Week 5

Task 1 In your own words (which means in your own words) write a summary of the topics about radiative heat transfer we went through including the definitions of emissivity, absorptivity and reflectivity, the view factor, the heat exchange between two black surfaces, the heat exchange between the two grey surface and finally the definition of radiative resistances

Everything around constantly emits radiation, and the emissivity represents the emission characteristics of those bodies. This means that everybody, including our own, is constantly bombarded by radiation coming from all directions over a range of wavelengths. Recall that radiation flux incident on a surface is called irradiation and is denoted by G. When radiation strikes a surface, part of it is absorbed, part of it is reflected, and the remaining part, if any, is transmitted. The fraction of irradiation absorbed by the surface is called the absorptivity, the fraction reflected by the surface is called the reflectivity, and the fraction transmitted is called the transmissivity. where G is the radiation energy incident on the surface, and Gabs, Gref, and Gtr are the absorbed, reflected, and transmitted portions of it, respectively. The first law of thermodynamics requires that the sum of the absorbed, reflected, and transmitted radiation energy be equal to the incident radiation.

Therefore, Emissivity can be defined as the measure of an object's ability to emit infrared energy. Emitted energy indicates the temperature of the object. Emissivity can have a value from 0 (shiny mirror) to 1.0 (blackbody). The emissivity of a surface depends not only on the material but also on the nature of the surface. also depends on the temperature of the surface as well as wavelength and angle.

Accordingly, Absorptivity is the amount of radiation absorbed by a surface compared to what is absorbed by a black surface, hence, the fraction of irradiation absorbed by the surface is called the absorptivity (α). It is the ratio of absorbed radiation (G_{abs}) to incident radiation (G). Its value: $0 \leq \alpha \leq 1$

Finally, Reflectivity is the fraction of radiation reflected by the surface is called the reflectivity (ρ). It is the ratio of reflected radiation (G_{ref}) to incident radiation (G). Its value: $0 \leq \rho \leq 1$

The view factor is the radiation heat transfer between surfaces depends on the orientation of the surfaces relative to each other as well as their radiation properties and temperatures. View factor (or shape factor) is a purely geometrical parameter that accounts for the effects of orientation on radiation between surfaces. In view factor calculations, we assume uniform radiation in all directions throughout the surface, i.e., surfaces are isothermal and diffuse. Also, the medium between two surfaces does not absorb, emit, or scatter radiation.

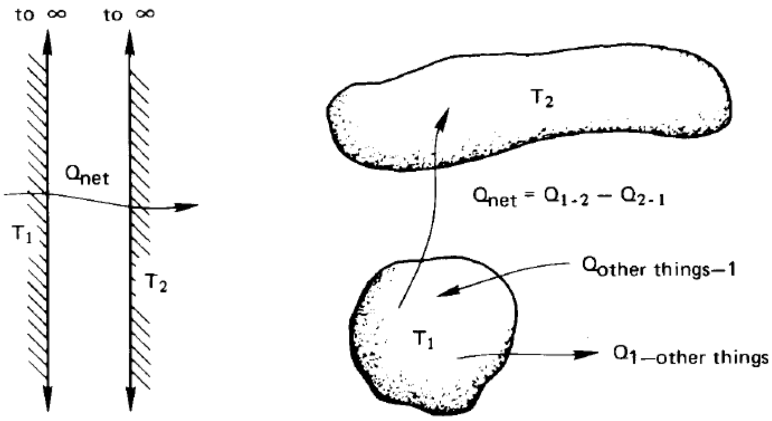
$F_{i\rightarrow j}$ or F_{ij} = the fraction of the radiation leaving surface i that strikes surface j directly. Note the following: The view factor ranges between zero and one.

$F_{ij} = 0$ indicates that two surfaces do not see each other directly.

$F_{ij} = 1$ indicates that the surface j surrounds surface i.

The radiation that strikes a surface does not need to be absorbed by that surface. F_{ii} is the fraction of radiation leaving surface i that strikes itself directly. $F_{ii} = 0$ for plane or convex surfaces, and $F_{ii} \neq 0$ for concave surfaces.

The heat exchange between two black surfaces, The model for the perfect thermal radiator is a so-called black body. This is a body which absorbs all energy that reaches it and reflects nothing. The term can be a little confusing, since such bodies emit energy. Thus, if it possessed infrared vision, a black body would glow with "color" appropriate to its temperature. of course, perfect radiators are "black" in the sense that they absorb all visible light (and all other radiation) that reaches them. the purely geometric problem of evaluating the view factor, F1–2. Although the evaluation of F1–2 is also used in the calculation of heat exchange among diffuse, nonblack bodies, it is the only correction of the Stefan-Boltzmann law that we need for black bodies. Some evident results. normally, when the surfaces are each isothermal and diffuse, this corresponds to F1–2 = fraction of energy leaving the first surface that reaches the second surface.



a) Object 1 radiates only to object 2

b) Object 1 radiates to object 2 and to other things as well

A second apparent result regarding the view factor is that all the energy leaving a body (1) reaches something else. Thus, conservation of energy requires where (2), (3),…,(n) are all of the bodies in the neighbourhood of (1). Therefore, It sees all three bodies, but it also views itself, in part. This accounts for the inclusion of the view factor, F1–1 in eq.

By the same token, it should also be apparent that the kind of sum expressed would also be true for any subset of the bodies seen by surface 1. Thus, Of course, such a sum makes sense only when all the view factors are based on the same viewing surface (surface 1 in this case).

The easiest method to calculate radiative heat transfer between two bodies is when they are assumed to be black bodies. However, in reality most surface are grey bodies. Recall that grey bodies absorb a certain amount of radiation while reflecting a portion of the radiation of the surface back into space. the total radiation that encounter a surface per unit time and unit area. While J represents the radiosity which is the total amount of radiation that is reflected off a surface per unit time and unit area. The equation below can be used to determine the value for J.

radiative resistances the resistance to heat transfer via radiation may be calculated by the following equation:

$R_{rad} = 1/ h_{rad} A_{Rrad}$

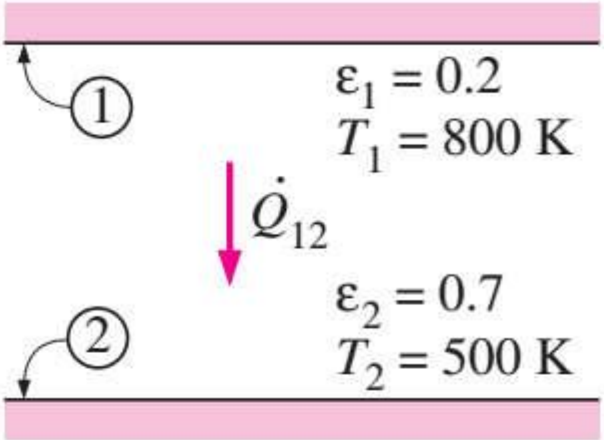
This allows radiative heat transfer to be easily grouped together with other heat transfer modes when considering total heat transfer for a given system, however the radiative heat transfer coefficient must first be calculated.

Task 2 Solve the last example you solved in the class (radiative heat exchange between two parallel plates) awhile considering the two emissivities to be 0.1, what can you conclude from the result?

ε1&2 =0.1

T1=800k

T2=500k



When the $\boldsymbol{\varepsilon 1 = 0.2}$ & $\boldsymbol{\varepsilon 2}$ **=0.7**

$$Q=\frac{A\sigma(T_1^4-T_2^4)}{\frac{1}{\epsilon}+\frac{1}{\epsilon}-1}$$

$$Q=\frac{Ax5.67x10^8(800x10^4-500x10^4)}{\frac{1}{0.2}+\frac{1}{0.7}-1}$$

Q=3625.37W

Then when the $\boldsymbol{\varepsilon 1 = \varepsilon 2}$ **=0.1**

$$Q=\frac{A\sigma(T_1^4-T_2^4)}{\frac{1}{\epsilon}+\frac{1}{\epsilon}-1}$$

$$Q=\frac{Ax5.67x10^8(800x10^4-500x10^4)}{\frac{1}{0.1}+\frac{1}{0.1}-1}$$

Q=1035.82W