TES Homework 3

23 October 2019 08:06

Guidelines for this week's submission:

#Week 3 In this week's assignment you should first dfinlize 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

- You should solve again the simplified wall calculation procedure replacing the glass fiber one with urethane rigif foam andwhile replacing the fiberboard with plywood and find the two R_unit values

From <https://github.com/bnajafi/TES_2019-2020_weeklySubmissions/tree/master/Week%203>

Answer:

In a parallel setting, the measure of resistances must take into account the position of the materials in relation to one another.
Also in this case, the total material height is assumed to be 1m

The total resistances will be:

$$\boldsymbol{R_{total} = R_{conductive} + R_{foam} + R_{totalparallel} + R_{plaster} + R_{convective}}$$

1) $$\boldsymbol{R_{conductive} = \frac{1}{h1\,A} = \frac{1}{10\frac{W}{m^0C} * (0.015 + 0.22 + 0.015)m\ * 1m} = \frac{0.4^0C}{W}}$$

2) $$\boldsymbol{R_{foam} = \frac{lf}{kf\,A} = \frac{0.03\,m}{0.026\frac{W}{m^0C} * (0.015 + 0.22 + 0.015)m\ * 1m} = \frac{4.615^0C}{W}}$$

3) $Calculating\ R_{totalparallel}$

$R_{plaster1} = R_{plaster2}$

$$R_{plaster1} = \frac{L_{plaster1}}{k_{plaster1}A_{plaster1}} = \frac{0.32\,m}{0.022\frac{W}{m^0C} * 0.015m\ * 1m} = \frac{96.97^0C}{W}$$

$$R_{brick} = \frac{L_{brick}}{k_{brick}A_{brick}} = \frac{0.32\,m}{0.72\frac{W}{m^0C} * 0.22m\ * 1m} = \frac{2.02^0C}{W}$$

$$\frac{1}{R_{totalparallel}} = \frac{1}{R_{plaster1}} + \frac{1}{R_{plaster2}} + = \frac{1}{R_{brick}}$$

$$\frac{1}{R_{totalparallel}} = 2 * \left(\frac{1}{\frac{96.97^0C}{W}}\right) + \frac{1}{\frac{2.02^0C}{W}} = \frac{0.516\,W}{^0C}$$

$$\boldsymbol{R_{totalparallel} = \frac{1}{\frac{0.516\,W}{^0C}} = \frac{1}{R_{plaster1}} = \frac{1.94^0C}{W}}$$

4) $\boldsymbol{R_{plaster} = \frac{1}{h1\ A} = \frac{0.02\ m}{0.022 \frac{W}{m^0 C} * (0.015 + 0.22 + 0.015) m\ * 1m} = \frac{0.363^0 C}{W}}$

5) $\boldsymbol{R_{convective} = \frac{1}{h2\ A} = \frac{1\ m}{40 \frac{W}{m^0 C} * (0.015 + 0.22 + 0.015) m\ * 1m} = \frac{0.1^0 C}{W}}$

6) $R_{total} = R_{conductive} + R_{foam} + R_{totalparallel} + R_{plaster} + R_{convective}$

$$R_{total} = \frac{0.4 + 4.615 + 1.94 + 0.363 + 0.1\ ^0C}{W} = \frac{\boldsymbol{7.781^0 C}}{\boldsymbol{W}}$$

7) $\dot{Q} = \frac{dT}{R\_\text{total}}$

$$\dot{Q} = \frac{20^0 C - (-10^0 C)}{\frac{7.781^0 C}{W}} = \boldsymbol{3.86\ W}$$

8) In brick with 16cm thickness:

$$\boldsymbol{R_{total16cm} = \frac{6.81^0 C}{W}}$$

$$\dot{Q} = \frac{20^0 C - (-10^0 C)}{\frac{6.81^0 C}{W}} = \boldsymbol{4.40\ W}$$

9) Summary:

$\dot{Q_{32cm}} = \boldsymbol{3.86\ W}$
$\dot{Q_{16cm}} = \boldsymbol{4.40\ W}$

$Q_{32cm} < \dot{Q_{16cm}}$ *, but only slightly*

Increasing brick thickness does not significantly change the heat transfer rate.