Answer on Question #72721, Engineering / Mechanical Engineering

A piston cylinder contains gas initially at 3500 kPa with a volume of 0.03 cubic meter. The gas is compressed during a process where pV raise to 1.25 = C to a pressure of 8500 kPa. The heat transfer from the gas is 2.5 kJ. Determine the change in internal energy, neglecting changes in kinetic and potential energies. Graph a PV and TS Plane.

Solution:

The polytropic process is one in which the pressure-volume relation is given as

$$pV^n = constant$$

In our case,

$$pV^{1.25} = constant$$

$$p_1V_1^{1.25} = p_2V_2^{1.25}$$

Thus,

$$V_2 = V_1\left(\frac{p_1}{p_2}\right)^{\frac{1}{1.25}} = 0.03\left(\frac{3500}{8500}\right)^{\frac{1}{1.25}} = 0.01475\ m^3$$

The work done during the polytropic process is found by substituting the pressure volume relation into the boundary work equation. The result is

$$W = \int_1^2 pdV = \frac{p_2V_2 - p_1V_1}{1-n}$$

So,

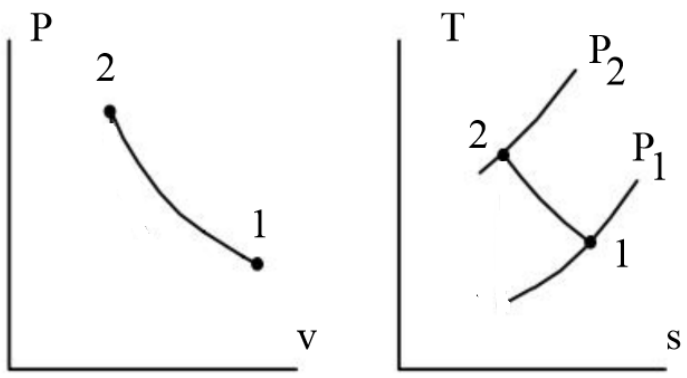
$$W = \frac{8500 \times 10^3 \times 0.01475 - 3500 \times 10^3 \times 0.03}{1 - 1.25} = -81500\ J$$

Then, according to the first law of thermodynamics,

$$\Delta U = Q - W$$

where ΔU is the change in the internal energy of the system and W is work done by the system.

$$\Delta U = -2500 + 81500 = 79000\ J = 79\ kJ$$



Answer: $\Delta U = 79\ kJ$.