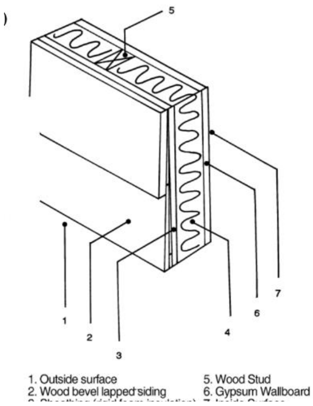
Week 4 --- Kou Yu

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 urethane rigid foam insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm playwood and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75% of the heat transmission area while the studs, plates, and sills constitute 21%. The headers constitute 4% 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.



	Wood	Insulation
Outside Air	0.03	0.03
Wood bevel (13*200 (mm)	0.14	0.14
Plywood (13mm)	0.11	0.11
Urethane rigid foam (90mm)	-	0.98*(90/25)=3.528
Wood studs (90mm)	0.63	-
Gypsum (13mm)	0.079	0.079
Inside air	0.12	0.12

R wood= 0.03+0.14+0.11+0.63+0.079+0.12=1.109 (m2C/W)

R insulation= 0.03+0.14+0.11+3.528+0.079+0.12=4.007 (m2C/W)

Uwood = 1 ⁄ R' wood = 1 ⁄ 1.109 = 0,9017 W ⁄ m2C

Uinsulation = 1 ⁄ R' insulation= 1 ⁄ 4.007 = 0.2496 W ⁄ m2C

Utot=Uwood*Awood ⁄ Atot + Uins *Ains ⁄ Atot=0.25*Uwood+0,75*Uins=0.25*0.9017+0.75*0.2496=0.4125 W ⁄ m2C

ΔT=22-(-2)=24 C

Qtot=Utot*Atot*ΔT=0.4125*100*24=990W

2. In 2 pages you should write a summary of what you have learnt in this session about radiation and radiative heat transfer

Introduction

Thermal radiation, the phenomenon in which an object radiates electromagnetic waves due to its temperature. One of the three ways of heat transfer. All objects with temperatures above absolute zero can generate heat radiation. The higher the temperature, the greater the total energy radiated and the more short-wave components. The spectrum of thermal radiation is a continuum, and the wavelength coverage can theoretically range from 0 to ∞. The general thermal radiation mainly depends on the longer wavelength visible light and infrared rays. Since the propagation of electromagnetic waves does not require any medium, thermal radiation is the only way to transfer heat in a vacuum.

While the object radiates outward, it also absorbs energy radiated from other objects. The energy radiated or absorbed by an object is related to its temperature, surface area, blackness and other factors. However, in the state of thermal equilibrium, the ratio of the spectral radiation exitance r) of the radiator to its spectral absorption ratio a) is only a function of the wavelength and temperature of the radiation, independent of the nature of the radiator itself. λ **= c/v**

Thermal Radiation

Due to the heat, the object expands in the form of electromagnetic waves and emits radiant energy.

Heat rays are divided into visible rays and infrared rays

Radio waves, infrared rays, visible light, ultraviolet rays, X-rays, and gamma rays are electromagnetic waves. The frequency of the light wave is much higher than the frequency of the radio wave, and the wavelength of the light wave is much shorter than the wavelength of the radio wave; the frequency of the X-ray and the gamma ray is higher and the wavelength is shorter.

Light

Light waves as a specific frequency band are electromagnetic waves whose color is related to frequency. The violet light has the highest frequency and the shortest wavelength in visible light. Red light is just the opposite.

Infrared rays, ultraviolet rays, X-rays, and the like are all invisible light.

The infrared frequency is lower than red light and the wavelength is longer.

Ultraviolet, X-ray and other frequencies are higher than violet light and the wavelength is shorter.

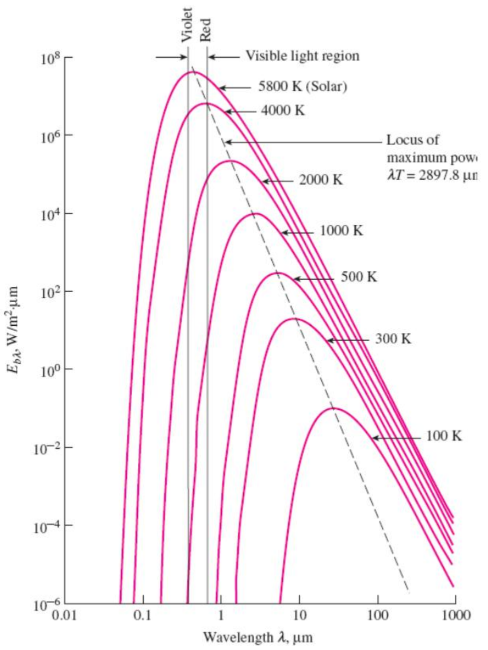
Black Body Radiation

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.

Black body has two characteristics:

- u At the same temperature, the radiation capacity is the highest;
- u Absorption capacity and radiation capacity are related to temperature.

The radiation energy emitted by a black body : $E_b(T) = \sigma T^4 \quad (\mathrm{W/m^2})$



- Corresponding to each temperature T accompanied by an energy distribution curve
- The larger T is, the more E moves to the shorter wavelength
- The radiation emitted by the sun,considered as a black body at 5800 K ,reaches its peak in the visible light region.
- 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.

Radiation Intensity

The radiant flux transmitted by a point source in a solid angle in a certain direction. The radiation intensity of most sources is proportional to the cosine of the angle between the direction and the surface normal.