1) Definition of shape factor

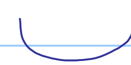
Properties of shape factor → 1) Purely fu$^n$ of geometry

2) $F_{2-1} A_2 = F_{1-2} A_1$

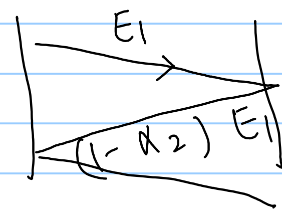
3) $F_{1-1} + \dots + F_{1-n} = 1$

4) flat $F_{1-1} = 0$

5) $F_{1-1} \neq 0$



Heat exchange betn



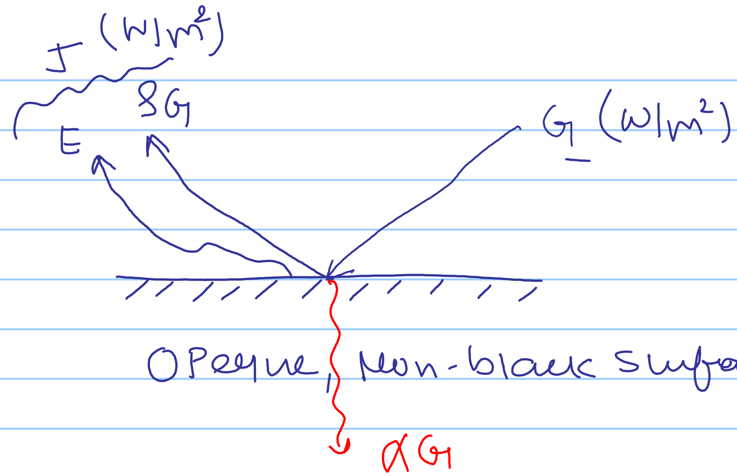

$\alpha_2 E_1$

$$\phi_{1-2} = f_{1-2}\, \sigma (T_1^4 - T_2^4)$$

$$f_{1-2} = \frac{1}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

$E_b \to E$ $\quad \varepsilon = \frac{E}{E_b}$

## Radiosity :-




Opaque, Non-black surface

$\tau = 0$

$\alpha \neq 1$

$\alpha + \rho + \tau = 1$

$\alpha + \rho = 1 , \quad \tau = 0$

$\rho = 1 - \alpha$

$\alpha = \varepsilon$

$$\varepsilon = \frac{E}{E_b}$$

$$E = \varepsilon E_b$$

$$J = E + \rho G$$

$$= E_b \varepsilon + (1-\alpha) G$$

$$J - \varepsilon E_b = (1-\alpha) G \Rightarrow G = \frac{J - \varepsilon E_b}{(1-\alpha)}$$

$$G = \frac{J - \varepsilon E_b}{1 - \varepsilon}$$

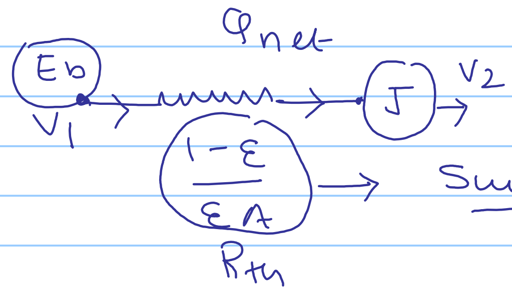
$$G = \frac{J - \varepsilon E_b}{1-\varepsilon}$$

$$q_{net} = \frac{\varepsilon (E_b - J) \cdot A}{1-\varepsilon}$$

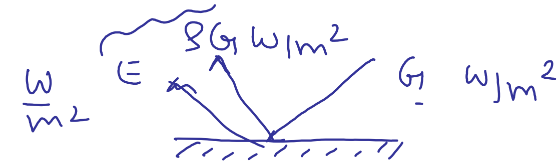
$$\boxed{q_{net} = \frac{E_b - J}{\frac{1-\varepsilon}{\varepsilon A}}}$$

$$V = IR$$

$$I = \frac{V}{R}$$




Surface Resistance




Net heat exchange from surface

$$\frac{q_{net}}{A} = J - G$$

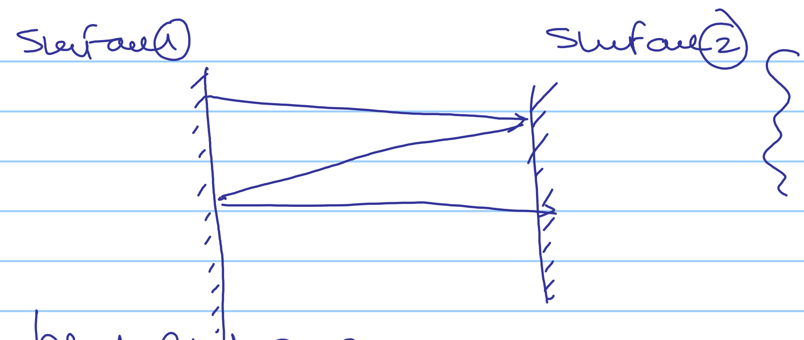
$$\frac{q_{net}}{A} = J - \frac{J - \varepsilon E_b}{1-\varepsilon}$$

$$= \frac{J(1-\varepsilon) - J + \varepsilon E_b}{1-\varepsilon}$$

$$= \frac{\cancel{J} - J\varepsilon - \cancel{J} + \varepsilon E_b}{1-\varepsilon}$$

$$= \frac{\varepsilon E_b - J\varepsilon}{1-\varepsilon}$$

$$= \frac{\varepsilon (E_b - J)}{1-\varepsilon}$$




$$\varphi_1 = J_1 A_1 F_{1-2} \rightarrow \text{Heat exchange } 1 \rightarrow 2$$

$$\varphi_2 = J_2 A_2 F_{2-1} \rightarrow \text{Heat exchange } 2 \rightarrow 1$$

$$\varphi_1 = \frac{\sigma T_1^4}{E_{b1}} A_1 F_{1-2} \qquad \varphi_2 = \frac{\sigma T_2^4}{E_{b2}} A_2 F_{2-1}$$

$$= E_{b1} A_1 F_{1-2} \qquad = E_{b2} A_2 F_{2-1}$$

Net heat exchange

$$\varphi_{1-2} = \varphi_1 - \varphi_2$$

$$= J_1 \underline{A_1 F_{1-2}} - J_2 A_2 \underline{F_{2-1}}$$

$$A_1 F_{1-2} = A_2 F_{2-1}$$

$$= A_1 F_{1-2} (J_1 - J_2)$$

$$= A_2 F_{2-1} (J_1 - J_2)$$

$$\varphi_{1-2} = \varphi_1 - \varphi_2$$

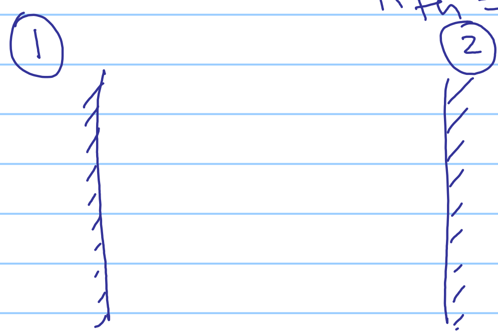
$$\varphi_{1-2} = \frac{J_1 - J_2}{\frac{1}{A_1 F_{1-2}}}$$

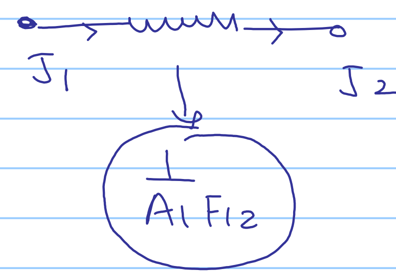
$$V = IR$$

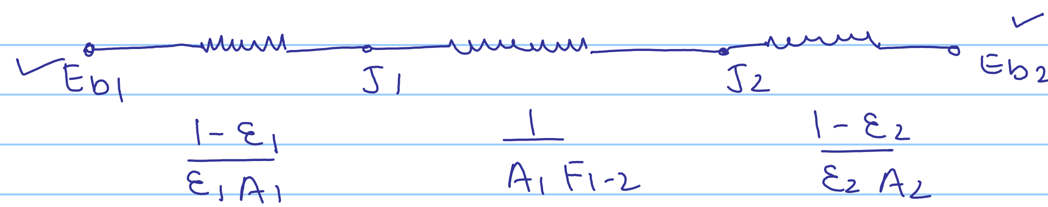
$$I = \frac{V}{R}$$

$$\Phi_{1-2} = \frac{J_1 - J_2}{\frac{1}{A_1 F_{1-2}}} \qquad I = \frac{V}{R}$$

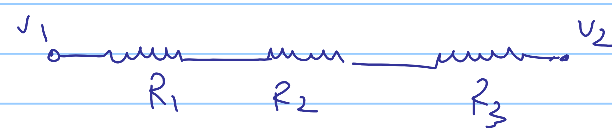
$$R_{th} = \frac{1}{A_1 F_{1-2}}$$




$$\Phi_{1-2} = \frac{E_{b1} - E_{b2}}{\frac{1-\varepsilon_1}{\varepsilon_1 A_1} + \frac{1}{A_1 F_{1-2}} + \frac{1-\varepsilon_2}{\varepsilon_2 A_2}}$$




$$\frac{V_2 - V_1}{R_1 + R_2 + R_3}$$

$$q_{1-2} = \frac{E_{b1} - E_{b2}}{\frac{1-\varepsilon_1}{\varepsilon_1 A_1} + \frac{1}{A_1 F_{1-2}} + \frac{1-\varepsilon_2}{\varepsilon_2 A_2}}$$

$$E_b = \sigma T^4$$

$$E_{b1} = \sigma T_1^4$$

$$E_{b2} = \sigma T_2^4$$

$$= \frac{\sigma T_1^4 - \sigma T_2^4}{\frac{1-\varepsilon_1}{\varepsilon_1 A_1} + \frac{1}{A_1 F_{12}} + \frac{1-\varepsilon_2}{\varepsilon_2 A_2}}$$

$$= \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{\varepsilon_1} + \frac{1}{F_{1-2}} + \frac{1-\varepsilon_2}{\varepsilon_2} \cdot \frac{A_1}{A_2}}$$

$$q_{1-2\,net} = \underline{(f_g)}_{1-2}\, A_1 \sigma \,(T_1^4 - T_2^4)$$

grey body factor

* Special case

1) infinite Parallel Plate

$A_1 = A_2 \qquad F_{1-2} = F_{2-1} = 1$

$$Q_{1-2\,net} = \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{\varepsilon_1} + \frac{1}{1} + \frac{1-\varepsilon_2}{\varepsilon_2} \cdot \frac{A_1}{A_2}} \qquad \frac{A_1}{A_2} = 1$$

$$= \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} - \cancel{1} + \cancel{1} + \frac{1}{\varepsilon_2} - 1} = \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

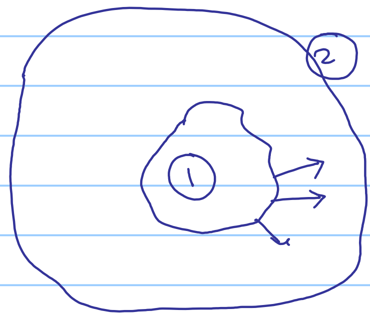
2) Concentric Cylinder

$A_1 = \cancel{4}\cancel{\pi} r_1^2 \qquad F_{1-2} = 1$

$A_1 = \cancel{\pi} d \cancel{L}$

$$Q_{1-2\,net} = \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{\varepsilon_1} + 1 + \frac{1-\varepsilon_2}{\varepsilon_2} \cdot \frac{A_1}{A_2}} = \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} - \cancel{1} + \cancel{1} + \frac{1-\varepsilon_2}{\varepsilon_2} \frac{A_1}{A_2}} = \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_2} + \frac{1-\varepsilon_2}{\varepsilon_2} \frac{A_1}{A_2}}$$

3) Small body in large enclosure




$A_1 <<< A_2 \qquad \frac{A_1}{A_2} \to 0$

$F_{1-2} = 1$

$$\varphi_{1-2} = \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{\varepsilon_1} + \frac{1}{1} + 0}$$

$$= \frac{A_1 \sigma (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} - \cancel{1} + \cancel{1} + 0} = A_1 \varepsilon_1 \sigma (T_1^4 - T_2^4)$$