Answer on Question #44801-Physics-Molecular Physics-Thermodynamics

A fluid undergoes the following processes:

(i) Heated reversibly at a constant pressure of 1.05 bar until it has a specific volume of 0.1 m3/kg.

(ii) It is then compressed reversibly according to a law pv = constant to a pressure of 4.2 bar.

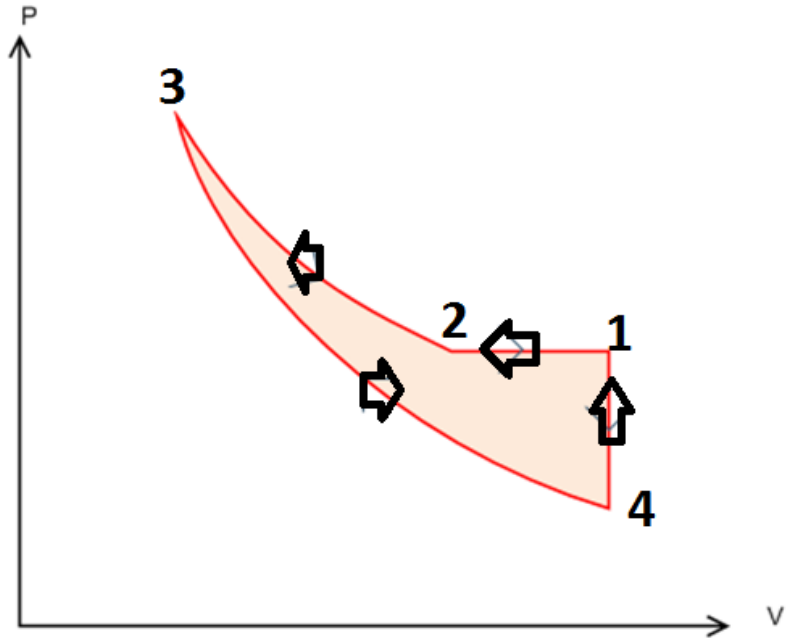
(iii) It is then allowed to expand reversibly according to a law pv1.3 = constant.

(iv) Finally it is heated at constant volume back to initial conditions.

The work done in the constant pressure process is 515 Nm and the mass of fluid present is 0.2 kg.

Calculate the net work done on or by the fluid in the cycle and sketch the cycle on a p-v diagram.

Solution



Let's calculate the net work done on the fluid in the cycle.

1.

$$W_{12} = P(V_1 - V_2) = 515\ \text{J} = 0.515\ \text{kJ}.$$

$$V_1 = \frac{0.515}{105} + 0.1 \cdot 0.2 = 0.02490\ \text{m}^3.$$

2. $P_2V_2 = P_3V_3$.

$$V_3 = \left(\frac{105}{420}\right) 0.1 \cdot 0.2 = 0.005\ m^3.$$

$$W_{23} = P_3V_3 \ln\frac{V_2}{V_3} = 420 \cdot 0.005 \ln\frac{0.02}{0.005} = 2.911\ kJ.$$

3. $P_4 = P_3\left(\frac{V_3}{V_4}\right)^{1.3} = 4.20\left(\frac{0.005}{0.0249}\right)^{1.3} = 0.52\ bar.$

$$W_{34} = \frac{P_3V_3 - P_4V_4}{1 - 1.3} = \frac{420 \cdot 0.005 - 52 \cdot 0.0249}{-0.3} = -2.684kJ.$$

4. $W_{41} = 0.$

   The net work done on the fluid in the cycle:

$$W_{net} = W_{12} + W_{23} + W_{34} + W_{41} = 0.515 \ + 2.911 - 2.684 + 0 = 0.742 \ kJ = 742 \ J.$$