APPENDIX - III

FIN LOSS CALCULATIONS:

From equation (3.4) in Chapter - III (P-107) the fin heat loss is

\[ Q_c = \int_{r_0}^{r_1} 2\pi r h_c \Delta T(r) \, dr \]

where \( h_c \) is shown in Fig. 3.4, Chapter - III.

Again from equation (3.2) in Chapter - III (P-106) \( h_c \), the natural convection heat-transfer coefficient is given as

\[ (h_c \frac{2r_1}{K}) = 0.54(Gr, Pr)^{1/4} \]

with the use of above two equations and on simplifications \( Q_c \) can be expressed as

\[ Q_c = 0.54\pi K(Gr, Pr)^{1/4} (T_w - T_{Sat}) \left[ \frac{r_1 + (r_1 + r_o)}{2r_1} - \frac{r_1^2 + r_1r_o + r_o^2}{3r_1} \right] \]

Where \( Gr = Grashoff \) Number = \( \frac{g \beta (T_w - T_{Sat}) L^3}{K^2} \)

& \( Pr = Prandtl \quad \frac{\sqrt{A}}{\lambda} \) being area of heating surface.

For Copper Surface: (From Table, 3.1, Chapter - III, P-108)

\[ r_1 = 4.0 \text{cm, } r_o = 2.75 \text{cm} \]

\[ A = \pi r_1^2 = \pi \times 16 = 50.2851 \text{cm}^2; L = \sqrt{A} = 7.091241 \text{cm} \]

\[ \therefore Q_c = 0.54 \pi K(Gr, Pr)^{1/4} (T_w - T_{Sat}) \times (0.4948) \]
On calculation of the term \((Gr, Pr)^\frac{1}{4}\) with the help of the data in Table 3.2 (Chapter - III, P-109) one gets the following:

For Water on Copper, \(Q_c = 0.1153 (\Delta T)^{5/4}\)

For Isopropanol on Copper, \(Q_c = 0.02806 (\Delta T)^{5/4}\)

For Butanol on Copper, \(Q_c = 0.02764 (\Delta T)^{5/4}\)

\(\Delta T\) being measured by thermocouples in the fin.

For Brass Surface: (From Table 3.1, Chapter - III, P-109)

\(r_1 = 3.970\) cm, \(r_0 = 2.675\) cm

\(L = \sqrt{A} = \sqrt{49.534} = 7.03805\) cm.

\(Q_c = 0.54\pi K (Gr, Pr)^{\frac{1}{4}} (T_W - T_{Sat}) \times (0.5067)\)

On calculation of the term \((Gr, Pr)^{\frac{1}{4}}\) with the help of the data in Table 3.2 (Chapter - III, P-109) one gets the following.

For Water on Brass,

\(Q_c = 0.12237 \times (\Delta T)^{5/4}\)

For Isopropanol on Brass

\(Q_c = 0.02858 \times (\Delta T)^{5/4}\)

For Butanol on Brass

\(Q_c = 0.02814 \times (\Delta T)^{5/4}\)

The value of \(\Delta T\) in the above equations was measured by thermocouples (discussed in Chapter - III, P-106) and was always found to be equal to the difference between wall temp. \(T_W\) & Liquid Saturation temp. \(T_{Sat}\).
From equation (3.1), (Chapter - III, P-106)

\[(Q/A)_{\text{Net}} = \frac{Q_T - Q_C}{A_0}\]

was calculated as given in Tables 3.9, 3.10 (Chapter - III, P-117 to 120) and also in Tables 5.3 & 5.4 (Chapter - V, P-178 to 182).