WEEK 3 weekly submission

CANLAS, GLEN CARLO

Continuation of last week's problem:

R_I = 0.40 $\frac{°C}{W}$

R_f = 4.62 $\frac{°C}{W}$

$R_{P_1\,P_2}$ = 0.36 $\frac{°C}{W}$

R_O = 0.10 $\frac{°C}{W}$

R_{PC} = 48.48 $\frac{°C}{W}$

R_B = 1.01 $\frac{°C}{W}$

$R_{PARALLEL}$ = 0.97 $\frac{°C}{W}$

R_{TOTAL} = 6.81 $\frac{°C}{W}$

Heat Transfer Rate:

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{TOTAL}} = \frac{20\ °C - (-10\ °C)}{6.81\ \frac{°C}{W}} = 4.41\ W$$

Example D:

A 3 m high and 5 m wide wall consists of long 32 cm 22 cm cross section horizontal bricks (k = 0.72 W/m · °C) separated by 3 cm thick plaster layers (k = 0.22 W/m · °C). There are also 2 cm thick plaster layers on each side of the brick and a 3-cm-thick rigid foam (k 0.026 W/m · °C) on the inner side of the wall. The indoor and the outdoor temperatures are 20°C and -10°C, and the convection heat transfer coefficients on the inner and the outer sides are h1 = 10 W/m2 · °C and h2 = 40 W/m2 · °C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

$$R_I = \frac{1}{h_I * A} = \frac{1}{10 * 0.25} = 0.40\ \frac{°C}{W}$$

$$R_f = \frac{L_f}{(K_f * A)} = \frac{0.03}{0.026 * 0.25} = 4.62\ \frac{°C}{W}$$

$$R_{P_1\,P_2} = \frac{L_P}{(K_P * A)} = \frac{0.02}{0.22 * 0.25} = 0.36\ \frac{°C}{W}$$

$$R_{PC} = \frac{L_{PC}}{(K_{PC} * A)} = \frac{0.32}{0.22 * 0.015} = 96.97\ \frac{°C}{W}$$

$$R_B = \frac{L_B}{(K_B * A)} = \frac{0.32}{0.72 * 0.22} = 2.02\ \frac{°C}{W}$$

$$R_O = \frac{1}{h_O * A} = \frac{1}{40 * 0.25} = 0.10\ \frac{°C}{W}$$

$$R_{PARALLEL} = \frac{1}{R_{PC}} + \frac{1}{R_B} + \frac{1}{R_{PC}} = \frac{1}{96.97} + \frac{1}{2.02} + \frac{1}{96.97} = 1.93\ \frac{°C}{W}$$

$$R_{TOTAL} = R_I + R_f + R_{P1} + R_{PARALLEL} + R_{P2} + R_B$$

$$= 0.40\ \frac{°C}{W} + 4.62\ \frac{°C}{W} + 0.36\ \frac{°C}{W} + 1.93\ \frac{°C}{W} + 0.36\ \frac{°C}{W} + 0.10\ \frac{°C}{W} = 7.77\ \frac{°C}{W}$$

Heat Transfer Rate:

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{TOTAL}} = \frac{20\ ^{\circ}C - (-10\ ^{\circ}C)}{7.77\ \frac{^{\circ}C}{W}} = 3.86\ W$$

Comparison of the two results

Doubling the thickness of the brick inside the composite wall barely affects the total thermal resistance of the composite wall. Thus, the rate of heat transfer did not significantly decrease.

Simplified Wall Calculation

Determine the overall unit thermal resistance (the R-value) and the overall heat transfer coefficient (the U-factor) of a wood frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400 mm. The 90-mm-wide cavity between the studs is filled with urethane rigid foam. The inside is finished with 13-mm gypsum wall board and the outside with 13-mm plywood and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75 percent of the heat transmission area while the studs, plates, and sills constitute 21 percent. The headers constitute 4 percent of the area, and they can be treated as studs.

	Wood (A section)	Insulation (B section)
Outside	*0.03*	*0.03*
Wood Bevel	*0.14*	*0.14*
Plywood	*0.11*	*0.11*
Urethane rigid foam	*No*	*0.98*(90/25)=3.53*
Wood Studs	*0.63*	*No*
Gypsum board	*0.079*	*0.079*
Inside Surface	*0.12*	*0.12*

$$R_{WOOD} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109\ \frac{m2^{\circ}C}{W}$$

$$R_{INSULATION} = 0.03 + 0.14 + 0.11 + 3.53 + 0.079 + 0.12 = 4.009\ \frac{m2^{\circ}C}{W}$$