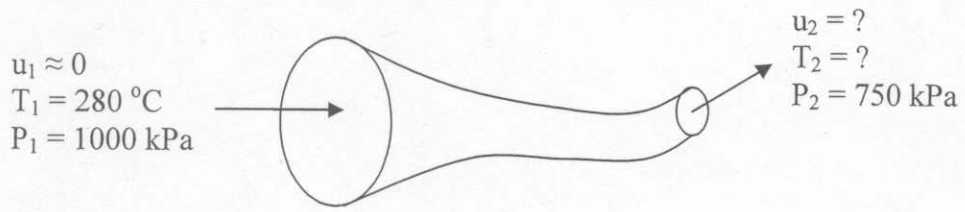
## Example 1

Steam at 1000 kPa and 280 °C enters with negligible velocity to an isentropic nozzle and discharges at 750 kPa. Find the steam exit temperature and velocity.




For isentropic nozzle $\Delta S = 0$

$\Rightarrow S_1 = S_2$

at $T_1 = 280\ ^\circ C$ and $P_1 = 1000$ kPa

$S_1 = 7.0485 \frac{kJ}{kg\,K}$ & $H_1 = 3009 \frac{kJ}{kg}$

To find the conditions at state 2 we need to properties.

$P_2 = 750$ kPa and $S_2 = S_1 = 7.0485 \frac{kJ}{kg\,K}$

using $P_2$ and $S_2$ find $T_2$ and $H_2$ from steam tables.

From steam tables at 750 kPa

$T = 240\ ^\circ C$ $\quad s = 7.0303 \left(\frac{kJ}{kg\,K}\right)$

$T = 260\ ^\circ C$ $\quad s = 7.1128$ (")

$\Rightarrow$ By interpolation: ($S_2$)

$$\frac{T_2 - 240}{260 - 240} = \frac{7.0485 - 7.0303}{7.1128 - 7.0303}$$

$$\Rightarrow T_2 = 244.4\ ^\circ C$$

To find steam exit velocity apply energy balance

$$\Delta H + \frac{1}{2}\Delta u^2 = 0$$

$$(H_2 - H_1) + \frac{1}{2}(u_2^2 - u_1^2) = 0$$

$u_1 \approx 0$ (given) $\Rightarrow u_2 = \sqrt{-2(H_2 - H_1)}$

to find $H_2$ at 750 kPa and 244.4 °C

$T = 240\ ^\circ C$ $\quad H = 2930.6\ (kJ/kg)$

$T = 260\ ^\circ C$ $\quad H = 2973.7$ (")

By interpolation

$$\frac{244.4 - 240}{260 - 240} = \frac{H_2 - 2930.6}{2973.7 - 2930.6}$$

$$\Rightarrow H_2 = 2940 \ \frac{kJ}{kg}$$

$$\Rightarrow u_2 = \sqrt{-2(2940 * 10^3 - 3009 * 10^3)}$$

↑ convert kJ to J

$$= 371.26 \left(\frac{m}{s}\right)$$