Week3-NKiarostami

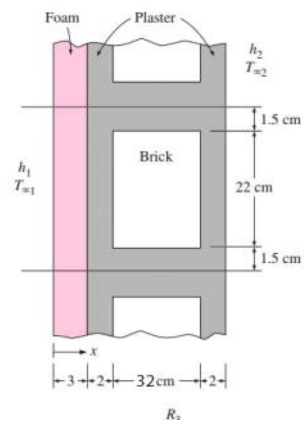
Tuesday, October 22, 2019 3:13 PM

Question: Finalize the composite wall question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32 cm and comment on the results.

Temp (indoor) = 20 $°C$
T (outdoor) = -10 $°C$

R total = 6.81 $°C/W$
ΔT = 20-(-10)=30 $°C$

$\dot{Q}$ = (T indoor - T outdoor)/R total= 30/6.81 = 4.40 W



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 =25 W/m2 · °C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

R conv 1 = 1/h1.A = 1/(10*0.25)=0.4 $\frac{C°}{W}$
R conv 2 = 1/h2.A = 1/(40*0.25)=0.1 $\frac{C°}{W}$

R conduction in series

- R cond. Foam = L/(Kf.A) = 0.03/(0.026*0.25)=4.6154 $\frac{C°}{W}$
- R_plaster 1 = R_plaster 2 = L/(K.A) = 0.02/(0.22*0.25)=0.3636 $\frac{C°}{W}$

R conduction in parallel

- R pc1= R pc2= L/(K.A) = 0.32/(0.22*0.015) = 96.9697 $\frac{C°}{W}$
- R brick= L/K.A= 0.32/(0.72*0.22)=2.0202 $\frac{C°}{W}$
- 1/R total = 1/ R pc1 + 1/R brick + 1/R pc2= 1/96.9697 + 1/2.0202 + 1/96.9697 =0.5156 $\frac{C°}{W}$
- R total = 1/0.5156=1.9395 $\frac{C°}{W}$

<u>R total</u> = R conv. 1+ R cond. foam + R pc1 + R pc2 + R total parallel. + R conv. 2 = 0.4+4.6154+0.3636+1.9395+0.3636+0.1=7.7821 $\frac{C°}{W}$

$\dot{Q}$ = (Tind - Tout)/ R tot = (20-(-10))/7.7821=3.855 W

We can see from the results that by doubling the thickness of the brick the thermal resistance of the brick is doubled because the thickness has direct relation with the thermal resistance, however the heat transfer through the brick doesn't have significant decrease. It means that increasing the thickness of brick is not a good solution for decreasing the heat transfer and it might be a waste of money. The best solution is to add insulation layer such as foam to the wall.

Question: Solve again the simplified wall calculation procedure replacing the glass fiber one with urethane rigid foam and while replacing the fiberboard with plywood and find the two R values.

$R'_{with\ wood}$ = 0.03+0.14+0.11+0.63+0.079+0.12=1.109 (m2.$°C$)/W

$R'_{with\ insulation}$ = 0.03+0.14+0.11+3.528+0.079+0.12=4.007 (m2.$°C$)/W

	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)=3.528
Wood Studs	0.63	no
Gypsum board	0.079	0.079
Inside Surface	0.12	0.12