Given: Flow of standard air, $V = 600 \, m/s$

Find: P_o, h_o, T_o

Solution:

Computing equations: $\dfrac{P_o}{P} = \left[1 + \dfrac{k-1}{2} M^2\right]^{k/k-1}$

$$\dfrac{T_o}{T} = 1 + \dfrac{k-1}{2} M^2$$

$$c = \sqrt{kRT}$$

Assumption: air behaves as an ideal gas. $k = 1.4$

$$c = (kRT)^{1/2} = \left(1.4 \times 287 \, \dfrac{N \cdot m}{kg \cdot K} \times 288K \times \dfrac{kg \cdot m}{N \cdot sec^2}\right)^{1/2} = 340 \, m/s$$

$$M = \dfrac{V}{c} = \dfrac{600}{340} = 1.76$$

$$P_o = P\left[1 + \dfrac{k-1}{2} M^2\right]^{k/k-1} = 101 \, kPa \left[1 + 0.2(1.76)^2\right]^{3.5} = 546 \, kPa \quad \underrightarrow{\hspace{2cm}} \quad P_o$$

$$T_o = T\left[1 + \dfrac{k-1}{2} M^2\right] = 288 \, K \left[1 + 0.2(1.76)^2\right] = 466 \, K \quad \underrightarrow{\hspace{2cm}} \quad T_o$$

$dh = C_p dT$.   For $C_p = constant$

$$h_o - h = \int_h^{h_o} dh = \int_T^{T_o} C_p dT = C_p (T_o - T) = 1000 \, \dfrac{J}{kg \cdot K} (466 - 288) K$$

$$h_o - h = 178 \, kJ/kg \quad \underrightarrow{\hspace{2cm}} \quad h_o - h$$