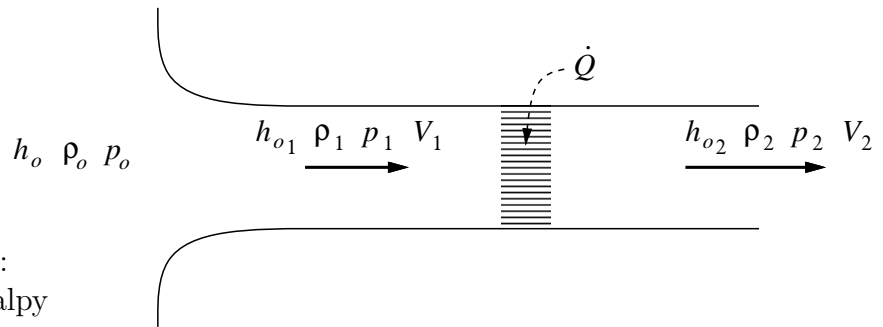


F11+12. Air is drawn at high speed out of a large reservoir through a duct of constant area  $A$ , which contains a radiator delivering a known  $\dot{Q}$  to the flow (in Watts). The heating and friction of the duct walls are negligible.



The known flow quantities are:

- $h_o = h_{o1}$  reservoir total enthalpy
- $\rho_o$  reservoir total density
- $p_o$  reservoir total pressure
- $p_2$  outlet pressure (drives the flow)

The remaining six unknown quantities inside the duct are:

- $h_{o2}$  outlet total enthalpy
- $V_1$  inlet velocity
- $V_2$  outlet velocity
- $\rho_1$  inlet density
- $\rho_2$  outlet density
- $p_1$  inlet pressure

A total of six equations are needed to solve for the six unknowns. One of these equations is the isentropic relation between the reservoir and station 1,

$$\frac{p_1}{p_o} = \left( \frac{h_{o1} - \frac{1}{2}V_1^2}{h_o} \right)^{\gamma/(\gamma-1)}$$

and two additional ones are the state equations at stations 1 and 2.

$$p_1 = \frac{\gamma - 1}{\gamma} \rho_1 \left( h_{o1} - \frac{1}{2}V_1^2 \right)$$

$$p_2 = \frac{\gamma - 1}{\gamma} \rho_2 \left( h_{o2} - \frac{1}{2}V_2^2 \right)$$

Write down the remaining three equations by constructing a suitable control volume and applying the integral mass, momentum, energy equations. (Do not try to solve the six equations — it gets very messy!)