Problem Set 8, PS8 due Monday June 7

PS8-1 4-61 Air at 300 kPa, and 200 C enters a nozzle at 30 m/sec and leaves at 100 Kpa and 180 m/sec. The nozzle has an inlet area of 80 cm^2. Determine a) the mass flow rate, b) the exit temperature of the air and, c) the exit area of the nozzle.

PS8-2 4-83 Steam at 10 MPa, 500 C enters an adiabatic turbine at 3 kg/sec and leaves the turbine at 20 kPa. The turbine produces 2 MW. Neglecting kinetic energy changes determine the temperature of the steam leaving the turbine

PS8-3 4-86 R-134a at a flow rate of 1.2 kg/sec is compressed in an adiabatic compressor from a saturated vapor at -20 C to .7 MPa and 70 C. Determine a) the power input to the compressor and, b) the volume flow rate at the compressor inlet

<u>4-61</u>

$$v_1 = \frac{RT}{p} = \frac{.287 \times (273.15 + 200)}{300\,\text{kPa}} = .4526\,\text{m}^3/\text{kg}$$

a) $$m = \frac{AV}{v} = \frac{80}{10^4} \times 30\,\text{m/sec} \times \frac{1}{.4526} = .5303\,\text{kg/sec}$$

b) open system

$$Q = 0, W = 0$$

$$h + \frac{V^2}{2} = \text{constant}$$

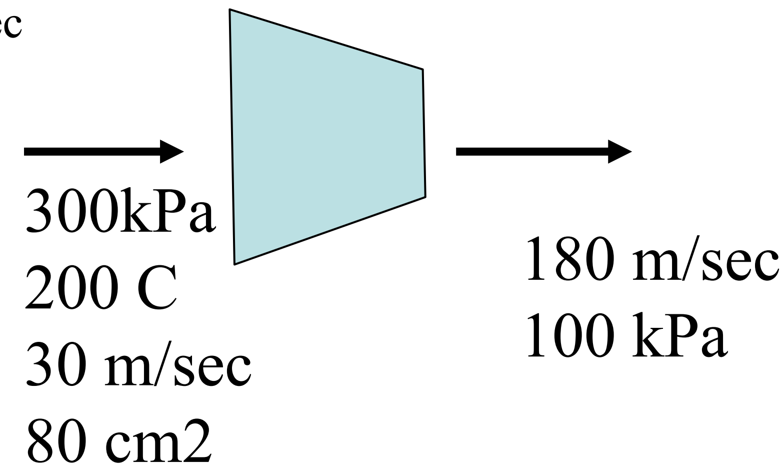
$$h_1 + \frac{V_1^2}{2} = h + \frac{V_2^2}{2}$$

$$c_p(T_1 - T_2) = \frac{V_2^2}{2} - \frac{V_1^2}{2}$$

$$(T_1 - T_2) = \frac{1}{c_p}\left(\frac{V_2^2}{2} - \frac{V_1^2}{2}\right)$$

$$(T_1 - T_2) = \frac{.5}{1.02}(180^2 - 30^2)$$

$$T_2 = 184.5^{\text{O}}\text{C}$$



$$v_2 = \frac{RT_2}{p_2} = \frac{.287 \times (273.15 + 184.5)}{100\,\text{kPa}}$$

$$v_2 = 1.313\,\text{m}^3/\text{kg}$$

$$m = \frac{A_2 V_2}{v_2}$$

$$A_2 = \frac{m \times v_2}{V_2} = \frac{1.313 \times .5303\,\text{kg/sec}}{180\,\text{m/sec}} = .00387 m^2$$

<u>4-83</u>

$h\ @\ 10\ \text{MPa},\ 500^{O}\text{C} = 3737.7\ \text{kJ/kg}$

open system

region in space

$W = m\Delta h$

$W = 2000\ \text{kJ/sec} = 2\ \text{kg/sec}(3737.7 - h_2)$

$$h_2 = 3373.7 - \frac{2000}{3} = 2707\ \text{kJ/kg}$$

$@\ h = 2707,\ p = 2\ \text{kPa},\quad T = 110.8^{O}\text{C}$ by interpolation

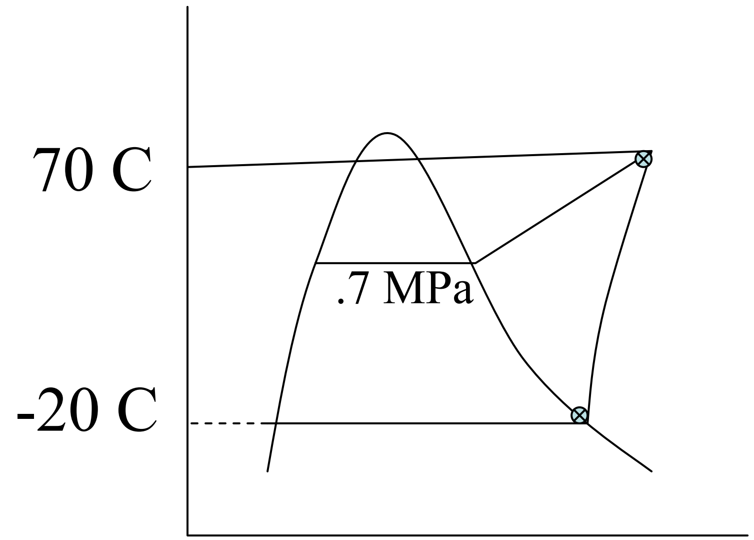
	.01kPa.	.02kPa	.05kPa
100	2687.5	***2686.5***	2682.5
110.6		2707	
200	2879.5	***2879.2***	2877.7

$$h@.01\text{kPa},100^{O}\text{C} = 2687.5 - \frac{.02-.01}{.05-.01}\times(2687.5-2682.5) = \mathbf{2686.5}$$

$$h@.05\text{kPa},200^{O}\text{C} = 2879.5 - \frac{.02-.01}{.05-.01}\times(2879.5-2877.7) = \mathbf{2879.2}$$

$$T@.02\text{kPa},h = 2707 = 100 + \left(\frac{2707-2686.5}{2879.2-2686.5}\right)\times 100 = 101.6^{O}\text{F}$$

4-86



$@-20^{O}C,\ v_g = .146\, m^3/kg,\ \ h_g = 235.3\, kJ/kg$

$@70^{O}C,\ \ .7\ \ MPa,\ \ \ h_g = 307.\ \ kJ/kg$

open system

$W = m\Delta h = 1.3 = 2kg\ \ (307.\ kJ/kg - 235.3\ \ kJ/kg)$

$W = 86.04\ \ kJ/sec$

$V = m\ v_1 = 1.2\ \ kg \times .146\ \ m^3/kg = .176\ \ m^3/sec$