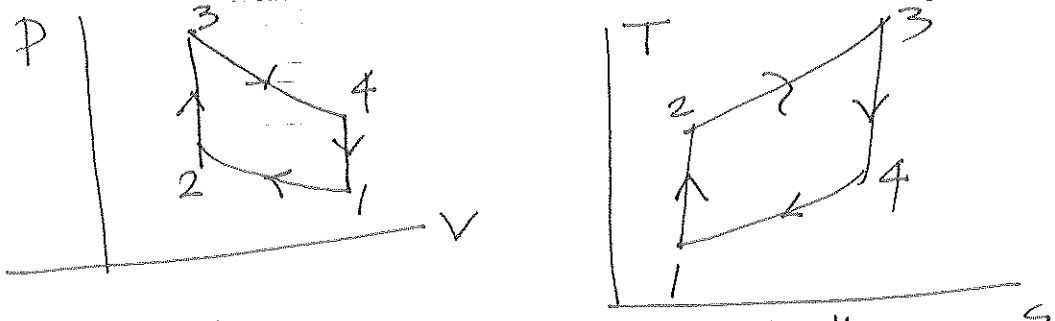
Cankaya University
Faculty of Engineering
Mechanical Engineering Department
Quiz 2
Spring 2017

An engine working on the air standard Otto cycle is supplied with air at 100 kPa,300 K. The compression ratio is 8. The heat supplied is 1400 kJ/kg. Calculate the maximum pressure and the temperature of the cycle, the cycle efficiency and the mean effective pressure.



① $T_1 = 300\,K$, $P_1 = 100\,kPa$ ⟹ $u_1 = 214.07\ kJ/kg$, $v_{r_1} = 621.2$, $P_{r_1} = 1.386$

② $v_{r_2} = v_{r_1}\left(\frac{v_2}{v_1}\right) = \frac{v_{r_1}}{\left(v_1/v_2\right)} = \frac{v_{r_1}}{r} = \frac{621.2}{8} = 77.65$

$T_2 = 673\,K$
$u_2 = 491.22$
$P_{r_2} = 24.89$

$$P_2 = P_1\left(\frac{P_{r_2}}{P_{r_1}}\right) = 100\,kPa\left(\frac{24.89}{1.386}\right) = 1.796\,MPa = 1196\,kPa$$

③ process 2-3:

$W_{23} = 0$

$$\frac{Q_{23}}{m} = u_3 - u_2 \rightarrow u_3 = \frac{Q_{23}}{m} + u_2 = 1400 + 491.22 = 1891.22\ kJ/kg$$

$u_3 = 1891.22$ kJ/kg

max. temperature

$\rightarrow T_3 = 2219.2$ kJ/kg

$v_{r3} = 1.955$

2-3 const. volume; so

$$\left.\begin{matrix} P_3 v_3 = RT_3 \\ P_2 v_2 = RT_2 \end{matrix}\right\} \Rightarrow \frac{P_3}{P_2} = \frac{T_3}{T_2} \Rightarrow P_3 = P_2 (T_3/T_2)$$

$$P_3 = (1.796)(2219.2/673) = 5.92 \text{ MPa}$$

(4) $v_{r4} = v_{r3}(v_4/v_3) = v_{r3}\left(\frac{v_1}{v_2}\right) =$ since $\frac{v_4}{v_3} = \frac{v_1}{v_2}$

recall

$$\left.\begin{matrix} \frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{k-1} \\ \frac{T}{T'} = \left(\frac{v}{v'}\right)^{k-1} \end{matrix}\right\} \Rightarrow \frac{v_1}{v_2} =$$

$v_{r4} = (1.955)(8) = 15.64$

$\rightarrow T_4 = 1170.3$ K

$u_4 = 907$ kJ/kg

$$\frac{W_{cycle}}{m} = \frac{Q_{23}}{m} - Q_{41}/m$$

$$= 1400 \frac{kJ}{kg} - (907 - 214.07) = 707.07 \text{ kJ/kg}$$

$$\eta = \frac{W_{cycle}/m}{Q_{23}/m} = \frac{707.07}{1400} = 0.505$$

50.5%