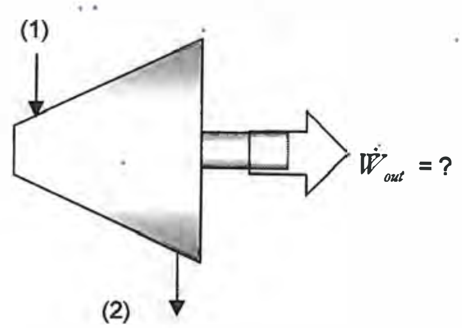
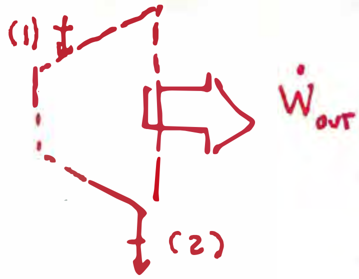
EXAMPLE: Steam turbine

1.25 kg/s of steam flows through a steady state turbine. The steam enters at 1 MPa and 300°C, and leaves at 100 kPa. If the process is adiabatic and reversible, find the power delivered by the turbine in kW.





CoE

$$\frac{d}{dt}(E_{sys}) = \dot{Q} + \dot{W}_{IN} + \dot{m}(h_1 + \ldots) - \dot{m}(h_2 + \ldots)$$

$$\dot{W}_{IN} = \dot{m}(h_2 - h_1)$$

$$\dot{W}_{OUT} = \dot{m}(h_1 - h_2)$$

?

PROPERTIES

$$h_1 = h(T_1, P_1) = \ldots = 3051.2 \text{ kJ/kg}$$

$$h_2 = h(?, P_2) = ? \quad (1)$$

ONLY ONE PROPERTY @ 2!
¿WHAT TO DO?

S-ACCT'ING

$$\frac{d}{dt}(S_{sys}) = \sum \frac{\dot{Q}}{T_b} + \dot{m}(s_1) - \dot{m}(s_2) + \dot{S}_{gen}$$

$s_2 = s_1$ (1) BECOMES $h_2 = h(P_2, s_2 = s_1)$

BACK TO PROPERTIES

$$s_1 = s(T_1, P_1) = \ldots = 7.1229 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$$

$s_2 = 7.1229$ $s_f < s_2 < s_g$ @ $P = 100\text{kPa}$

$$= (1 - x_2)s_f + x_2 s_g$$

$$= (1 - x_2)(1.3026) + x_2(7.3594) \Rightarrow x_2 = 0.961$$

$$h_2 = (1-x_2)h_f + x_2 h_g$$

$$= (1-0.961)(417.26) + (0.961)(2675.5)$$

$$= 2587.3 \text{ kJ/kg}$$

$$\dot{W}_{out} = (1.25 \tfrac{kg}{s})(3051.2 - 2587.3) \text{ kJ/kg}$$

$$= \boxed{580 \text{ kW}}$$