Part C

IV (3.0 v)

It is intended to condense vapour from saturated gas, at 78 °C. The saturated gas will flow inside a tube (k = 130 W·m^{-1}·K^{-1}, $h_{\text{int}} = 1.2$ kW m^{-2} K^{-1}), with internal diameter 46 mm, 2 mm wall thickness and 5 m long, which will be immersed in a water tank, with uniform temperature, T_∞=15 °C ($h_{\text{ext}} = 30$ W m^{-2} K^{-1}).

a) Estimate the flow rate of condensate, knowing that the enthalpy of vaporization of the fluid is 850 kJ/kg.

b) If the thickness of the wall were to be increased by 1 mm, what would be the condensate flow rate? Comment on the result.

V (2.5 v)

Consider the following simplified form of the equation of diffusion (or conduction) of heat:

$$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dT}{dr}\right) = -\frac{\dot{q}}{k}$$

a) Obtain the equation above, by making a heat balance to an adequate control volume. Justify your answer.

b) Between options A and B, which of them indicates the radial temperature distribution, for $0 \leq r \leq R_1$, for the geometry considered above, with $T|_{r=R_1} = T_1$, under the conditions of validity of the equation? Justify your answer.

A: $T = \frac{\dot{q}R_1^2}{4k}\left[1-\left(\frac{r}{R_1}\right)^2\right] + T_1$ B: $T = \frac{\dot{q}R_1^2}{6k}\left[1-\left(\frac{r}{R_1}\right)^2\right] + T_1$

a) Demonstrate if the following statement is true or false: “The rate of heat transfer inside the object referred in b), for the indicated conditions, is constant”.