week4_MelissaMartinoli

domenica 27 ottobre 2019 11:24

01.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 urethane rigif foam, the inside is finished with 13 mm gypsum wallboard and the outside with 13 mm plywood 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.
Find the two R_{unit} values.
At the end, 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 % of the wall area is occupied by glazing.

From last week assignment:

	Wood	Insulation
Outside air	0,03	0,03
Wood bevel (13x200mm)	0,14	0,14
Plywood (13mm)	0,11	0,11
Urethane rigid foam (90mm)	no	3,528
Wood studs (90mm)	0,63	no
Gypsum board (13mm)	0,079	0,079
Inside surface	0,12	0,12

$$R_{withwood} = 1{,}109 \frac{m^2\ °C}{W}$$

$$R_{withinsulation} = 4{,}007 \frac{m^2\ °C}{W}$$

$$U_{wood} = \frac{1}{R'_{withwood}} = \frac{1}{1{,}109} = 0{,}902 \frac{W}{m^2\ °C}$$

$$U_{insulation} = \frac{1}{R'_{withinsualtion}} = \frac{1}{4{,}007} = 0{,}25 \frac{W}{m^2\ °C}$$

We know that R' = R x A so R = R′/A, also we know that $R_{overall} = 1/U_{overall}$ and 1 / R' = U

$$\frac{1}{\frac{R'_{total}}{R_{total}}} = \frac{1}{\frac{R'_{wood}}{A_{wood}}} + \frac{1}{\frac{R'_{insulation}}{A_{insulation}}} \quad \rightarrow\rightarrow\rightarrow \quad \frac{A_{total}}{R'_{total}} = \frac{A_{wood}}{R'_{wood}} + \frac{A_{insulation}}{R'_{insulation}}$$

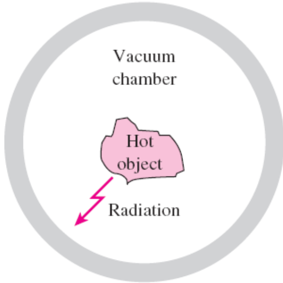
$$U_{total} = U_{wood} \times \frac{A_{wood}}{A_{total}} + U_{insulation} \times \frac{A_{insulation}}{A_{total}} = 0{,}902 \times 0{,}25 + 0{,}25 \times 0{,}75 = 0{,}413 \frac{W}{m^2\ °C}$$

$$R_{value} = \frac{1}{U_{total}} = \frac{1}{0{,}413} = 2{,}421 \frac{m^2\ °C}{W}$$

$$\dot{Q}_{total} = U_{total} \times A_{total} \times \Delta T = 0{,}413 \times [50 \times 2{,}5 \times (1 - 0{,}25)] \times [22 - (-2)] = 0{,}4126 \times 93{,}75 \times 24 =$$

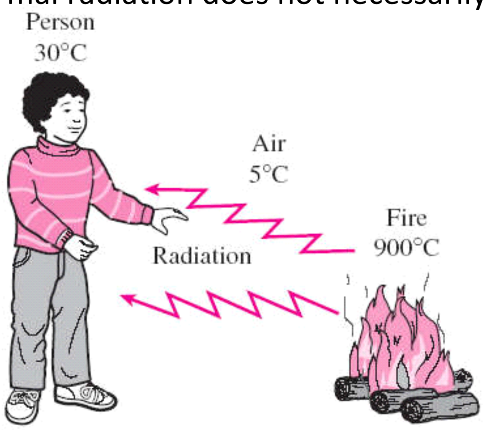
$$\dot{Q}_{total} = 928{,}35\ W$$

02.Summary about radiation and radiative heat transfer.



Thermal radiation is electromagnetic radiation generated by the thermal motion of particles in matter. All matter with a temperature greater than absolute zero emits thermal radiation, particle motion results in charge-acceleration or dipole oscillation which produces electromagnetic radiation. The radiation occurs at all temperatures, with the rate of emission increasing with the temperature.

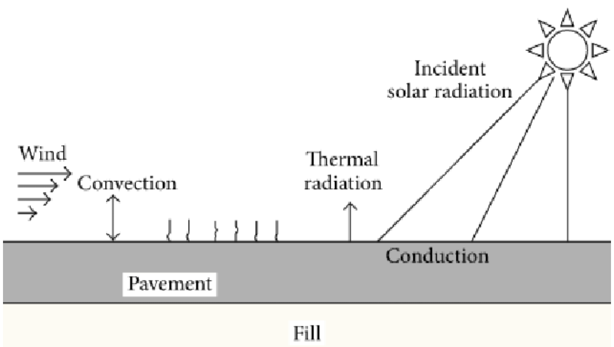
Thermal radiation is also one of the fundamental mechanisms of heat transfer; we know that, unlike conduction and convection, heat transfer by thermal radiation does not necessarily need a material medium for the energy transfer.
In the case of thermal radiation the medium could be vacuum, gas, or liquid. If the medium is a vacuum, since there are no molecules or atoms, the radiation energy is fully transmitted. For liquid medium, most of the radiation absorbed is a thin layer close to the solid surface and nothing is transmitted.
We could say that everything around us constantly emits thermal radiation.



Electromagnetic waves are characterized by their frequency (v) or their wavelength (λ), in relation with the speed of propagation of the wave (c).

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

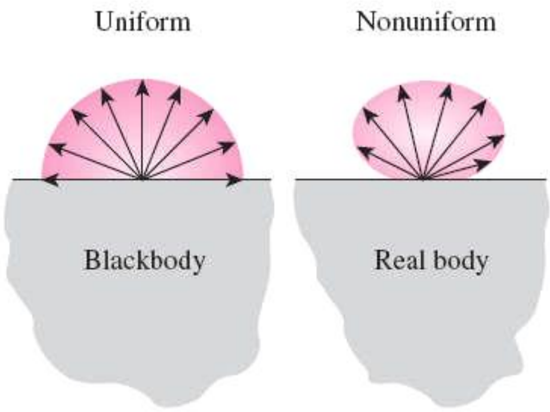
$c = c_0/n$	c = speed of propagation of a wave in that medium
	$c_0 = 2.9979 \times 10^8$ m/s, the speed of light in a vacuum
	n = the index of refraction of that medium
	n = 1 for air and most gases
	n = 1.5 for glass
	n = 1.33 for water



For us, the sun is the primary light source (a body that emits some radiation in the visible range) and its electromagnetic radiation is known as solar radiation.

A black body is an idealized physical body that absorbs all electromagnetic radiation, regardless of wavelength and direction. Therefore, we could say that a black body is a perfect emitter and absorber of radiation. If a radiation-emitting object meets the physical characteristics of a black body, the radiation is called blackbody radiation.

$E_b(T) = \sigma T^4$ (W/m^2)
is the formula to calculate
a black body emissive power
from which the Stefan–Boltzmann
constant is obtainable
$\sigma = 5.67 \times 10^{-8}$ ($W/m^2 \times K^4$)



Planck's law describes the spectral density of electromagnetic radiation emitted by a black body in thermal equilibrium at a given thermodynamic temperature (T) per unit time, per unit surface area, and per unit wavelength about the wavelength (λ).

$$E_{b\lambda}(\lambda, T) = \frac{C_1}{\lambda^5 \left[\exp\left(\frac{C_2}{\lambda T}\right) - 1\right]} \quad (W/m^2 \times \mu m)$$

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

$$(\lambda, T)_{maxpower} = 2897.8\ \mu m \times K$$