

QUESTION1:

- A 3m high and 5m wide wall consists of long 32cm 22cm cross section horizontal bricks($k=0.72\text{W/m}\cdot^\circ\text{C}$) separated by 3 cm thick plaster layers($k=0.22\text{W/m}\cdot^\circ\text{C}$)
- There are also 2 cm thick plaster layers on each side of the brick and a 3-cm-thick rigid foam($k=0.026\text{W/m}\cdot^\circ\text{C}$) on the inner sider 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 $h_1=10\text{W/m}^2\cdot^\circ\text{C}$ and $h_2=40\text{W/m}^2\cdot^\circ\text{C}$, respectively.
- Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of the heat transfer through the wall.

$$R_1 = \frac{1}{h_1 A} = \frac{1}{\frac{10\text{W}}{\text{m}^2 \cdot ^\circ\text{C}} \cdot 0.25\text{m} \cdot 1\text{m}} = 0.4\text{ }^\circ\text{C/W}$$

$$R_f = \frac{L_f}{k_f A} = \frac{0.03\text{m}}{\frac{0.026\text{W}}{\text{m} \cdot ^\circ\text{C}} \cdot 0.25\text{m} \cdot 1\text{m}} = 4.615\text{ }^\circ\text{C/W}$$

$$R_{p_{c_1}} = R_{p_{c_2}} = \frac{L_{p_{c_1}}}{k_p A} = \frac{0.32\text{m}}{\frac{0.22\text{W}}{\text{m} \cdot ^\circ\text{C}} \cdot 0.015\text{m} \cdot 1\text{m}}$$

$$= 96.97\text{ }^\circ\text{C/W}$$

$$R_f = \frac{L_f}{k_f A} = \frac{0.03\text{m}}{\frac{0.026\text{W}}{\text{m} \cdot ^\circ\text{C}} \cdot 0.25\text{m} \cdot 1\text{m}} = 4.615\text{ }^\circ\text{C/W}$$

$$R_b = \frac{L_b}{k_b A} = \frac{0.32\text{m}}{\frac{0.72\text{W}}{\text{m} \cdot ^\circ\text{C}} \cdot 0.22\text{m} \cdot 1\text{m}} = 2.02\text{ }^\circ\text{C/W}$$

$$\therefore \frac{1}{R_{\text{total-parallel}}} = \frac{1}{R_b} + \frac{1}{R_{p_{c_1}}} + \frac{1}{R_{p_{c_2}}}$$

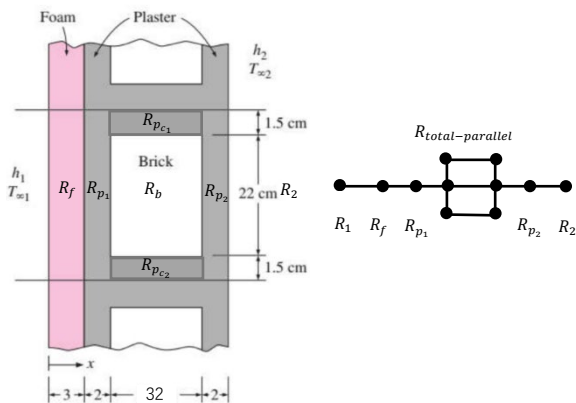
$$\therefore R_{\text{total-parallel}} = 0.66\text{ }^\circ\text{C/W}$$

$$R_{p_1} = R_{p_2} = \frac{L_{p_1}}{k_p A} = \frac{0.02\text{m}}{\frac{0.22\text{W}}{\text{m} \cdot ^\circ\text{C}} \cdot 0.25\text{m} \cdot 1\text{m}} = 0.363\text{ }^\circ\text{C/W}$$

$$R_2 = \frac{1}{h_2 A} = \frac{1}{\frac{40\text{W}}{\text{m}^2 \cdot ^\circ\text{C}} \cdot 0.25\text{m} \cdot 1\text{m}} = 0.1\text{ }^\circ\text{C/W}$$

$$\therefore R_{\text{total}} = R_1 + R_f + R_{p_1} + R_{\text{total-parallel}} + R_{p_2} + R_2 = 7.781\text{ }^\circ\text{C/W}$$

$$\dot{Q} = \frac{T_1 - T_\infty}{R_{\text{total}}} = \frac{20^\circ\text{C} - (-10^\circ\text{C})}{7.781^\circ\text{C/W}} = 3.86\text{W}$$

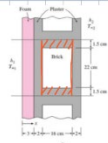


Comparing with those in class with the thickness of brick long 16m

2019年10月16日
2019年10月16日 上午11:07

A 3 m high and 5 m wide wall consists of long 16 cm 22 cm cross section horizontal bricks ($k = 0.72 \text{ W/m} \cdot ^\circ\text{C}$) separated by 2 cm thick plaster layers ($k = 0.22 \text{ W/m} \cdot ^\circ\text{C}$). There are also 2 cm thick plaster layers on each side of the brick and 2 cm thick rigid foam ($k = 0.026 \text{ W/m} \cdot ^\circ\text{C}$) 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 $h_1 = 10 \text{ W/m}^2 \cdot ^\circ\text{C}$ and $h_2 = 25 \text{ W/m}^2 \cdot ^\circ\text{C}$, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.



$$R_1 = \frac{1}{h_1 A} = \frac{1}{(10 \text{ W/m}^2 \cdot ^\circ\text{C}) \cdot 0.25 \text{ m}^2} = 0.4 \text{ } ^\circ\text{C/W}$$

$$R_f = \frac{L_f}{k_f A} = \frac{0.03 \text{ m}}{(0.026 \text{ W/m} \cdot ^\circ\text{C}) \cdot 0.25 \text{ m}^2} = 4.615 \text{ } ^\circ\text{C/W}$$

$$R_{pc1} = R_{pc2} = \frac{L_{pc}}{k_p A_{pc}} = \frac{0.01 \text{ m}}{(0.22 \text{ W/m} \cdot ^\circ\text{C}) \cdot 0.05 \text{ m}^2} = 4.545 \text{ } ^\circ\text{C/W}$$

$$R_b = \frac{L_b}{k_b A_b} = \frac{0.16 \text{ m}}{(0.72 \text{ W/m} \cdot ^\circ\text{C}) \cdot 0.22 \text{ m}^2} = 1.01 \text{ } ^\circ\text{C/W}$$

$$R_{tot-f} = R_b + R_{pc1} + R_{pc2} \therefore R_{tot-f} = 0.97 \text{ } ^\circ\text{C/W}$$

$$R_{p1} = \frac{L_{p1}}{k_p A_{p1}} = \frac{0.02 \text{ m}}{(0.22 \text{ W/m} \cdot ^\circ\text{C}) \cdot 0.25 \text{ m}^2} = 0.363 \text{ } ^\circ\text{C/W} = R_{p2}$$

$$R_2 = \frac{1}{h_2 A} = \frac{1}{(25 \text{ W/m}^2 \cdot ^\circ\text{C}) \cdot 0.25 \text{ m}^2} = 0.1 \text{ } ^\circ\text{C/W}$$

$$R_{total} = R_1 + R_f + R_{p1} + R_{tot-f} + R_{p2} + R_2 = 6.81 \text{ } ^\circ\text{C/W}$$

$$\dot{Q} = \frac{T_1 - T_2}{R_{total}} = \frac{20^\circ\text{C} - 10^\circ\text{C}}{6.81 \text{ } ^\circ\text{C/W}} = 1.47 \text{ W}$$

We can find that in this situation with the composite wall, simply adding the thickness of the wall doesn't help to increase the thermal resistance of the whole wall.

QUESTION2:

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel (13mm*200mm)	0.14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigid Foam Ins. (90mm)	No	3.528
Wood Studs(90mm)	0.63	No
Gypsum Borad(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$$R_{withwood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 \frac{\text{m}^2 \cdot ^\circ\text{C}}{\text{W}}$$

$$R_{withinsulation} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007 \frac{\text{m}^2 \cdot ^\circ\text{C}}{\text{W}}$$