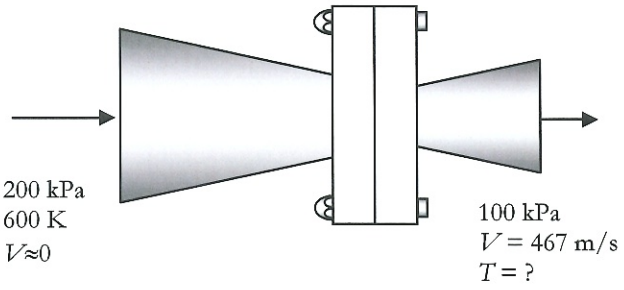
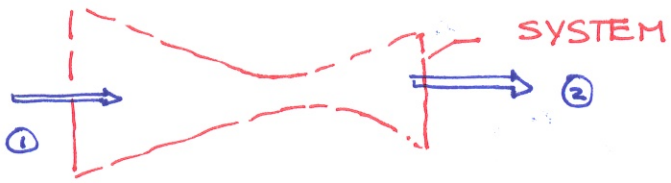
Example

Air flows steadily through a supersonic nozzle. The entering air has negligible velocity. If the exiting air has a velocity of 467 m/s, find the exit temperature. Assume air is an ideal gas with variable specific heats.





Conservation of energy

$$\frac{dE}{dt} = \dot{Q} + \dot{W} + \sum_{IN} \dot{m}\left(h + \frac{V^2}{2}\right) - \sum_{OUT} \dot{m}\left(h + \frac{V^2}{2}\right)$$

($\frac{dE}{dt} \to 0$, $\dot{Q} \to 0$, $\dot{W} \to 0$)

$$0 = \dot{m}\left(h_1 + \frac{V_1^2}{2}\right) - \dot{m}\left(h_2 + \frac{V_2^2}{2}\right)$$

(HAVE USED CONS. of MASS RESULT, $\dot{m}_1 = \dot{m}_2 = \dot{m}$)

$$h_2 = h_1 - \frac{V_2^2}{2}$$

$$h_1 = h(T_1) = 607.02 \text{ kJ/kg}$$

$$\therefore \quad h_2 = 607.02 \frac{\text{kJ}}{\text{kg}} - \frac{467^2 \text{ m}^2/\text{s}^2}{2} \left\langle \frac{\text{J/kg}}{\text{m}^2/\text{s}^2} \right\rangle \left\langle \frac{\text{kJ}}{1000 \text{ J}} \right\rangle$$

$$= 498.3 \text{ kJ/kg}$$

$$h_2 = h(T_2)$$

$$\boxed{T_2 = 495.5 \text{ K}}$$

SINCE IDEAL GAS DIDN'T NEED THE PRESSURES!