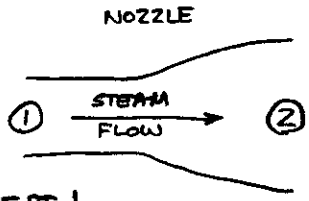
# STEAM TURBINE NOZZLE

STEAM EXPANDS IN A NOZZLE FROM 600 PSIA, 500°F TO 15 PSIA. THE NOZZLE IS ADIABATIC. THE STEAM VELOCITY ENTERING THE NOZZLE IS 50 $\frac{FT}{S}$.

FIND: DISCHARGE VELOCITY [$\frac{FT}{S}$] OF THE STEAM, $V_2$




| ST PT 1 | ST PT 2 |
|---|---|
| 600 PSIA | 15 PSIA |
| 500°F | |
| 50 FT/S | |

NOTES: (1) "ADIABATIC" MEANS $q_{12} = 0$. RECALL, AN ISENTROPIC PROCESS ON A T-S DIAGRAM MEANS $q_{12} = 0$. SO $1 \rightarrow 2$ IS ISENTROPIC

(2) NOZZLES INCREASE STEAM VELOCITY

(3) STEAM IN A NOZZLE IS A <u>COMPRESSIBLE</u> WORKING FLUID

START WITH SFEE FOR STEAM AS A COMPRESSIBLE WORKING FLUID:

$$\cancel{pe_1} + ke_1 + h_1 + \cancel{q_{12}}^{\,0} = \cancel{pe_2} + ke_2 + h_2 + \cancel{w_{12}}$$

→ ASSUMED HEIGHT DIFFERENCES NEGLIGIBLE (ie $pe_1 = pe_2$)

→ NO MECHANICAL WORK PERFORMED IN A NOZZLE (ie $w_{12} = 0$)

→ ADIABATIC NOZZLE: $q_{12} = 0$

$$\frac{1}{2g_c}(V_1)^2 + h_1 = \frac{1}{2g_c}(V_2)^2 + h_2$$

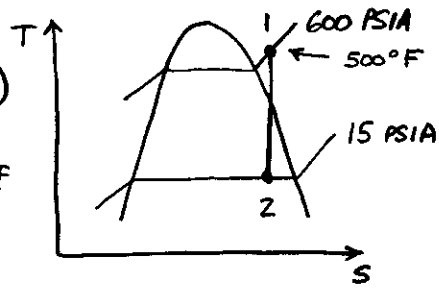
$$V_2^2 - V_1^2 = 2g_c(h_1 - h_2)$$, FIND $h_1$ AND $h_2$:

$$V_2^2 - \left(50\,\tfrac{FT}{S}\right)^2 = 64.4\,\frac{FT\,LBm}{LBF\,S^2}\left(264.3\,\frac{Btu}{LBm}\right) \times \frac{778\,FT\,LBF}{1\,Btu}$$

$$V_2^2 = 13.244 \times 10^6\,\frac{FT^2}{S^2}$$

$$\boxed{V_2 = 3639\,\frac{FT}{S}}$$

NOZZLE DISCH. VELOCITY




① → TABLE 3

② → TABLE 2

$$h_1 = 1215.9\,\frac{Btu}{LBm}, \quad s_1 = 1.459\,\frac{Btu}{LBm\,°R}$$

$$s_2 = s_1 = 1.459$$

STEP 1 $\quad s_2 = s_f + x_2(s_{fg})$

$$1.459 = .3137 + x_2(1.4415)$$

$$x_2 = .7945$$

STEP 2 $\quad h_2 = h_f + x_2(h_{fg})$

$$= 181.21 + (.7945)(969.7)$$

$$h_2 = 951.6\,\frac{Btu}{LBm}$$