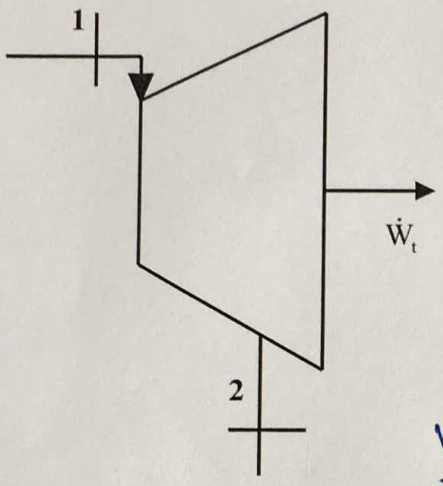
Cankaya University
Faculty of Engineering
Mechanical Engineering
ME 212 Thermodynamics II
Quiz 4
Spring 2017

Oxygen enters a turbine operating at steady state at 140 bar and 300 K and exits at 60 bar and 220 K. Using the enthalpy departure chart, determine the work developed, in kJ per kg of oxygen flowing, if heat transfer with the surroundings be ignored. Changes in kinetic and potential energy from inlet to exit also can be neglected.



SSSF
$\Delta KE = 0$
$\Delta PE = 0$

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

$\dot{Q}_{cv} \approx 0$

$$\frac{\dot{W}_{cv}}{\dot{m}} = h_1 - h_2$$

$$\frac{\dot{W}_{cv}}{\dot{m}} = \frac{1}{M}\left\{(\bar{h}_1^* - \bar{h}_2^*) - \bar{R}T_c\left[\left(\frac{\bar{h}^* - \bar{h}^*}{\bar{R}T_c}\right)_1 - \left(\frac{\bar{h}^* - \bar{h}}{\bar{R}T_c}\right)_2\right]\right\}$$

$T_1 = 300\,K$ $\quad \bar{h}_1^* = 8736$ kJ/kmol
$T_2 = 220K$ $\quad \bar{h}_2^* = 6404$ " "

$T_c = 154K$
$P_c = 50.5$ bar

inlet: $T_{R1} = \frac{300}{154} = 1.95$
$P_{R1} = \frac{140}{50.5} = 2,77$
$\Big\}$ $\left(\frac{\bar{h}^* - \bar{h}}{\bar{R}T_c}\right)_1 \approx 0.7$

exit $T_{R2} = \frac{220}{154} = 1.43$
$P_{R2} = 60/50.5 = 1,19$
$\Big\}$ $\left(\frac{\bar{h}^* - \bar{h}}{\bar{R}T_c}\right)_2 \approx 0.67$

$$\frac{\dot{W}_{CV}}{\dot{m}} = \frac{1}{32}\left[8736 - 6404 - 8.314\,(154)(0.7-0.67)\right]$$

$$= 71.7 \text{ kJ/kg}$$