

ENERGY BALANCE

FAT SPLITTER:

Specific heat capacity of

Stearic acid = 2359.42 J/kg K

Oleic acid = 2884.27 J/kg K

Glycerine = 2425.78 J/kg K

Water = 5861.8 J/kg K

Fat = 2110 J/kg K

From literature

Heat of formation of fatty acids is given by a linear relation

$$\Delta H = 368 + 33 * n$$

n = no. of carbon atoms

$$\begin{aligned}\Delta H_{f(\text{fatty acid})} &= 368 + 33 * 18 \\ &= 962 \text{ kJ/ mol}\end{aligned}$$

$$\Delta H_{f(\text{for fat})} = 42.66 \text{ J/mol}$$

$$\Delta H_{f(\text{for glycerine})} = - 90.81 \text{ kJ/mol}$$

Heat required to form 2.93 moles of Stearic acid

= Heat of formation of products – Heat of formation of reactants

$$= (-90.81) + (3.68 + 2.93)(962) - 2.05(42.66) + 6.15(1757.9)$$

$$= 16991.642 \text{ KJ}$$

Also heat has to be supplied to raise the heat of reacting components from 30° C to 245° C

$$= 1826.058 * 2110 * (245 - 30)$$

$$= 8.283912117 * 10^8 \text{ J}$$

$$\text{Total heat} = 8.28408203 * 10^8 \text{ J}$$

Latent heat of steam at 5 MPa = 1644.7 KJ/Kg

$$\text{Amount of steam required} = \frac{8.283912117 * 10^8}{1644.7 * 10^3}$$

$$= 503.83 \text{ Kg}$$

Assuming 10% loss in transmission = 1.1(503.83)

$$= 554.05 \text{ Kg.}$$

FLOODED CHILLER

Amount of heat to be removed = 205.25 kw

Latent heat of R-22 at 2° C = 202.55 KJ

$$\begin{aligned}\text{Amount of R-22 required} &= \frac{205.25}{202.55} \\ &= 1.0133 \text{ kg/s} \\ &= 0.045 \text{ m}^3/\text{s}\end{aligned}$$

$$\begin{aligned}\text{Volume of shell} &= \pi * (0.54)^2 * (6/4) \\ &= 1.37 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Volume occupied by finned tubes} &= \pi * (0.01905)^2 * 6 * 48 \\ &= 0.0821 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Volume of R-22 needed at any moment} &= (1.37/2) - 0.0821 \\ &= 0.603 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Taking 10 \% excess so that the tubes are completely immersed} &= 0.663 \text{ m}^3/\text{s} \\ &= 848.27 \text{ kg/s}\end{aligned}$$