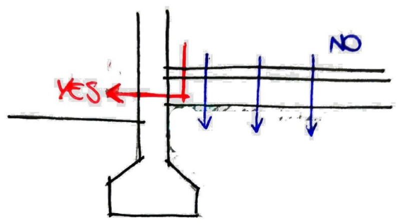
Heat transfer - RADIATION

lunedì 4 novembre 2019 16:40

23rd Oct. 2019: SUMMARY

Heat loss does not only concern vertical surfaces but can be found also in horizontal surfaces.

Since the ground has a milder temperature, we have an indirect heat transfer when we talk about concrete floors on grade and foundations.



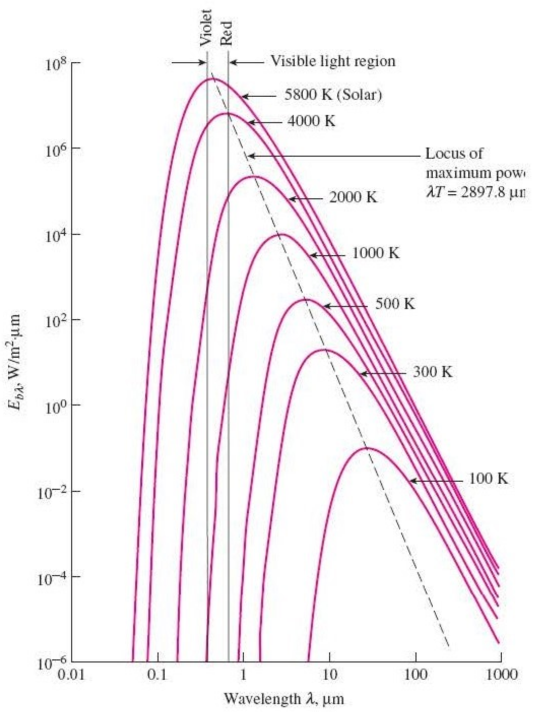
RADIATION HEAT TRANSFER

Radiation heat transfer, unlike conductive and convective heat transfer, does not require the presence of a material medium to take place. It is a complicated type of heat transfer that can't be neglected, since every object around us creates thermal radiation.

The radiation energy is emitted under the form of electromagnetic waves. A wave is characterized by a frequency **v** and a wavelength **λ**. Light is the visible portion of the electromagnetic spectrum and, inside this portion, every color has its wavelength range. A body that emits radiation in the visible range is a light source. The sun is an example of light source that sends different wavelengths in different intensities.

Knowing that different bodies emit different amounts of radiation, it is useful to define an ideal body, the **blackbody**, that is both a perfect emitter and absorber. A blackbody, in fact, emits the maximum radiation at a given temperature while absorbing all incident radiations. A blackbody is a diffuse surface, this means that it emits the same radiation in every direction. A blackbody emissive power represents the sum of the energy of all wavelengths, and it is defined by the formula:

$\mathbf{E_b\ (T) = \sigma\ T^4}$ (where σ is the Stefan-Boltzmann constant and T is the temperature of the blackbody)



However, in the reality, Eb (λ,T) is not constant. It depends on wavelength and temperature and it is possible to plot its variation. By looking at the plot we can state different things. The logaritmic curves show the variation of quantity of emissive power according to the variation of wavelenght, at a given temperature. While the wavelength is increasing, the emissive power increases, reaches a peak and starts decreasing. At a given temperature, radiation occurs in a defined range of wavelength. At any wavelength, the amount of radiation increases with the rise of temperature. If we integrate the area under a curve, we can calculate the total emissive power of the blackbody at that temperature.

The visible range, which is half of the emissive power of the sun (here shown as just a small fraction of the whole range because the plot is represented with logaritmic approximation). As it is shown in the plot, 800K is the limit of the emissive power visible range. This means that radiation is visible only for surfaces at more than 800K. In the reality we can see radiation from surfaces at less than 800K because they reflect light coming from another source. That being said we can state that if we see the colour of an object, we can predict its temperature.

The total emissive power generated by a wall in terms of Watts is the total emissive power of the blackbody, multiplied by the surface of the wall:

$$\mathbf{E_w (T) = \sigma T^4 A}$$

The blackbody serves as a standard to which real surfaces can be compared during calculations.

The radiation emitted by a surface goes in every direction but its distribution is not uniform. Thus we can define the **radiation intensity I** as the quantity of radiation emitted or incident in a certain direction.