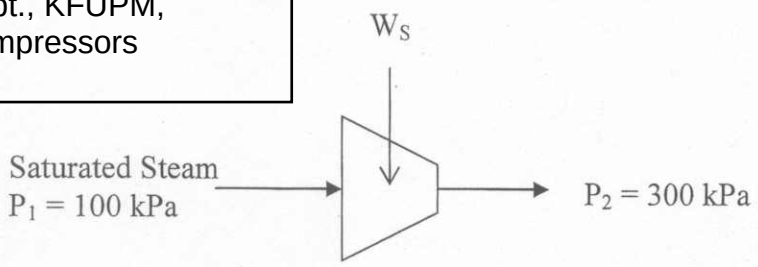
Example 7.8

Saturated steam at 100 kPa is compressed adiabatically to 300 kPa. If the compressor efficiency is 0.75, what is the work required?



$S_1 = 7.3598 \ \frac{kJ}{kg\,K}$

$H_1 = 2675.4 \ \frac{kJ}{kg}$

Step #1 Assume isentropic compressor ($\Delta S = 0$)

$\Rightarrow S_2' = S_1 = 7.3598$ kJ/(kg K)

$\Rightarrow P_2 = 300$ kPa $\quad S_2' = 7.3598$

note at 300 kPa $S_2^v = 6.9909 < S_2'$

$\Rightarrow$ steam at discharge is superheated

now, $P_2 = 300$ kPa $\quad S_2' = 7.3598$ kJ/(kg K)

$\Rightarrow T_2' = 211.3\ ^\circ C$ (by interpolation)

and $H_2' = 2888.8 \ \frac{kJ}{kg}$ (" ")

$(\Delta H)_S = H_2' - H_1 = 213.4 \ \frac{kJ}{kg}$

$$H_2 = \frac{(\Delta H)_s}{2} + H_1$$

$$= \frac{213.4}{0.75} + 2675.4 = 2959.9 \ \frac{kJ}{kg}$$

$$\Rightarrow \left.\begin{array}{l} P_2 = 300 \text{ kPa} \\ H_2 = 2959.9 \ \frac{kJ}{kg} \end{array}\right\} \Rightarrow \begin{array}{l} T_2 = 246.1 \ ^\circ C \\ S_2 = 7.5019 \ \frac{kJ}{kg\,K} \end{array}$$

$$W_s = H_2 - H_1 = 284.5 \ \frac{kJ}{kg}$$