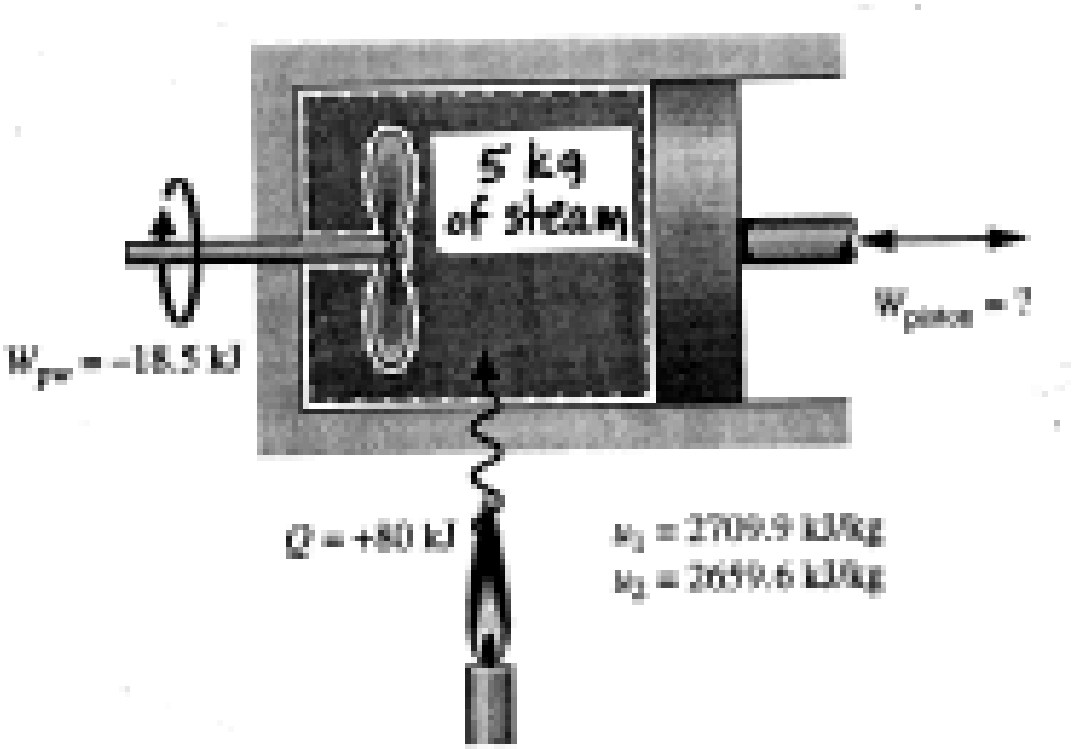
SET Problem
Session 2

Problem Statement 1

- Steam contained within a piston-cylinder assembly undergoes an **expansion** from state 1 ,where the specific internal energy is $\boldsymbol{u_1 = 2709.9 kJ/kg}$, to state 2,where $\boldsymbol{u_2 = 2659.6 kJ/kg}$. During the process, there is a **heat transfer to the system** with a magnitude of **80 kJ**. Also, a paddle wheel transfers **energy to the steam by work** in the amount of **18.5 kJ**. There is **no significant** change in the **kinetic or potential energy** of the steam. Determine the energy **transfer by work from the steam to the piston** during the process in kJ.

Figure


5 kg
of steam
$W_{piston} = ?$
$W_{pw} = -18.5$ kJ
$Q = +80$ kJ
$u_1 = 2709.9$ kJ/kg
$u_2 = 2659.6$ kJ/kg

Solution

- Energy balance for closed system:

- **(Change in the amount energy contained within a system during some time interval)=(Net amount of energy transferred in across the system boundary by heat transfer during the time interval)-(Net amount of energy transferred out across the system boundary by work during the time interval)**

Solution

- $Heat\ added\ to\ the\ system: 80\ kJ$
- $Change\ in\ internal\ energy = \left((2659.6 - 2709.9)\frac{kJ}{Kg}\right) * 5Kg = \mathbf{-251.5kJ}$
- $Work\ done\ on\ the\ system = \mathbf{-18.5\ kJ}$
- $Work\ done\ by\ the\ steam = ?$
- $-251.5 = 80 - (-18.5 + W)$
- $W = \mathbf{98.5 + 251.5 = 350kJ}$

Problem Statement 2

- A gas expands in a piston-cylinder assembly from $\boldsymbol{p_1 = 8\ bar, V_1 = 0.02\ m^3}$ to $\boldsymbol{p_2 = 2\ bar}$ in a process during which the relation between the pressure and volume is $\boldsymbol{pV^{1.2} = Constant}$. The mass of the gas is **0.25 Kg**. If the specific internal energy of the gas **decreases by 55 kJ/kg** during the process, determine the heat transfer, in kJ. Kinetic and potential energy effects are negligible.

Solution

- $p_1 {V^{1.2}}_1 = p_2 {V^{1.2}}_2,$
- $8 * 0.02^{1.2} = 2 * {V^{1.2}}_2$
- $V_2 = 0.063\, m^3$
- $Work\ done\ by\ expanding\ steam = \int_{V_1}^{V_2} pdV$
- $\int_{0.02}^{0.063} \frac{K}{V^{1.2}} dV = \frac{-K}{0.2} * (\frac{1}{0.063^{0.2}} - \frac{1}{0.02^{0.2}})$
- $K * 2.24 = W, W = (2.24 * 7316.88) = \mathbf{16.3kJ}$
- $K = 8 * 10^5 * 0.02^{1.2} = \mathbf{7316.88}$
- **(1 bar=10^5 pascal)**

Solution

- $-55 * 0.25 = Q - 16.3$
- $\boldsymbol{Q = 2.55\ kJ}$