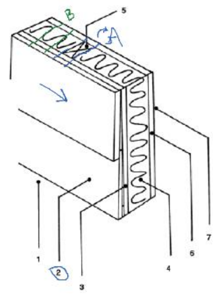
Determine the overall unit thermal resistance (the R-value) and the overall heat transfer coefficient (the U-factor) of a wood frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400 mm. The 90-mm-wide cavity between the studs is filled with **urethane rigif foam**. 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 (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.



Answer 1:

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel (13mm*200mm)	0.14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigif Foam Ins. (90mm)	/	3.528
Wood Studs(90mm)	0.63	No
Gypsum Borad(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$$\Delta T = 22-(-2) = 24$$

$$R'_{\text{with}wood} = 0.03+0.14+0.11+0.63+0.079+0.12 = 1.109 m^{2^\circ}C/W$$

$$R'_{\text{withins}} = 0.03+0.14+0.11+3.528+0.079+0.12 = 4.007 m^{2^\circ}C/W$$

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

$$R' = R * A$$

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

$$\frac{1}{\frac{R'_{total}}{A_{total}}} = \frac{1}{\frac{R'_{wood}}{A_{wood}}} = \frac{1}{\frac{R'_{ins}}{A_{ins}}}$$

$$\frac{A_{\text{total}}}{R'_{total}} = \frac{A_{wood}}{R'_{wood}} + \frac{A_{ins}}{R'_{ins}}$$

From the presentation

$$U = \frac{1}{R'}$$

$$U_{\text{total}} * A_{\text{total}} = U_{\text{wood}} * A_{wood} + U_{ins} * A_{ins}$$

Divide everything by A_{total}

$$\therefore U_{total} = \frac{A_{withwood}}{A_{total}} \cdot U_{withwood} + \frac{A_{withinsulation}}{A_{total}} \cdot U_{withinsulation}$$

$$\therefore U_{total} = 25\% \cdot U_{withwood} + 75\% \cdot U_{withinsulation}$$

$$= 25\% \cdot \frac{1}{R'_{withwood}} + 75\% \cdot \frac{1}{R'_{withinsulation}} = 25\% \cdot \frac{1}{1.109 \frac{m^2\ ℃}{W}} + 75\% \cdot \frac{1}{4.007 \frac{m^2\ ℃}{W}}$$

$$= 0.4126 \frac{W}{m^2\ ℃}$$

$$\text{R} - \text{value} = \frac{1}{U_{total}} = \frac{1}{0.4126 \frac{W}{m^2\ ℃}} = 2.4237 \frac{m^2\ ℃}{W}$$

From the definition of U

$$\dot{Q}_{total} = U_{total} \cdot A_{total} \cdot \Delta T = 0.4126 \frac{W}{m^2\ ℃} \cdot 50m \cdot 2.5m \cdot 80\% \cdot [22\ ℃ - (-2\ ℃)]$$

$$= 990.24W$$

In 2 pages you should write a summary (in your own word!, in your own words !!) of what you have learn in this session about radiation and radiative heat transfer

Answer :

Summary

This lesson introduces the content of radiation, which refers to the phenomenon of relying on the outer surface of an object to emit heat rays to transmit energy (electromagnetic waves capable of producing significant thermal effects).

Radiation is characterized by the fact that as long as the temperature of the object is above zero, its surface is constantly emitting radiant heat to the surroundings, while at the same time continuously absorbing the radiant heat projected by other objects and between the two objects involved in the heat exchange. There is no need for direct contact.

Any object is the same, it has the ability to emit heat radiation outward, and it is absorptive and reflective to foreign radiation, some of which are projectile like glass and plastic film. But most building materials are still opaque to heat rays. Of the radiant energy projected onto the surface of the opaque material, some of the energy is absorbed and the other part of the energy is reflected back.

At the same time, I also learned that the greater the radiation capacity of the material, the greater its absorption capacity for external radiation. The smaller the opposite radiation capacity, the smaller its absorption capacity. In the color of the material, the white surface is the strongest to reflect light, and for long-wave radiation, its reflection ability is very small compared to the black surface. The main determinants of the absorption and reflection properties of materials for thermal radiation are the color of the surface of the material, the nature of the material and the smoothness of the surface of the material. But for short-wave radiation, material color is the main factor.

Since any object has the ability to emit radiation and absorb radiation from external radiation, any two separate objects in space will generate radiative heat transfer between each other. If the temperature of the two objects is different, the hotter object will radiate outward. The excess heat is absorbed by the heat to get more heat, while the colder object is the opposite, so the radiation heat exchange between the two objects is formed. However, radiative heat transfer is also present when the temperatures of the two objects are the same, but in equilibrium.

This lesson also introduces the knowledge related to black body. Any object has the property of continuously radiating, absorbing, and reflecting electromagnetic waves. The electromagnetic waves radiated out are different in each band, that is, have a certain spectral distribution. This spectral distribution is related to the nature of the object itself and its temperature and is therefore referred to as thermal radiation. In order to study the law of thermal radiation that does not depend on the physical properties of matter, physicists have defined an ideal object, the black body, as a standard object for thermal radiation research.

A black body, an idealized body to serve as a standard against which the radiative properties of real surfaces may be compared, emits the maximum amount of radiation by a surface at a given temperature； absorbs all incident radiation, regardless of wavelength and direction. Under any conditions, an object that absorbs completely foreign radiation of any wavelength without any reflection, that is, an object with an absorption ratio of 1.

In black body radiation, the color of the light varies with temperature, and the black body exhibits a gradual process of red-orange-yellow-yellow-white-white-blue-white. The color of the light emitted by a light source appears to be the same as the color of the light emitted by the black body at a certain temperature. This temperature of the black body is called the color temperature of the light source. The higher the temperature of the "black body", the more blue components in the spectrum and the less red components. For example, the color of an incandescent lamp is warm white, its color temperature is 4700K, and the color temperature of a daylight fluorescent lamp is 6000K.