Tuesday, October 29, 2019 9:55 PM

Determine the overall unit thermal resistance (the R value) 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 rigid insulation. 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. 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 (glass) (Wall without glass 80%).

	$\frac{m^2\,°C}{W}$	$\frac{m^2\,°C}{W}$
	Insulation	Wood Studs
1. Outside air surface	0.03	0.3
2. Wood bevel (13*200) mm	0.14	0.14
3. Plywood (13 mm)	0.11	0.11
4.a Urethane rigid foam	$0.98 * \frac{90}{25} = 3.528$	/
4.b Wood Studs (90 mm)	/	0.63
5. Gypsum Wallboard (13 mm)	0.079	0.079
6. Inside air surface	0.12	0.12

The R_unit values are respectively:

R' with insulation =	$4{,}007 \ \frac{m^2\ °C}{W}$	
R' with wood studs =		$1{,}379 \ \frac{m^2\ °C}{W}$

$R'_{tot} = R*A \quad => \quad R = \frac{R'tot}{A}$ (R' is R_{unit})

$R_{unit} = \frac{1}{U} \quad => \quad \frac{1}{R'} = U$

$\frac{1}{R\ tot} = \frac{1}{R\ insul} + \frac{1}{R\ wood} \quad => \quad \frac{A\ tot}{R'tot} = \frac{A\ insul}{R'\ insul} + \frac{A\ wood}{R'\ wood}$

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

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

$U_{tot} = U_{ins} * 0.75 + U_{wood} * 0.25$ (insulated cavity -> 75% = 0.75 of the heat transmission area
studs, plates, sills + headers(/studs) -> 21+4 % = 0.25)

$U_{insul} = \frac{1}{R'\ insul} = \frac{1}{4.007} = 0{,}2496 \ \frac{W}{m^2\ °C}$

$U_{wood} = \frac{1}{R'\ wood} = \frac{1}{1.379} = 0{,}7252 \ \frac{W}{m^2\ °C}$

$U_{tot} = 0{,}2496 * 0.75 + 0{,}7252 * 0.25 = 0.1872 + 0.1813 = 0.3685 \ \frac{W}{m^2\ °C}$

$A_{tot} = 50 * 2.5 * 0.8 = 100\ m^2$ (0.8 is the 80% of the wall without glass)

$\Delta T = 22 - (-2) = 24\ °C$

$Q_{tot} = U_{tot} * A_{tot} * \Delta T = 884.4\ W$

THE RADIATION AND THE RADIATIVE HEAT TRANSFER:

Radiation is a wave made of electromagnetic. Electromagnetic waves transport energy just like other waves and they are characterized by their Frequency and wavelength.

As we know in physics, the term radiation is generally used to indicate the set of phenomena characterized by the transport of energy in space, where there are different surroundings conditions. The energy emitted by matter is the result of the changes in the electronic configurations of the molecules and this is the way how Electromagnetic waves transport energy. As temperature increases it causing an increase in energy in the movement of the molecules.

Speed of propagation of waves in the vacuum indicated by c (approximately 299792 km/s), from a frequency ν and its wavelength, indicated with the symbol λ. The frequency ν is defined as the number of wavelengths that pass in a second for a given point in space: ν equals to c divided by λ.

The highest wave frequency the smaller wavelength will be. So, the speed of light is constant for every electromagnetic radiation in a vacuum.

Visible light for the human eye is the electromagnetic radiation with a wavelength ranging from about 380 nm of violet to about 760 nm for red.

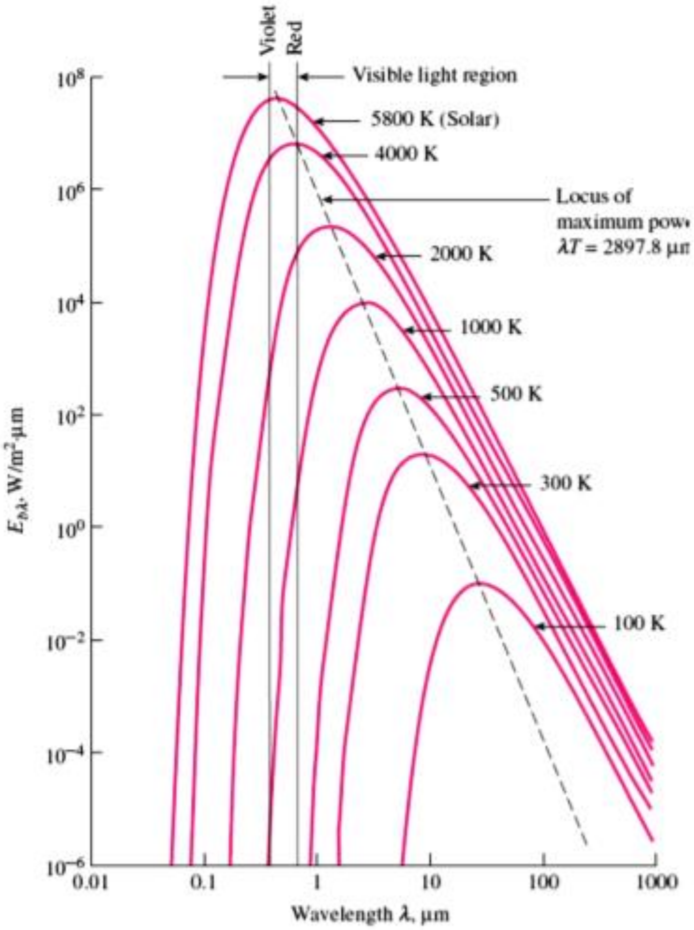
BLACK BODY:

A blackbody is an idealized body that emits the maximum amount of radiation: it is a perfect emitter and absorber of all incident radiation.

The radiation energy emitted by a blackbody: Eb(T) = σT^4 [W m^2] Blackbody emissive power

σ = 5.670 * 10^8 W / m^2 * k^4 Stefan−Boltzmann constant

The graph below represents the variety of the blackbody emissive power with wavelength for several temperatures. The axis of wavelength is on a logarithmic scale, while the axis of the emissive power is on a linear scale. The amount of emitted radiation increases with increasing temperature. The radiation emitted by the sun, which is considered to be a blackbody at 5800 K, reaches its peak in the visible light region of the spectrum. Surfaces at T < 800 K emit almost entirely in the infrared region and thus are not visible to the eye unless they reflect light coming from other sources.


Violet
Red
Visible light region
5800 K (Solar)
4000 K
Locus of
maximum pow
$\lambda T = 2897.8$ µm
2000 K
1000 K
500 K
300 K
100 K
10^8
10^6
10^4
10^2
10^0
10^{-2}
10^{-4}
10^{-6}
$E_{b\lambda}$, W/m^2·µm
0.01
0.1
1
10
100
1000
Wavelength λ, µm