

a) $\Delta T = (T_{sp} - T_{sat}) = (110 - 100) = 10^\circ\text{C}$

Como $\Delta T_{ex} = \Delta T, (< 30^\circ\text{C})$ esse processo é no regime de ebulição nucleada:

$$q = \mu \cdot h_{fg} \left[\frac{g_c (p_s - p_o)}{g_c \sigma^*} \right]^{1/2} \left[\frac{C_{p,l} \Delta T}{C_{sf} h_{fg} Pr_l^n} \right]^3 \quad (\text{adaptado para } q)$$

Dados: (TABELA A-9)

$\sigma^* = 0,0589 \text{ N/m}$ (TABELA 10-1)

$\rho_l = 957,9$

$C_{p,l} = 4217 \text{ J/kg K}$

$Pr_l = 1,75$

$g_c = 1$

$h_{fg} = 2257,10^3 \text{ J/kg}$

$\mu = 0,282 \cdot 10^{-3} \text{ kg/m}^3$

$C_{sf} = 0,0130$ (Tabela 10-3)

$n = 1$

Substituindo os valores:

$$q = 0,282 \cdot 10^{-3} \cdot 2257,10^3 \cdot \left[\frac{9,81(957,9 - 96)}{1 \cdot 0,0589} \right]^{1/2} \left[\frac{4217(110 - 100)}{0,0130 \cdot 2257,10^3 \cdot 1,75^1} \right]^3$$

$q = 636,474 \cdot 399,307 \cdot 0,554$

$q = 14,1 \cdot 10^4 \text{ W/m}^2$

Taxa de calor

$Q = A \cdot q$

$A = \pi D^2/4 = \pi (0,3)^2/4 = 0,07069 \text{ m}^2$

$Q = 0,07069 \cdot 14,1 \cdot 10^4$

$Q = 9952,88 \text{ W}$

b) $Q = M \cdot h_{fg} \Rightarrow M = Q/h_{fg}$

$M = 9952,88 \text{ W}$

$2257,10^3 \text{ J/kg}$

$M = 4,41 \cdot 10^{-3} \text{ kg/s}$

tilibra

c) Fluxo máximo:

$$q_{\text{max}} = F(L') \cdot 0,131 \cdot p_b^{\frac{1}{2}} \cdot h_{\text{fg}} (\sigma^* \cdot g \cdot g_c (p_b - p_0))^{\frac{1}{4}}$$

$$L' = L \cdot \left(\frac{g (p_b - p_0)}{\sigma} \right)^{\frac{1}{2}}$$

Dados:

$$\sigma^* = 0,0589 \text{ N/m}$$

$$p_b = 957,9 \text{ kg/m}^3 \text{ e } p_0 = 96 \text{ kg/m}^3$$

$$h_{\text{fg}} = 2257 \cdot 10^3 \text{ J/kg}$$

$$g_c = 9$$

$$p_0(105^\circ\text{C}) = 97121$$

em água

$$L' = 0,3 \left(\frac{9,81 \cdot (957,9 - 97121)}{0,0589} \right)^{\frac{1}{2}} = 119,78 \text{ m}$$

$$L' \geq 2,7 \Rightarrow F(L') = 1,14$$

$$q_{\text{max}} = 1,14 \cdot 0,131 \cdot (97121)^{\frac{1}{2}} \cdot 2257 \cdot 10^3 \cdot (0,0589 \cdot 9,81 \cdot 1 \cdot (957,9 - 97121))^{\frac{1}{4}}$$

$$q_{\text{max}} = 1,39 \cdot 10^6 \text{ W/m}^2$$