WEEK 5 ASSIGNMENT

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QUESTION 1

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 gray surface and finally the definition of radiative resistances.

ANSWER:

Definitions

a) Emissivity (Ɛ)
Emissivity can be defines as the ratio of the energy that is radiated from a surface of a material to that radiated from a perfect emitter which is also known as a blackbody, given at the same temperature and wavelength and under the same viewing conditions. It has no dimensions and ranges between 0 (Perfect reflector) and 1 (perfect emitter). The emissivity of a real surface is affected by the temperature of the surface, the wavelength and the direction of the emitted radiation.

b) Absorptivity (α)
Absorptivity is a property of a material which describes how much radiation is absorbed in the material in relation to the amount of radiation incident on that material.
Absorptivity depends on the wavelength and direction of the incident radiation, type of the material (metal, plastic, etc.), chemical composition and structure of the material, and state of the material and its surface.
Absorptivity = Absorbed Radiation / Incident Radiation

c) Reflectivity (ρ)
Reflectivity is a property of a material which describes how much radiation is reflected from the surface of the material in relation to the amount of radiation incident on that material.
Reflectivity depends on the wavelength of light, direction of the incident and reflected light, type of the material (metal, plastic, etc.), chemical composition and structure of the material, and state of the material and its surface.
Reflectivity = Reflected Radiation / Incident Radiation

d) The View Factor (F)
The view factor is the fraction of radiation leaving one surface which is intercepted by the second surface. It is the degree to which heat carried by radiation can be passed between two surfaces.

e) The heat exchange between two black body surfaces
Considering two black body objects 1 and 2 with their areas A_1 and A_2 respectively are radiating heat energy and the energy leaving the first object is E_1A_1 and for the second object E_2A_2. Hence, the energy leaving the first object to the second object will be $E_1A_1F_{12}$ and the energy leaving the second object to the second will be $E_2A_2F_{21}$. The net energy interchange from object 1 to object 2 is $E_1A_1F_{12} - E_2A_2F_{21} = Q_{(dot)\ 12}$.

f) Heat exchange between two grey surfaces
Grey bodies absorb a certain amount of radiation on the surface as well as reflect a portion of radiation off of the surface. If there are two surfaces, the reflected radiation of one object will be absorbed by the other

object for a certain fraction and reflect the other radiation. The same thing happens for the other surface. The radiation will generally lose power during this process.

g) Radiation Resistance
It is the resistance of a specific medium or system to heat flow across its boundaries and depends on medium's geometric and thermal properties such as thermal conductivity.

QUESTION 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?

ANSWER:

Given

$\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$
T1 = 800K
T2 = 500K

$Q_{net\ 12} = A\sigma(T_1^4 - T_2^4) / [(1/\varepsilon_1) + (1/\varepsilon_2) - 1]$ = ***3629.15W***

Where ε_1=0.2 and ε_2=0.7

For ε_1=0.1 and ε_2=0.1

$Q_{net\ 12} = A\sigma(T_1^4 - T_2^4) / [(1/\varepsilon_1) + (1/\varepsilon_2) - 1]$

$= 1 \times 5.67 \times 10^{-8} (800^4 - 500^4) / 1/0.1 + 1/0.1 - 1$ = ***1035.81W***

When comparing the two values, there is a drastic change in the value of Q_{net} when there is a change in the value of emissivity.