Week3_YSerageldin

Monday, December 16, 2019 9:16 PM

Example: Heat loss through a composite wall

Wednesday, October 23, 2019 6:20 AM

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 (k0.026 W/m ·°C) on the inner side of the wall. The indoor and the outdoor temperatures are20°C and 10°C, and the convection heat transfer coefficients on the inner and the outer sides areh1=10W/m2 ·°C andh2 =25 W/m2 ·°C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

Answer:

$$A = (0.015 + 0.22 + 0.015) * 1 = 0.25\text{m2}$$

$$\text{R1, conv.} = \frac{1}{\text{h1xA1}} = \frac{1}{10\text{x}0.25} = 0.4\ \frac{\text{C}}{\text{W}}$$

$$\text{Rf} = \frac{\text{Lf}}{\text{KfxA1} - \text{dimen}} = \frac{0.03}{0.026\text{x}0.25} = 4.615\frac{\text{C}}{\text{W}}$$

$$\text{Rp1} = \text{Rp2} = \frac{\text{Lp}}{\text{Kp} * \text{Ap}} = \frac{0.32}{0.22 * 0.15 * 1} = 96.97\ \frac{\text{C}}{\text{W}}\ \text{(p: 2cm thick plastic layers)}$$

$$\text{Rb} = \frac{\text{Lb}}{\text{KbxAb}} = \frac{0.32}{0.72\text{x}0.22\text{x}1} = 2.02\ \frac{\text{C}}{\text{W}}$$

$$\frac{1}{\text{Rtotal. parallel}} = \frac{1}{96.97} + \frac{1}{2.02} + \frac{1}{96.97} = 0.516\ \frac{\text{C}}{\text{W}}\ \text{(Brick and two plastic layers)}$$

Rtotal parallel$=\frac{\mathbf{1}}{\mathbf{0.516}} = \mathbf{1.94}\ \frac{\mathbf{C}}{\mathbf{W}}$

$$\text{Rp1} = \text{Rp2} = \frac{\text{Lp}}{\text{Kp} * \text{Ap}} = \frac{0.02}{0.22\text{x}0.25\text{x}1} = 0.363\ \frac{\text{C}}{\text{W}}\ \text{(p: 2cm thick plastic layers)}$$

$$\text{R2, conv.} = \frac{1}{\text{h2} * \text{A1}} = \frac{1}{40\text{x}0.25} = 0.1\ \frac{\text{C}}{\text{W}}$$

Rwall total =0.4+4.615+0.363+1.94+0.363+0.1=7.781 $\frac{\mathbf{C}}{\mathbf{W}}$

The Rate of heat transfer loss: $\dot{\mathbf{Q}} = \frac{\mathbf{T1-T\infty}}{\mathbf{Rwall.total}} = \frac{\mathbf{20-(-10)}}{\mathbf{7.781}} = \mathbf{3.86\ W}$

But Rwall.total when Thickness of brick=16 mm $=6.81\ \frac{\text{C}}{\text{W}}$

SO, the heat transfer rate is:

$$\dot{\text{Q}} = \frac{\text{T1} - \text{T}\infty}{\text{Rwall. total}} = \frac{20 - (-10)}{6.81} = 4.41\ \text{W}$$

So By comparing the two results 4.41w and 3.86w, we found that: double the thickness of a brick inside a composite wall increases slightly the thermal resistance of thewall, so the rate of heat transfer slightly decreases.

Task two:

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 rigif foam insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm polywood 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.

Find the two R values

Answer:

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel(13mm*200mm)	0.14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigif Foam Ins.(90mm)	No	0.98*90/25=3.528
Wood Studs(90mm)	0.63	No
Gypsum Board(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$$R'_{with\ wood} = (0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12)m^2\frac{°C}{W} = 1.109\frac{m^2°C}{W}$$

$$R'_{with\ insulation} = (0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12) = 4.007\frac{m^2°C}{W}$$