

Heat Conduction Solution Manual Latif M Jiji

PROBLEM 2.24 (continued)

$$\overline{Nu}_D = \frac{\overline{h} D}{k} = f(Re_D)$$
(c)

The Reynolds number is defined as

$$Re_D = \frac{V_\infty D}{V}$$
 (d)

where

 V_{∞} = free stream velocity, m/s

v = kinematic viscosity, m²/s

Solving equation (c) for \overline{h}

$$\overline{h} = \frac{k}{D} f(Re_D) \qquad (e)$$

Applying (2) to the two spheres and taking the ratio to eliminate k

$$\frac{\overline{h}_{1}}{\overline{h}_{2}} = \frac{D_{2} f(Re_{D1})}{D_{1} f(Re_{D2})}$$
(f)

where the subscripts 1 and 2 refer to sphere 1 and 2, respectively. Using (d) to determine the two Reynolds numbers

$$Re_{D_1} = \frac{V_{\infty 1}D_1}{V}$$
(g)

and

$$Re_{D2} = \frac{V_{\infty 2}D_2}{V} \tag{h}$$

The total heat transfer rate is determined using Newton's law of cooling

$$q_T = hA(T_s - T_{\infty}) \qquad (i)$$

where A is surface area of sphere given by

$$A = \pi D^{2}$$
 (j)

(j) into (i)

$$q = \pi h D \left(T_s - T_{\infty}\right) \tag{k}$$

Applying (k) to the two spheres and taking their ratio

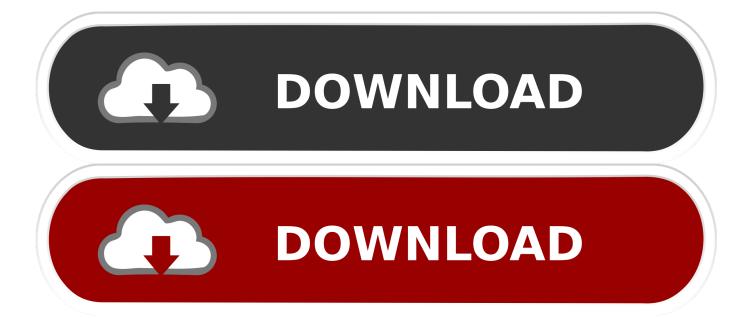
$$\frac{q_1}{q_2} = \frac{\pi \overline{h}_1 D_1 (T_s - T_{\infty})}{\pi \overline{h}_2 D_2 (T_s - T_{\infty})} = \frac{\overline{h}_1 D_1}{\overline{h}_2 D_2}$$
(1)

(iii) Computations. Substituting numerical values in (g) and (h)

$$Re_{D_1} = \frac{23.4(\text{m/s})3.2(\text{m})}{v(\text{m}^2/\text{s})} = \frac{74.88(\text{m}^2/\text{s})}{v(\text{m}^2/\text{s})}$$

and

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