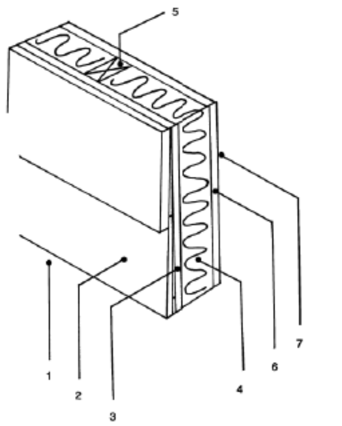
Week4_hulinxue

1.complete the modified example of simplified wall calculations that you went through in the assignment of week 3 and find the total heat transfer through wall

Determine the overall unit thermal resistance (the R-value) and the overall heat transfer coefficient (the U-factor) of a wood frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400 mm. 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 fiberboard and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75 percent of the heat transmission 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 (this means 75% of area is insulation and 25% can be considered wood)
Also, determine the rate of heat loss through the walls of a house whose perimeter is 50 m and wall height is 2.5 m in Las Vegas, Nevada, whose winter design temperature is -2 C. Take the indoor design temperature to be 22 C and assume 20 percent of the wall area is occupied by glazing



1. Outside surface
2. Wood bevel lapped siding
3. Sheathing (rigid foam insulation)
4. Mineral fiber batt insulation
5. Wood Stud
6. Gypsum Wallboard
7. Inside Surface

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel lapped siding	0.14	0.14
Plywood,13mm	0.11	0.11
Urethane rigif foam	No	0.98*90/25=3.528
Wood studs	0.63	No
Gypsum board 13mm	0.079	0.079
Inside surface	0.12	0.12

$R_{withwood}$=0.03+0.14+0.11+No+0.63+0.079+0.12=1.109㎡ • ℃/W
$R_{withins}$=0.03+0.14+0.11+3.528+No+0.079+0.12=4.007㎡ • ℃/W

$$\frac{1}{R_{total}} = \frac{1}{R_{wood}} + \frac{1}{R_{ins}}$$

$$R' = R \times A \rightarrow R = \frac{R'}{A}$$

$$\frac{1}{\frac{R'_{total}}{A_{tot}}} = \frac{1}{\frac{R'_{wood}}{A_{wood}}} + \frac{1}{\frac{R'_{ins}}{A_{ins}}} \qquad \rightarrow \qquad \frac{A_{tot}}{R'_{total}} = \frac{A_{wood}}{R'_{wood}} + \frac{A_{ins}}{R'_{ins}}$$

$$1/R' = U$$

$$U_{tot} \times A_{tot} = U_{wood} \times A_{wood} + U_{ins} \times A_{ins}$$

$$U_{tot} = U_{wood} \times \frac{A_{wood}}{A_{tot}} + U_{ins} \times \frac{A_{ins}}{A_{tot}} = 0.25 \times U_{wood} + 0.75 \times U_{ins}$$

$$U_{wood} = \frac{1}{R'_{wood}} = \frac{1}{1.109} = 0.9017$$

$$U_{ins} = \frac{1}{R'_{ins}} = \frac{1}{4.007} = 0.2495$$

$U_{tot} = 0.25 \times U_{wood} + 0.75 \times U_{ins} = 0.25 * 0.9017 + 0.75 * 0.2496 = 0.4126 \frac{W}{m^2 °C}$

$Q_{tot} = U_{tot} \times A_{tot} \times \Delta T = 0.4126 * 100 * 24 = 990.24\, W$

2.summary of what you have learnt in this session about radiation and radiative heat transfer.

If a hot object is put on a table in vacuum environment ,this object will eventually cool down after a long time.this is because the heat transfer to the surrounding by radiation. So radiation a king of heat transfer.BUT radiation have a difference from conduction and convection, because it does not require the presence of a material medium to take place.radiation also happened in solids,liquids as well as gases. For example, in winter, heating radiator can transfer heat to the air of the house and than the air can transfer heat to the person who stay at home. In a word, radiation happens everywhere.everything around us constantly emit thermal radiation.

1.As long as the temperature of object is higher than 0 K, the object can continue to emit heat radiation to the surrounding space.
2.radiation can happen in vacuum environment.
3.when radiation happens, the form of energy change
4.radiation have direction.
5.radiation relates to temperature and wavelength

Electromagnetic waves transport energy just like other waves and they are characterized by their frequency V or wavelength . These two properties in a medium are related by

$c = c_n / n$

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

c, the speed of propagation of a wave in that medium
c0 = $2.9979*10^8$ m/s, the speed of light in a vacuum
n, the index of refraction of that medium
n =1 for air and most gases, n = 1.5 for glass, and n = 1.33 for water

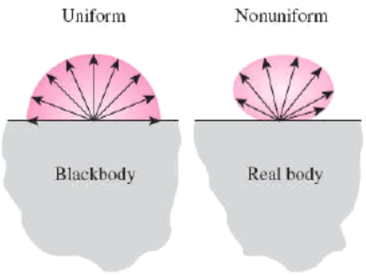
$$e = h\nu = \frac{hc}{\lambda}$$

The energy of a photon is inversely proportional to its wavelength.

$h = 6.626069 \times 10^{-34}$ J · s is *Planck's constant*.

-The type of electromagnetic radiation that is pertinent to heat transfer is the thermal radiation emitted as a result of energy transitions of molecules, atoms, and electrons of a substance.
-Temperature is a measure of the strength of these activities at the microscopic level, and the rate of thermal radiation emission increases with increasing temperature.
-Thermal radiation is continuously emitted by all matter whose temperature is above absolute zero.

Blackbody:An object that absorbs all of the heat radiant energy that is applied to its surface. It is a scientific hypothetical object. But it can not exsit in a real life, but we can make a artificial blackbody which is similar with blackbody.

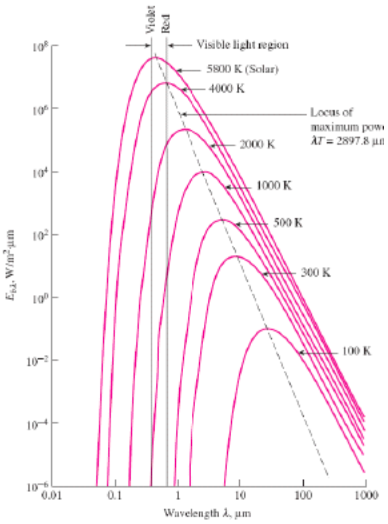


The radiation energy emitted by a blackbody:

$$E_b(T) = \sigma T^4 \qquad (\mathrm{W/m^2})$$

$$\sigma = 5.670 \times 10^{-8}\ \mathrm{W/m^2 \cdot K^4}$$

The variation of the blackbody emissive power with wavelength for several temperatures



The wavelength at which the peak occurs for a specified temperature is given by Wien's displacement law:

$$(\lambda T)_{\text{max power}} = 2897.8\ \mu\mathrm{m} \cdot \mathrm{K}$$