HEAT, MASS,

AND

MOMENTUM TRANSFER

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TABLE 6.1 ORDER OF MAGNITUDE OF h, BTU/HR FT^2 F

Gases (natural convection)	0.9–5
Flowing gases	2–50
Flowing liquids (nonmetallic)	30–1,000
Flowing liquid metals	1,000–50,000
Boiling liquids	200–50,000
Condensing vapors	500–5,000

For a wall, the equivalent h is k/x. For example, for a steel wall 0.12 in. thick and $k = 26$ Btu/hr ft F, the equivalent h is $26 \times 12/0.12$ or 2600, but for an asbestos wall 1 ft thick with $k = 0.13$ Btu/hr ft F, the equivalent h is 0.13/1 or 0.13.

For certain combinations of these various resistances in series, some may be negligible compared with others.

Example 6.1: What resistances are negligible when heat is transferred through 1 ft^2 of a 0.12-in. thick steel plate ($k_w = 26$) with a flowing liquid ($h_l = 1000$) on one side and a flowing gas on the other ($h_{g_o} = 10$)?

Assume a scale coefficient of $h_s = 1000$ on the liquid side. From Eq. (6.22)

$$\frac{1}{U} = \frac{1}{h_l} + \frac{1}{h_s} + \frac{x_w}{k_w} + \frac{1}{h_{g_o}} = \frac{1}{1000} + \frac{1}{1000} + \frac{0.12}{(26)(12)} + \frac{1}{10}$$

$$\cong \frac{1}{10} = \frac{1}{h_{g_o}}$$

In this case, the only significant resistance is at the gas side surface.

Example 6.2: Same as Example (6.1) with the flowing gas replaced by condensing steam ($h = 1000$).

$$\frac{1}{U} = \frac{1}{1000} + \frac{1}{1000} + \frac{1}{2600} + \frac{1}{1000}$$

In this case, none of the resistances is negligible.

Example 6.3: Same as Example (6.1) with the flowing liquid replaced by another flowing gas ($h_{g_i} = 5$).

$$\frac{1}{U} = \frac{1}{5} + \frac{1}{1000} + \frac{1}{2600} + \frac{1}{10} \cong \frac{1}{5} + \frac{1}{10} = \frac{1}{h_{g_1}} + \frac{1}{h_{g_o}}$$

In this case the wall and scale resistances are negligible.