1}
   c.) 0.115 d^{-1}
   d.) 0.165 d^{-1}

BOD Exertion, from FE Exam Equation Book

$y_T = L(1 - e^{-kt})$ where y_T = BOD Exerted at Time T
L = BOD ultimate
T = time
k = rate constant, first order (per time)

given
$L = 457\ mg/L$
$y_5 = 200\ mg/L$
$T = 5$ Days

so

$$200\frac{mg}{L} = 457\frac{mg}{L}(1 - e^{-k \cdot 5 days})$$

$$\frac{200\ mg/L}{457\ mg/L} = (1 - e^{-k \cdot 5 days}) \quad \text{or} \quad 0.437 = 1 - e^{-k \cdot 5 days}$$

$$0.562 = e^{-k \cdot 5 days}$$

$$\ln(0.562) = \ln e^{-k \cdot 5 days}$$

$$-0.575 = -k \cdot 5 days$$

$$k = 0.115/day = (c.)$$