FDE 208 HEAT TRANSFER AND THERMAL PROCESSES

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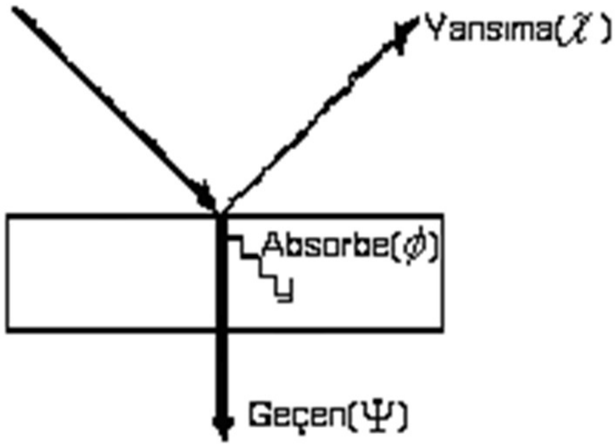
RADIATION HEAT TRANSFER

- It does not require medium. The electromagnetic waves directly heats the target.

$$Q = a.\varepsilon.\sigma.(T_1^4 - T_2^4).F$$

F: shape factor



$$\chi + \phi + \Psi = 1$$

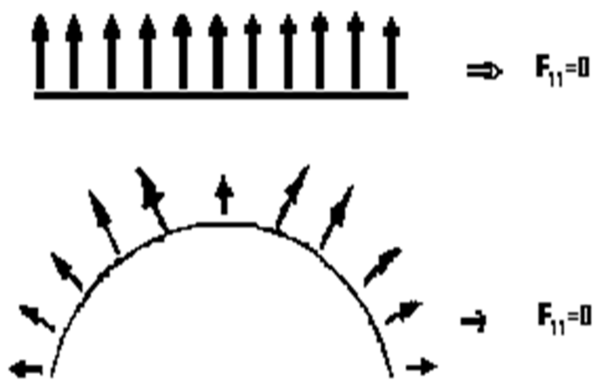
- For the black body;

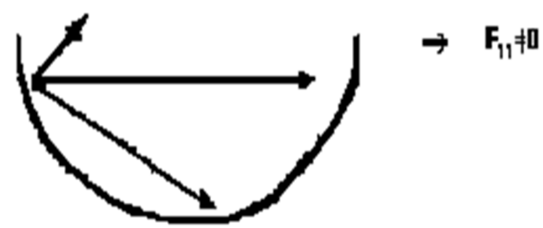
$$\phi \approx 1$$
$$\varepsilon = 1 \Rightarrow E_i = J_i = \sigma \cdot T_i^4$$

- Kirchoff law;

$$\phi = \varepsilon$$

- Radiation occurs between two surfaces.
- The rate of heat transfer mostly depends on the position of these surfaces according to each other.

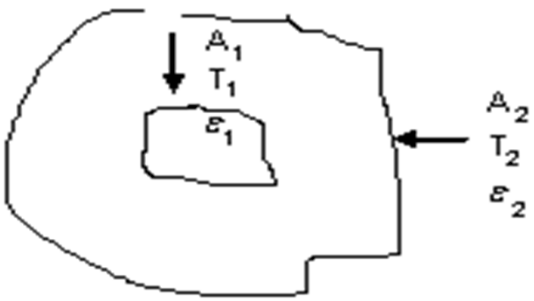




- If the particle is too small with respect to heating space;

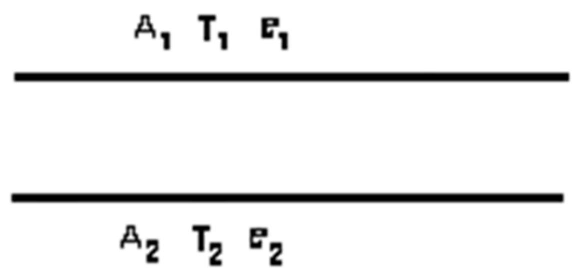
$$\frac{A_1}{A_2} \approx 0 \qquad F_{12} = 0$$

$$Q_{12} = A_1 \cdot \sigma \cdot (T_1^4 - T_2^4)$$



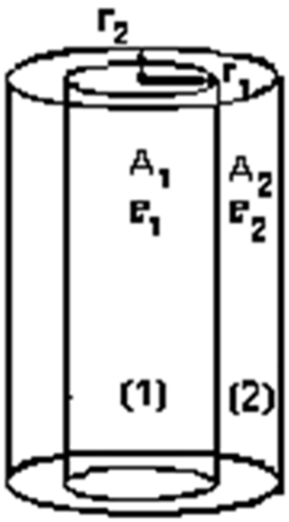
- For paralel surfaces;

$$\frac{A_1}{A_2} = \frac{r_1}{r_2}$$



$$F_{12} = 1$$

- For cocentric cylindirical surfaces;

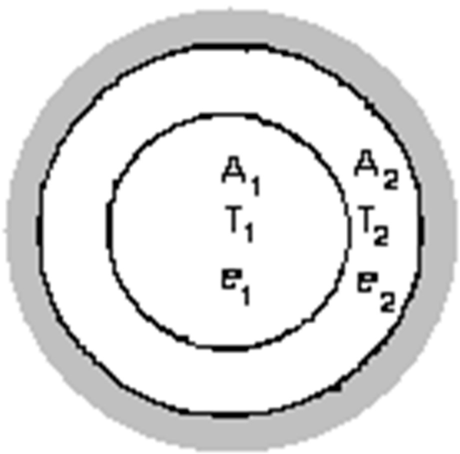


$$\frac{A_1}{A_2} = \frac{r_1}{r_2}$$

$$F_{12} = 1$$

$$Q_{12} = \frac{A_1 \cdot \sigma \cdot (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1-\varepsilon_2}{\varepsilon_2}\left(\frac{r_1}{r_2}\right)}$$

- For cocentrical spherical surfaces;



$F_{12} = 1$

$$Q_{12} = \frac{A_1 \cdot \sigma \cdot (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1-\varepsilon_2}{\varepsilon_2}\left(\frac{r_1}{r_2}\right)^2}$$

$$Q_{ij} = A_i.J_i.F_{ij} - A_j.J_j.F_{ji}$$

$$A_i.F_{ij} = A_j.F_{ji}$$

$$\Rightarrow Q_{ij} = A_i.F_{ij}(J_i. - J_j) = \frac{(J_i. - J_j)}{\left.\frac{1}{A_i.F_{ij}}\right\}(R_{ij})}$$

$$Q_i = \sum_{j=1}^{N} Q_{ij} = \sum_{j=1}^{N} \frac{J_i - J_j}{R_{ij}}$$

$$\frac{E_i - J_i}{R_i} = \sum_{j=1}^{N} \frac{J_i - J_j}{R_{ij}}$$

$$Q_i = \sum_{j=1}^{N} \frac{J_i - J_j}{\frac{1}{A_i.F_{ij}}} \Rightarrow Q_i = A_i.\sum_{j=1}^{N} F_{ij}.(J_i - J_j)$$

$$E_i = J_i + R_i A_i \sum_{j=1}^{N} F_{ij}.(J_i - J_j)$$

$$E_i = J_i + \frac{1-\varepsilon_i}{\varepsilon_i.A_i} A_i \sum_{j=1}^{N} F_{ij}.(J_i - J_j)$$

$$E_i = J_i + \frac{1-\varepsilon_i}{\varepsilon_i} \sum_{j=1}^{N} F_{ij}.(J_i - J_j) = \sigma.T_i^4$$