ASSIGMENT 4

Task 1: Complete the modified example of simplified wall calculations from the assignment of week 3 and find the total heat transfer through wall.

Question:

A wood frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400mm. The 90 mm wide cavity between the studs is filled with glass fiber insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13-mm wood fibreboard and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75% of heat transimission 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_{unit} values and determine the overall unit thermal resistance and the overall heat transfer coefficient.

Also determine the rate of heat loss through the walss of a house whose perimeter is 50 meter and wall height is 2,5 meter in Las Vegas, whose winter design temperature is -2℃. Take the indoor design temperature to be 22℃ and assume 20% of the wall area is occupied by glazing.

Solution:

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel	0.14	0.14
Urethane rigidfoam	/	(0.98/25)x90 = 3.53
Plywood	0.11	0.11
Gypsum board	0.079	0.079
Inside surface	0.12	0.12
Wood studs	0.63	/

R'wood=0.03+0.14+0.11 + 0.079 + 0.12 + 0.63 =**1.11** $\frac{\mathrm{m2}\cdot{}^{\circ}\mathrm{C}}{W}$

R'insulation= 0.03+0.14+3.53+0.11+0.079+0.12=**4.01** $\frac{\mathrm{m2}\cdot{}^{\circ}\mathrm{C}}{W}$

$$U_{tot} = U_{ins} * \frac{A_{ins}}{A_{tot}} + U_{wood} * \frac{A_{wood}}{A_{tot}}$$

$$U_{tot} = U_{ins} * 0.75 + U_{wood} * 0.25$$

$$U_{ins} = \frac{1}{R'_{ins}} = \frac{1}{4.01} = 0.249\ \frac{W}{m^2{}^{\circ}\mathrm{C}}$$

$$U_{wood} = \frac{1}{R'_{wood}} = \frac{1}{1.11} = 0.901\frac{W}{m^2°C}$$

$$\boldsymbol{U_{tot}} = 0.249 * 0.75 + 0.901 * 0.25 = 0.18675 + 0.2275 = \boldsymbol{0.41425\frac{W}{m^2°C}}$$

$$A_{tot} = 50 * 2.5 * 0.8 = 100m^2$$

$$\Delta T = 22 - (-2) = 24°C$$

$$\boldsymbol{Q_{tot} = U_{tot} * A_{tot} * \Delta T = 994.2\ W}$$

Task 2: In 2 pages write a summary of what you have learnt about radiation and radiative heat transfer.

Answer:

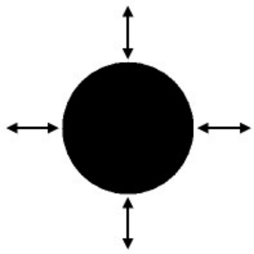
- Beside conduction and convection, third type of heat transfer, that enables bodies to exchange energy, is thermal radiation. Difference between radiation and other two types is simple, because radiation doesn't require medium material for transfer of energy. That means, direct contact between source of heat and heated object is not required.

- Everything around us emits some type of thermal radiation. All objects in the universe emit thermal radiation. Radiation is the energy emission or transmission by electromagneticalwaves(infrared, ultraviolet, microwave, etc.). Specific kind of radiation, thermal radiation requires certain temperatures for bodies to emit electromagnetic radiation. Radiation happens on temperatures above apsolute zero, that is 0 Kelvins or -273,15°C.

- Radiation of all bodies is in the form of photons moving in a random direction, with random phase and frequency. When radiated photons reach some different kind of surface, there is three ways how that can end. They can be transmitted, reflected or apsorbed. The radiation characteristics of surfaces can be changed completely by applying different types of thin coatings on them.Electromagnetic waves travel at the speed of light, that is 3 x 10^8 m/s through vacuum. They are characterized by frenquency and wavelength. Speed of light is C, wavelength (for thermal radiation from 0,1 μm to 100 μm) is λ. Frequency of that waves is v.In total, we have equation:

$$\lambda = \frac{c}{v}$$

The Black Body



Radiation heat transfer - black body

Blackbody is body that emits the energy maximum. Therefore, blackbody is defined as a perfect emitter and absorber of radiation. That body is ideal body, used as standard to compare with other cases.At aspecified conditions, perfect conditions for temperature, wavelength and frenquency, no surface can emit more energy than ablackbody.

The radiation energy per unit time from a **black body** is proportional to the fourth power of the absolute temperature and can be expressed with **Stefan-Boltzmann Law** as

$$q = \sigma T^4 A$$

q = heat transfer per unit time **(W)**

σ = 5.6703 10^{-8} (W/m^2K^4) - **The Stefan-Boltzmann Constant**

T = absolute temperature **(K)**

A = area of the emitting body **(m^2)**

The Stefan-Boltzmann law gives the total radiation emitted by a blackbody at all wavelengths from 0 to infinity. But we are often interested in the amount of radiation emitted over some wavelength band.