M262 - THERMODYNAMICS I Brent Williams.

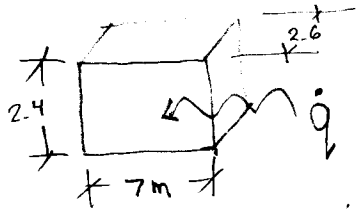
ASSIGNMENT # 4

Q. #1. $T_{air} = 30^\circ C$ $V = 85$ km/h.

$Q = 633$ kJ/min

radiation is negligable

half capacity.



$$Q = 633 \text{ kJ/min} \times \frac{1 \text{ min}}{60 \text{ sec}} \times (\tfrac{1}{2} \text{ capacity}) = 5.525 \text{ KW}.$$

$$V = 85 \text{ km/hr} \times \left(\frac{1000 \text{ m}}{1 \text{ km}}\right) \times \left(\frac{1 \text{ hr}}{3600 \text{ s}}\right) = 23.61 \text{ m/s}.$$

Air @ 30°C → $k = 0.02588$ w/m°K ✓

$P_R = 0.7282$

$\nu = 1.608 \times 10^{-5}$ m²/s

$$R_E = \frac{VL}{\nu} = \frac{(23.61 \text{ m/s})(7 \text{ m})}{(1.608 \times 10^{-5} \text{ m}^2/\text{s})} = 1.028 \times 10^7 \checkmark$$

$$N_{UL} = 0.037 P_R^{1/3} R_E^{0.8} = 0.037(0.7282)^{1/3}(1.028 \times 10^7)^{0.8}$$

$$= 13546 \checkmark$$

$$h = N_U \frac{k}{L} = \frac{(13546)(0.02588 \text{ w/m°K})}{7 \text{ m}} = 50.08 \text{ w/m}^2\text{°C}$$

$$R_T = \frac{1}{hA} = \frac{1}{(2 \times 2.4 \times 7) + (2 \times 2.6 \times 7) + (2 \times 2.6 \times 2.4)(50.08)}$$

$$R_T = 2.42 \times 10^{-4} \text{ w/°K}$$

$$Q_{RAD} = \frac{T_\infty - T_{surf}}{R_T} \rightarrow T_{surf} = T_\infty - Q_{RAD} R_T$$

$$= 30^\circ C - 5.525(2.42 \times 10^{-4})(1000)$$

$$\boxed{T_{surf} = 28.66^\circ C} \checkmark$$

5/5

2. $d = 1.5\,m$ $\ell = 5\,m$ filled with propane.

$\rho_{prop.} = 581\ kg/m^3$

$T_{ambient} = 25°C$ radiation is negligible

$T_{inside} = -42°C$

$h = 425\ kJ/kg$. not insulated.

$\rho_{air} = 1.341\ kg/m^3$

$$V = \frac{\pi d^2}{4} \cdot \ell = \frac{\pi (1.5m)^2}{4} \cdot (5m) = 8.836\ m^3 \checkmark$$

$$m = \rho_{propane} \cdot V = 581\ kg/m^3 \cdot 8.836\ m^3 = 5133.6\ kg. \checkmark$$

$$Q_{empty} = h_{evap}\, m = 425\ kJ/kg \cdot 5133.6\ kg$$
$$= 2{,}181{,}762.5\ kJ$$

$$G_R = \frac{g\beta(T - T_\infty) D^3 \rho^2}{\mu^2} = \frac{(9.81)(0.00378)(67)(1.5)^3 (1.341)^2}{(1.68 \times 10^{-5})^2}$$

$G_R = 5.3425 \times 10^{10}$ ✓

$G_R P_R = (5.3425 \times 10^{10})(0.7387) = 3.95 \times 10^{10}$

$k \rightarrow 0.02288\ w/m°C \rightarrow C = 0.13 \quad n = 1/3$

$$N_u = C (G_R P_R)^n = 0.13 (3.95 \times 10^{10})^{1/3} = 442.7 \checkmark$$

$$h = \frac{N_u k}{D} = \frac{(442.7)(0.02288)}{1.5m.} = 6.753\ w/m^2C \checkmark$$

$$Q = hA\Delta T = (6.753)(2\pi\, 0.75^2 + \pi(1.5)(5))\,67$$

$Q_{evap} = 12259.7\ w$

$$t = \frac{h_{evap}}{Q_{evap}} = \frac{2.18 \times 10^9}{12259.7} = 177818\ s$$ 5/5

$$177818\ s \times \left(\frac{3600\ s}{1\ hr}\right)^{-1} = \underline{49.39\ hous.} \checkmark$$