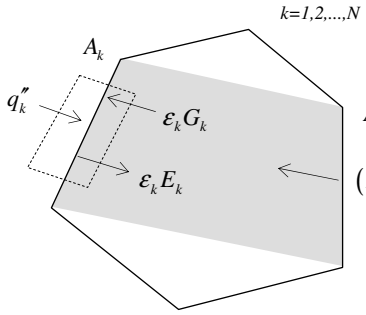
NET RADIATION METHOD
FOR ANALYSIS OF RADIATION EXCHANGE IN DIFFUSE-GRAY ENCLOSURES

Consider an N -surface enclosure:



$\varepsilon_k = \alpha_k = 1 - \rho_k$

Net radiative flux at the surface k : $q_k'' = \varepsilon_k E_{bk} - \varepsilon_k G_k$ (1)

Solve for $G_k = E_{bk} - \dfrac{q_k''}{\varepsilon_k}$ (2)

Irradiation of the surface k : $A_k G_k = q_{i\to k} + \ldots + q_{N\to k}$

$$= \left[(1-\varepsilon_1)G_1 + \varepsilon_1 E_{b1}\right]A_1 F_{1k} + \ldots + \left[(1-\varepsilon_N)G_N + \varepsilon_N E_{bN}\right]A_N F_{Nk}$$

substitute (2) and use reciprocity rule

$$= \left[(1-\varepsilon_1)\left(E_{b1} - \frac{q_1''}{\varepsilon_1}\right) + \varepsilon_1 E_{b1}\right]A_k F_{k1} + \ldots + \left[(1-\varepsilon_N)\left(E_{bN} - \frac{q_N''}{\varepsilon_{kN}}\right) + \varepsilon_N E_{bN}\right]A_k F_{kN}$$

Expand, divide by A_k and simplify $G_k = \left[E_{b1} - \left(\dfrac{1}{\varepsilon_1} - 1\right)q''\right]F_{k1} + \ldots + \left[E_{bN} - \left(\dfrac{1}{\varepsilon_N} - 1\right)q''\right]F_{kN}$ (3)

Substitute (3) into (1)

$$\frac{q_k''}{\varepsilon_k} = E_{bk} - G_k$$

$$= E_{bk} - \left[E_{b1} - \left(\frac{1}{\varepsilon_1} - 1\right)q''\right]F_{k1} - \ldots - \left[E_{bN} - \left(\frac{1}{\varepsilon_N} - 1\right)q''\right]F_{kN}$$

Move terms with fluxes to the left:

$$\frac{q_k''}{\varepsilon_k} - F_{k1}\left(\frac{1}{\varepsilon_1} - 1\right)q_1'' - F_{k2}\left(\frac{1}{\varepsilon_2} - 1\right)q_2'' - \ldots - F_{kN}\left(\frac{1}{\varepsilon_N} - 1\right)q_N'' = E_{bk} - E_{b1}F_{k1} - E_{b2}F_{k2} - \ldots - E_{bN}F_{kN} \qquad (4)$$

Write $E_{bk} = E_{bk}\cdot 1 = E_{bk}\cdot\left(F_{k1} + F_{k2} + \ldots + F_{kN}\right) = E_{bk}F_{k1} + E_{bk}F_{k2} + \ldots + E_{bk}F_{kN}$, then combine with the right had side of (4)

$$\frac{q_k''}{\varepsilon_k} - \left(\frac{1}{\varepsilon_1} - 1\right)F_{k1}\,q_1'' - \left(\frac{1}{\varepsilon_2} - 1\right)F_{k2}\,q_2'' - \ldots - \left(\frac{1}{\varepsilon_N} - 1\right)F_{kN}\,q_N'' = F_{k1}\left(E_{bk} - E_{b1}\right) + \ldots + F_{kN}\left(E_{bk} - E_{bN}\right) \qquad (\textbf{NRM})$$