Evaluators Handout

ZEOVAULT

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1 Energy consumed Calculations

Energy consumed by pumps:

$$E_p = 2 \times N \times n \times P \times t$$

Given:

$N = 3$ **layers**
$n = 5$ **Cycles**
$P = 6$ **Watts**
$t = 70$ **Seconds**

Note: the multiplier (2) is used because the pump works twice to deliver to and receive water from the layers.

$$E_p = 2 \times 3 \times 5 \times 6\,\mathrm{W} \times 70\,\mathrm{s}$$
$$E_p = \boxed{1.26{\times}10^4 J}$$

Energy consumed by UV layer:

$$E_{uv} = n \times P_{uv} \times t_{uv}$$

Given:

$n = 5$ **Cycles**
$P_{uv} = 6$ **Watts**
$t_{uv} = 75$ **Seconds**

$$E_{uv} = 5 \times 6\,\mathrm{W} \times 75\,\mathrm{s}$$
$$E_{uv} = \boxed{2.25{\times}10^3 J}$$

Energy consumed by the Electrocoagulation layer:

$$E_{ec} = P_{ec} \times T_{uv}$$

Given:

$P_{uv} = 36$ **Watts**
$t_{uv} = 1200$ **Seconds**

$$E_{ec} = 36\,\mathrm{W} \times 1200\,\mathrm{s}$$
$$E_{ec} = \boxed{4.32{\times}10^4 J}$$

Total Energy Consumption:

$$E_T = E_p + E_{uv} + E_{ec}$$

$$E_T = 1.26 \times 10^4 J + 2.25 \times 10^3 J + 4.32 \times 10^4 J$$
$$E_T \approx \boxed{6{\times}10^4 J}$$

2 Concentration Calculations

loss of concentration =

$$1 - \frac{C_f}{C_o}$$

2.1 Total Dissolved Solids concentration loss

$$C_1 = 1 - \frac{120\,\text{ppm}}{1092\,\text{ppm}} = 89.0\%$$
$$C_2 = 1 - \frac{190\,\text{ppm}}{1082\,\text{ppm}} = 82.4\%$$
$$C_3 = 1 - \frac{80\,\text{ppm}}{1202\,\text{ppm}} = 93.3\%$$

$$C_{avg} = \frac{0.890 + 0.824 + 0.933}{3} = \boxed{88.2\%}$$

2.2 VOCs concentration loss

$$C_1 = 1 - \frac{1980\,\text{ppb}}{10068\,\text{ppb}} = 80.3\%$$
$$C_2 = 1 - \frac{1865\,\text{ppb}}{10100\,\text{ppb}} = 81.5\%$$
$$C_3 = 1 - \frac{1792\,\text{ppb}}{11032\,\text{ppb}} = 83.8\%$$

$$C_{avg} = \frac{0.803 + 0.815 + 0.838}{3} = \boxed{81.9\%}$$

2.3 Turbidity percentage loss

$$C_1 = 1 - \frac{5\%}{17\%} = 70.5\%$$
$$C_2 = 1 - \frac{4\%}{20\%} = 80.0\%$$
$$C_3 = 1 - \frac{3\%}{18\%} = 83.3\%$$

$$C_{avg} = \frac{0.705 + 0.800 + 0.838}{3} = \boxed{77.9\%}$$

3 Life Capicitance

3.1 Zeolite layer

Lifetime:

$$L_Z = \frac{\text{Total Capicity (meq)}}{\text{Salt Load per hour (meq/h)}} = \frac{C_T}{S_L}$$

Step 1: Total Capacity:

$$C_T = M \times CEC$$

Given:

$M_z = 0.5$ Kg
Cation Exchange Capicity(CEC) = 2 meq/g

$$C_T = 500\, g \times 2\, meq/g$$

$$C_T = 1000\, meq$$

Step 2: Converting the concentration from ppm to meq/l:
Note: ppm equals mg/l

$$\text{meq/L} = \frac{mg/L}{M_{Na^+}(mg/meq)}$$

Given:

Molceular Weight(M_{Na^+}) = 58.5 meq/g

$$\text{meq/L} = \frac{400}{58.5}$$

$$\text{meq/L} = 6.9$$

Step 3: Salt Load per hour

$$S_L = Q \times (meq/L)$$

Given:

water flow rate(Q) = 120 L/h

$$S_L = 120\,\mathrm{L/h} \times 6.9\,meq/L$$
$$S_L = 828\,meq/h$$

Step 4: Life Time:

$$L_Z = \frac{C_T}{S_L}$$
$$L_Z = \frac{1000}{828} \times 60$$
$$L_Z = \boxed{72\mathrm{min}}$$

Number of cycles is 36

3.2 UV Layer

Life Time is 16000 hours

Number of cycles is 240000

3.3 Electrocoaqulation Layer

The energy consumption :

129600J/h

Number of cycles is 864