Q. 2

Ans →

$C_{p\,gly} = 2560 \ J/kg\,°C$

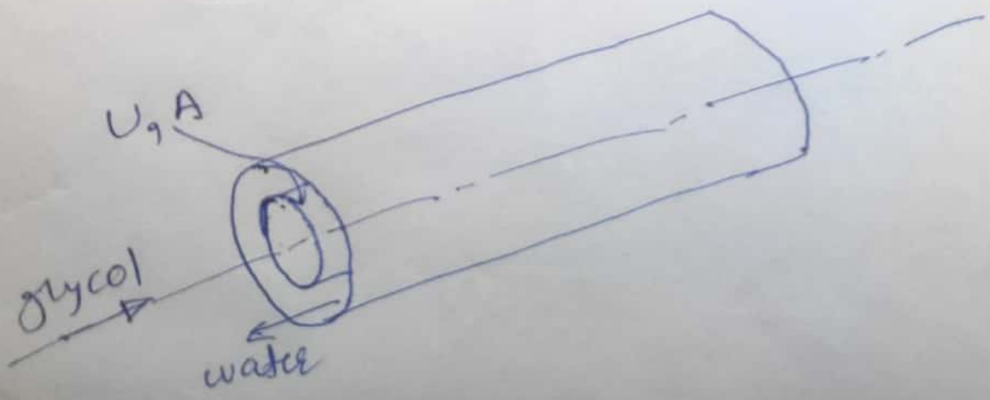
$C_{p\,wat} = 4180 \ J/kg\,°C$

$\dot{m}_{gly} = 3.5 \ kg/s$

$T_{i\,wat} = 20°C$, $T_{o\,wat} = 55°C$

$T_{i\,gly} = 80°C$, $T_{o\,gly} = 40°C$

Overall heat transfer coefficient $U = 250 \ W/m^2\,°C$.



Heat capacity rates

$C_{gly} = \dot{m}_{gly} \times C_{pgly} = 3.5 \times 2560 = 8960 \ W/°C$

$\therefore C_{wat} = \dfrac{C_{gly}(T_{igly} - T_{ogly})}{(T_{owat} - T_{iwat})} = 8960 \times \dfrac{40}{25}$

$C_{wat} = 14336 \ W/°C$

$\therefore C_{min} = C_{gly} = 8960 \ W/°C$

max possible heat transfer

$Q_{max} = C_{min} \times (T_{igly} - T_{iwat})$

$= 8960 \ (80-20)$

$\boxed{Q_{max} = 537.6 \ \text{watt}}$

$C_{wat} = \dot{m}_{wat} \times C_{pwat} = 14336 \ W/°C$

$\therefore \dot{m}_{wat} = \dfrac{14336}{4180} = 3.429 \ kg/se$

$\boxed{\dot{m}_{wat} = 3.43 \ kg/se}$

$Q = \cancel{\dots}\ \dot{m}_{gly} \times C_{p\,gly} \times (T_{i\,gly} - T_{o\,gly})$

$Q = 8960 \times (80-40)$

$= 358.4$ watt

Effectiveness, $\varepsilon = \dfrac{Q}{Q_{max}} = \dfrac{358.4}{537.6}$

$$\boxed{\varepsilon = 0.67}$$

$$C = \frac{C_{min}}{C_{max}} = \frac{8960}{14336} = 0.625$$

$$NTU = \frac{1}{C-1} \ln\left(\frac{\varepsilon - 1}{\varepsilon C_r - 1}\right) = \frac{1}{(0.625-1)} \ln\left(\frac{0.67-1}{0.67 \times 0.625 - 1}\right)$$

$$= -2.66 \ln\left(\frac{0.33}{0.58125}\right)$$

$$NTU = 1.5057$$

Now heat transfer area,

$$A = \frac{NTU \times C_{min}}{U}$$

$$= \frac{1.5057 \times 8960}{250}$$

$$\boxed{A = 53.96\ m^2}$$

Heat exchanger performance degrades as the diposites accumulates on the surface of heat exchanger.

Layer of deposits creates additional resistance to heat transfer & causes rate of heat transfer to decrease.

Types of fouling → pricipitation, corrosion & chemical fouling

→ pricipitation → caused by hard water

To avoid such type of precipitate, the water is extensively treated before entry into heat exchanger.

Such treatment → Increases the cost of operation but the effectiveness of heat exchanger increses.

→ Corrosion & chemical fouling → caused by accumulation of products of chemical reaction.

Such type of fouling can be avoided by

- coating metal pipes with glass

or

- using plastic pipes instead of metal

For such type of treatment, the cost of operating increases but the effectiveness also increase.