3)

$$A_p = \pi d_o N_p (L_p - N_s d)$$

$$= \pi \times 0.020 \times 84 \times (1.18 - 225 \times 0.0005)$$

$$= 563 m^2$$

$$A_s = 2 N_s \left[L_x L_y - N_p \frac{\pi}{4} d_o^2\right]$$

$$= 2(225) \times \left(0.85 \times 0.4 - 84 \times \frac{\pi}{4} \times 0.020^2\right)$$

$$= 141.1 m^2$$

$$H = (1.13b - d_o)/2$$

$$= (1.13b \times 65 \times 10^{-3} - 20 \times 10^{-3})/2 = 0.0267$$

From Figure 26.

$$Z_1 = H(2h_2/dk)^{0.5}$$

$$= 0.0267\sqrt{(2 \times 18)/(0.0005 \times 20)}$$

$$= 0.507$$

$$Z_2 = 1 + 2H/d_o$$

$$= 1 + 2(0.0267)/0.02$$

$$= 3.67$$

$$\Rightarrow \eta_f = 0.86$$

$$A_1 = 84 \times 1.18 \times \pi \times 0.017$$

$$= 5.29 \text{m}^2$$

$$\frac{1}{UA} = \frac{1}{h_1 A_1} + \frac{x}{\lambda A_{12}} + \frac{1}{h_2 (A_p + \eta_f A_f)}$$

$$= \frac{1}{430 \times 5.29} + \frac{0.0015}{200 \times 5.29} + \frac{1}{18(5.63 + 0.865 \times 141.1)}$$

$$= 4.2 \times 10^{-4} + 1.41 \times 10^{-6} + 4.35 \times 10^{-4}$$

$$= 8.56 \times 10^{-4}$$

$$UA = \frac{1}{8.56 \times 10^{-4}}$$

$$= 1169 \text{ W/K}$$

Hence

$$\phi = UA \Delta\theta$$

$$= 1169 \times 12.3 = 14370 \text{ W}.$$

This is about 4% short of the required heat transfer. In practice the condensation temperature would rise by about $\frac{1}{2}$ a degree to increase the temperature difference slightly.