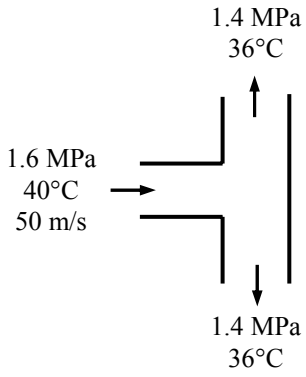
6-156 The mass flow rate of a compressed air line is divided into two equal streams by a T-fitting in the line. The velocity of the air at the outlets and the rate of change of flow energy (flow power) across the T-fitting are to be determined.

Assumptions **1** Air is an ideal gas with constant specific heats. **2** The flow is steady. **3** Since the outlets are identical, it is presumed that the flow divides evenly between the two.

Properties The gas constant of air is $R = 0.287$ kPa·m^3/kg·K (Table A-1).



Analysis The specific volumes of air at the inlet and outlets are

$$\nu_1 = \frac{RT_1}{P_1} = \frac{(0.287\ \text{kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(40+273\ \text{K})}{1600\ \text{kPa}} = 0.05614\ \text{m}^3/\text{kg}$$

$$\nu_2 = \nu_3 = \frac{RT_2}{P_2} = \frac{(0.287\ \text{kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(36+273\ \text{K})}{1400\ \text{kPa}} = 0.06335\ \text{m}^3/\text{kg}$$

Assuming an even division of the inlet flow rate, the mass balance can be written as

$$\frac{A_1V_1}{\nu_1} = 2\frac{A_2V_2}{\nu_2} \longrightarrow V_2 = V_3 = \frac{A_1}{A_2}\frac{\nu_2}{\nu_1}\frac{V_1}{2} = \frac{0.06335}{0.05614}\frac{50}{2} = \mathbf{28.21\ m/s}$$

The mass flow rate at the inlet is

$$\dot{m}_1 = \frac{A_1V_1}{\nu_1} = \frac{\pi D_1^2}{4}\frac{V_1}{\nu_1} = \frac{\pi(0.025\ \text{m})^2}{4}\frac{50\ \text{m/s}}{0.05614\ \text{m}^3/\text{kg}} = 0.4372\ \text{kg/s}$$

while that at the outlets is

$$\dot{m}_2 = \dot{m}_3 = \frac{\dot{m}_1}{2} = \frac{0.4372\ \text{kg/s}}{2} = 0.2186\ \text{kg/s}$$

Substituting the above results into the flow power expression produces

$$\begin{aligned}\dot{W}_{\text{flow}} &= 2\dot{m}_2P_2\nu_2 - \dot{m}_1P_1\nu_1 \\ &= 2(0.2186\ \text{kg/s})(1400\ \text{kPa})(0.06335\ \text{m}^3/\text{kg}) - (0.4372\ \text{kg/s})(1600\ \text{kPa})(0.05614\ \text{m}^3/\text{kg}) \\ &= \mathbf{-0.496\ kW}\end{aligned}$$

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