Week 3

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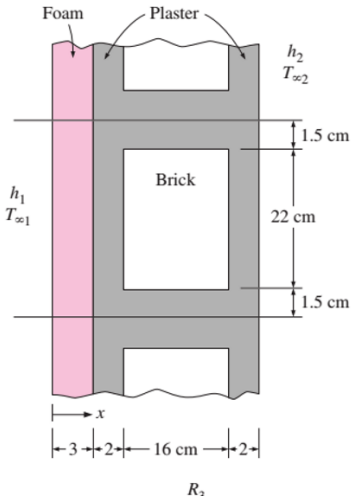
Task 1

A 3 m high and 5 m wide wall consists of long 16 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.



$$R_{1,\,conv} = \frac{1}{h1 \times A1} = \frac{1}{10\,\frac{W}{m2\cdot °C} \times 0.25m \times 1m} = 0{,}4\,\frac{°C}{W}$$

$$R_{foam} = \frac{Lf}{kf \times A1} = \frac{0.03m}{0.026\,\frac{W}{m\cdot °C} \times 0.25m \times 1m} = 4{,}615\,\frac{°C}{W}$$

$$R_{plaster.up} = R_{plaster.down} = \frac{Lp1}{kp \times Ap} = \frac{0.32m}{0.22\frac{W}{m\cdot °C} \times 0.015m \times 1m} = 96.97\,\frac{°C}{W}$$

$$R_{brick} = \frac{Lb}{kb \times Ab} = \frac{0.32m}{0.72\,\frac{W}{m\cdot °C} \times 0.22m \times 1m} = 2.02\,\frac{°C}{W}$$

$$\frac{1}{Rtotal.paralel} = 2 \times \frac{1}{Rplaster.up/down} + \frac{1}{Rb} = 2 \times \frac{1}{96.97\,\frac{°C}{W}} + \frac{1}{2.02\,\frac{°C}{W}}$$

$$\frac{1}{Rtotal.paralel} = 0.516\,\frac{W}{°C}$$

$$R_{total.parallel} = \frac{1}{0.52\,\frac{W}{°C}} = 1.94\,\frac{°C}{W}$$

$$R_{plaster.left} = R_{plaster.right} = \frac{Lp2}{kp \times A1} = \frac{0.02m}{0.22\frac{W}{m\cdot °C} \times 0.25m \times 1m} = 0.363\,\frac{°C}{W}$$

$$R_{2,conv.} = \frac{1}{h2 \times A1} = \frac{1}{25\,\frac{W}{m2\cdot °C} \times 0.25m \times 1m} = 0.16\,\frac{°C}{W}$$

$$R_{wall,\,total} = R_1 + R_f + R_{total.parallel} + R_{plaster.left} + R_{plaster.right} + R_2$$

$$R_{wall} = 0.4+4.61+1.93+0.36+0.36+0.16 = 7.82\,\frac{°C}{W}$$

$$\dot{Q} = \frac{T1-T\infty}{Rwall} = \frac{20°C-(-10°C)}{7.82\ °C/W} = 3.836\ W$$

In comparison 16 cm brick and 32cm brick inside of composite wall, The result shows there is not notable difference.

Task 2

A wood frame wall that is bulid 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 foad insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13-mm polywood and 13 mm 200mm wood bevel lapped siding. The insulted cavity constitutes 75 percet of the heat transimission 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.

$$R'_{wood} = 0.03 + 0.14 + 0.11 + 0.079 + 0.12 + 0.63 = 1.11 \frac{m2 \cdot °C}{W}$$

$$R'_{insulation} = 0.03 + 0.14 + 3.53 + 0.11 + 0.079 + 0.12 = 4.01 \frac{m2 \cdot °C}{W}$$