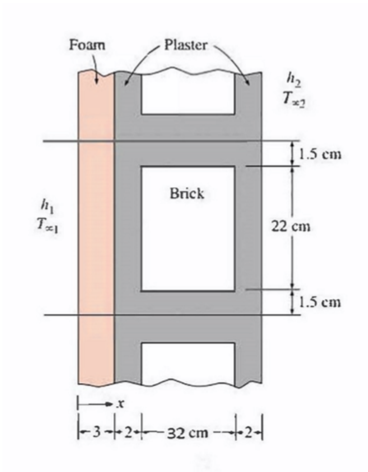
Adami,Amirmohammad

Technical Environmental System



Heat loss through a composite wall:

A 3-m high and 5-m wide wall consists of long 32-cm 22-cm cross section horizontal brick s (=0.72 W/m °C) separated by 3 cm thick plaster layers (= 0.22 W/m °C).

There are also 2 cm thick plaster layers on each side of the brick and a 3-cm-thic rigid foam (= 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 = 10 W/m2 °C and = 40 W/m2 °C, respectively. Assuming one- dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

$$R1conv = \frac{1}{h1 * A1 - dimen} = \frac{1}{10\ \frac{w}{m^2℃} * (0.015 + 0.22 + 0.015)m * 1m} = 0.4\ \frac{℃}{w}$$

$$Rfoam = \frac{Lfoam}{h1 * A1 - dimen} = \frac{0.03m}{0.026\ \frac{w}{m^2℃} * (0.015 + 0.22 + 0.015)m * 1m} = 4.615\ \frac{℃}{w}$$

$$Rplaster.up = Rplaster.down = \frac{Lp.up\ \ or\ \ Lp.down}{Kp * Ap.up\ or\ down * A1 - dimen} = \frac{0.32m}{0.22\ \frac{w}{m℃} * 0.015m * 1m} \approx 96.97\ \frac{℃}{W}$$

$$Rbrick = \frac{Lbrick}{Kbrick * Abrick * 1 - dimen} = \frac{0.32m}{0.72\ \frac{W}{m℃} * 0.22m * 1m} \approx 2.02\frac{℃}{w}$$

$$\frac{1}{Rt - parallel} = \frac{1}{Rplaster.up} + \frac{1}{Rbrick} + \frac{1}{Rbrickplaster.down} \approx \frac{1}{96.97\frac{℃}{w}} + \frac{1}{2.02\frac{℃}{w}} + \frac{1}{96.97\frac{℃}{w}} \approx 0.516\ \frac{℃}{w}$$

$$i.e., Rt - parallel = \frac{1}{0.516\frac{℃}{w}} \approx 1.94\ \frac{℃}{w}$$

$$Rplaster.left = Rplaster.right = \frac{Lplaster\ left\ \ or\ right}{Kp * Aplaster\ left\ \ or\ right\ (1 - dimen)} = \frac{0.02m}{0.022\ \frac{℃}{w} * (0.015 + 0.22 + 0.015)m * 1m}$$

$$= 0.363\ \frac{℃}{w}$$

$$R2conv = \frac{1}{h2 * A1 - dimen} = \frac{1}{40\ \frac{w}{m^2℃} * (0.015 + 0.22 + 0.015)m * 1m} = 0.1\ \frac{℃}{w}$$

$$Rwall.total(1 - dimen)$$
$$= R1conv + Rfoam + Rplaster.left + Rtotal - parallel + Rplaster.right + R2conv \sim 0.4 + 4.615 + 0.363 + 1.94 + 0.363 + 0.1 = 7.781\frac{℃}{w}$$

The heat transfer rate:

$$Q = \frac{T1 - Tinf}{Rwall, total} \approx \frac{20 - (-10)℃}{7.781\frac{℃}{w}} \approx 3.86\ W$$

$$Rwall, total(thickness\ of\ brick = 16mm) \approx 6.81\frac{℃}{w}$$

In this condition , the heat transfer rate is:

$$Q' = \frac{T1 - Tinf}{Rwall, total(thickness\ of\ brick = 16mm)} \approx \frac{20 - (-10)℃}{6.81\frac{℃}{w}} \approx 4.41\ W$$

By comparing the two answers we can have this conclusion that by doubling the thickness of a brick inside doesn't significantly. Increase the thermal resistance of the whole wall, thus the rate of heat transfer doesn't significantly decrease.

2-

A wood frame wall that is built around 38mm*90mm wood studs with a center-to-center distance of 400mm. The 90mm wide cavity between the studes in filled with urethane rigif foam insulation.The inside is finished with 13mm gypsum wallboard and the outside with 13mm polywood and 13mm*200mm wood bevel lapped siding.The insulted cavity constitudes 75% of the heat transmission area while the studes, plates, and sills sonstitute 21%. The headers constitute 4% of the area, and they can be treated as studes.

Find the two $\boldsymbol{Runit}$ values.

	Wood	Insulation
Outside	0.03	0.03
Wood Bevel(13mm*200mm)	14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigif Foam Ins.(90mm)	No	0.98*.90/25=3.528
Wood studes(90mm)	0.63	No
Gypsum Board(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$$\boldsymbol{R' with. wood = (0.03 + 14 + 0.11 + 0.63 + 0.079 + 0.12) m^2 \frac{℃}{W} = 1.109\ \frac{w}{m^2℃}}$$

$$\boldsymbol{R' with. Insulation = (0.03 + 14 + 0.11 + 3.528 + 0.079 + 0.12) = 4.007\ \frac{w}{m^2℃}}$$