

3.3 STRICTLY ONE-DIMENSIONAL TRANSIENT TRANSFER

The preceding section was devoted to the presentation of the notions of thermal resistance, 'current' and 'tension' source in steady-state transfer. We now present similar notions in a one- directional transient transfer.

3.3.1 The Notion of a Thermal Quadrupole: the Passive 'Wall'

The procedure for constructing the quadrupole matrix of a homogeneous 'wall' (thickness e , diffusivity a) in a one-directional transfer in the z -direction will be detailed here. There is no internal source in the medium which is at thermal equilibrium at the initial time. The corresponding heat equation and initial conditions are

$$\begin{cases} \frac{\partial^2 T}{\partial z^2} = \frac{1}{a} \frac{\partial T}{\partial t} & \text{for } 0 < z < e \\ T = 0 & \text{for } t = 0 \end{cases} \quad (3.36)$$

Let θ_{in} and θ_{out} be the Laplace transforms of the temperature at $z = 0$ and $z = e$ and ϕ_{in} and ϕ_{out} the Laplace transforms of the heat fluxes at $z = 0$ and $z = e$.

In a very general way there exists a linear relationship between the input quantities $(\theta_{\text{in}}, \phi_{\text{in}})$ and the corresponding output quantities $(\theta_{\text{out}}, \phi_{\text{out}})$, since the problem is linear:

$$\theta_{\text{in}} = A\theta_{\text{out}} + B\phi_{\text{out}}; \quad \phi_{\text{in}} = C\theta_{\text{out}} + D\phi_{\text{out}} \quad (3.37)$$

where matrix $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$ is the inverse transfer matrix of the quadrupole that is associated with the wall as shown in Figure 3.8.

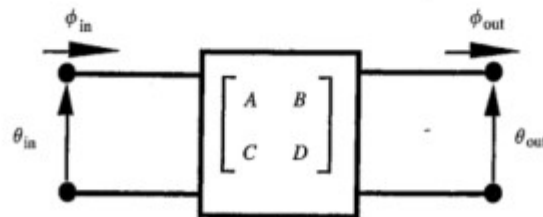


Figure 3.8 Quadrupole of a passive wall