2D Physical World Report
F06 Team 06

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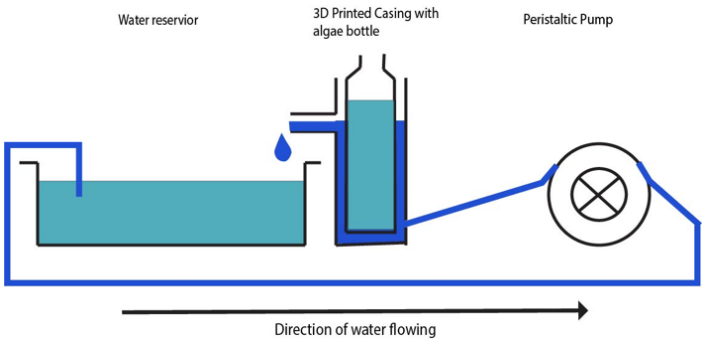

Figure 1

A #how the experiment is conducted, to find λ_{algae}

#how to find the theoretical λ_{algae} value is a range

#experimental λ_{algae} should be within theoretical λ_{algae}

B (a) The equation of control volume in the heat exchanger

$$\frac{dE_{cv}}{dt} = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m}_i \left(h_i + \frac{V_i}{2} + g z_i \right) + \dot{m}_e \left(h_e + \frac{V_e}{2} + g z_e \right)$$

Assume steady state, so $\dot{m}_i = \dot{m}_e = \frac{dE_{cv}}{dt} = \dot{m}$ *No change in potential and kinetic energy Air is ideal gas.*

$$\frac{dE_{cv}}{dt} = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m} \left(h_1 - h_2 \right)$$

(b) The rate of heat entering control volume

$$\dot{Q}_{cv} = \dot{Q}_{exchanged}$$

$$\dot{Q}_{cv} = m_a c_a \left(\frac{dT_a}{dt} \right) - \dot{Q}_{ambient}$$

$$\dot{Q}_{cv} = m_a c_a \left(\frac{dT_a}{dt}\right) - \lambda_{algaebottle}\left(T_a - T_{amb}\right)$$

By substituting value of $\lambda_{algaebottle} = 1.76$

$$\dot{Q}_{cv} = m_a c_a \left(\frac{dT_a}{dt}\right) - 1.76\left(T_a - T_{amb}\right)$$

(c) The equation of control volume in the heat exchanger
From simplified $\frac{dE_{cv}}{dt}$ *equation in the previous part*

$$\frac{dE_{cv}}{dt} = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m}\left(h_1 - h_2\right)$$

(d) Express $\dot{W}_{cv} = f\left(T_a\right)$ assuming $\dot{W}_{cv}$ is a constant *Assume that* $\frac{dE_{cv}}{dt} = 0$

$$0 = m_a c_a \left(\frac{dT_a}{dt}\right) - \lambda_{algaebottle}\left(T_a - T_{amb}\right) - \dot{W}_{cv} + \dot{m}[c_w\left(T_i - T_e\right)]$$

$$\lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{W}_{cv} - \dot{m}[c_w\left(T_i - T_e\right)] = m_a c_a \left(\frac{dT_a}{dt}\right)$$

$$\int 1dt = \int \frac{m_a c_a}{\lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{W}_{cv} - \dot{m}[c_w\left(T_i - T_e\right)]} dT_a$$

$$t + c = \frac{m_a c_a}{\lambda_{algaebottle}} \ln(\lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{W}_{cv} - \dot{m}[c_w\left(T_i - T_e\right)])$$

$$\frac{\lambda_{algaebottle}\left(t + c\right)}{m_a c_a} = \ln(\lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{W}_{cv} - \dot{m}[c_w\left(T_i - T_e\right)])$$

$$e^{\frac{\lambda_{algaebottle}(t+c)}{m_a c_a}} = \lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{W}_{cv} - \dot{m}[c_w\left(T_i - T_e\right)]$$

$$\dot{W}_{cv} = e^{\frac{\lambda_{algaebottle}(t+c)}{m_a c_a}} - \lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{m}[c_w\left(T_i - T_e\right)]$$

C Plot $\dot{W}_{cv}$ vs t

$$To\ find\ the\ value\ of\ c,\ substitute\ t = 0,\ \dot{W}_{cv} = -\left(6V * 0.22A\right) = -1.32$$

$$T_a = 308.65K\ and\ T_i - T_e = 0$$

$$\dot{W}_{cv} = Ke^{\frac{\lambda_{algaebottle}(t+c)}{m_a c_a}} - \lambda_{algaebottle}\left(T_a - T_{amb}\right) + \dot{m}[c_w\left(T_i - T_e\right)]\ where\ K = e^{\frac{\lambda_{algaebottle}(t+c)}{m_a c_a}}$$

$$-1.32 = K - 1.76\,(T_a - T_{amb}) + \dot{m}[c_w\,(T_i - T_e)]$$

D None Yet