

Calculation of the rate of heat transfer for L(brick) = 16 cm

$$\left\{ \begin{array}{l} R_{TOTAL} = 6,81^{\circ}\text{C/W} ; T_{\infty 1} = 20^{\circ}\text{C} ; T_{\infty 2} = -10 \\ \dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{TOTAL}} = \frac{20 - (-10)}{6,81} \Rightarrow \boxed{\dot{Q} = 4,14 \text{ W}} \end{array} \right.$$

Calculation of the total resistance and the rate of heat transfer for L(brick) = 32 cm

$$\begin{aligned} R_{i \text{ (inside)}} &= \frac{1}{h_i \times A} = \frac{1}{10 \times 0,25} = 0,4^{\circ}\text{C/W} \quad (A = 0,25 \text{ m} \times 1 \text{ m}) \\ R_{f \text{ (foam)}} &= \frac{L_f}{k_f \times A} = \frac{0,03}{0,026 \times 0,25} = 4,615^{\circ}\text{C/W} \\ R_{P1} &= R_{P2} = \frac{L_P}{k_P \times A} = \frac{0,02}{0,22 \times 0,25} = 0,363^{\circ}\text{C/W} \\ R_o \text{ (outside)} &= \frac{1}{h_o \times A} = \frac{1}{40 \times 0,25} = 0,1^{\circ}\text{C/W} \\ \frac{1}{R_{\text{parallel}}} &= \frac{1}{R_b \text{ (brick)}} + 2 \times \frac{1}{R_P \text{ (plaster)}} \\ &= \frac{k_b \times A_b}{L_b} + 2 \times \left( \frac{k_P \times A_P}{L_P} \right) \\ &= \frac{(0,72 \times 0,22)}{0,32} + 2 \times \left( \frac{0,22 \times 1,5 \times 10^{-2}}{0,32} \right) \\ &= \left[ 0,495 \left( \frac{1}{2,102} \right) \right] + 2 \times \left[ 0,101 \left( \frac{1}{1,00} \right) \right] = 1/0,515 \\ \boxed{R_{\text{parallel}} = 1,94^{\circ}\text{C/W}} \\ \Rightarrow R_{TOTAL} &= R_i + R_f + 2 \times R_{P1} + R_{\text{parallel}} + R_o \\ &= 0,4 + 4,615 + (2 \times 363) + 1,94 + 0,1 \\ \boxed{R_{TOTAL} = 7,78^{\circ}\text{C/W}} &\Rightarrow \boxed{\dot{Q} = 3,856 \text{ W}} \end{aligned}$$

- The resistance of the parallel plasters is neglected compared to the resistance of the brick => the heat transfer happens mainly through the brick.
- The resistance of the brick has increased by increasing its thickness ( the double ) and so has decreased the heat transfer by 0,544 W.

### The R\_unit values

The simplified wall calculation procedure replacing the glass fiber one with urethane rigid foam and while replacing the fiberboard with plywood :

#### INSULATION :

Outside (winter)	0.03
13-mm 200-mm wood bevel lapped siding	0.14
13-mm Polywood	0.11
90 mm urethane rigid foam	$(90/25) \cdot 0.98 = 3.528$
13-mm gypsum wallboard	0.079
Inside	0.12

$$R_{\text{unit}} (1) = \sum R_{\text{units}} = 4,007 \text{ m}^2 \cdot ^\circ\text{C} / \text{W}$$

#### WOOD :

Outside (winter)	0.03
13-mm 200-mm wood bevel lapped siding	0.14
13-mm Polywood	0.11
38-mm 90-mm wood studs	0.63
13-mm gypsum wallboard	0.079
Inside	0.12

$$R_{\text{unit}} (2) = \sum R_{\text{units}} = 1,109 \text{ m}^2 \cdot ^\circ\text{C} / \text{W}$$