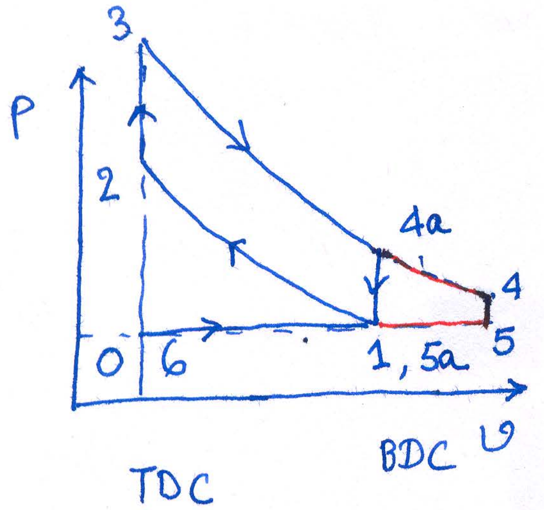
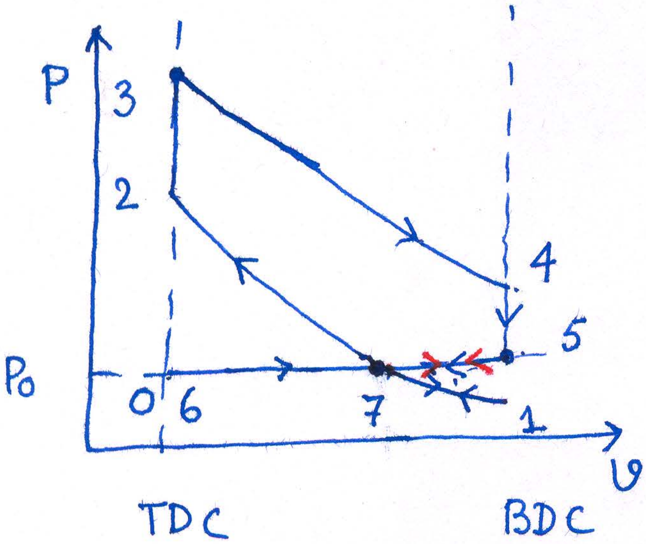



Atkinson Cycle
Over expanded

0-1
1-2
3-4a → 3-4
~~4-5~~
5-6
2-3
4-5 Exhaust Blow Down

$_{3}W_{4}$ ✓

$_{1}W_{2}$ ✓



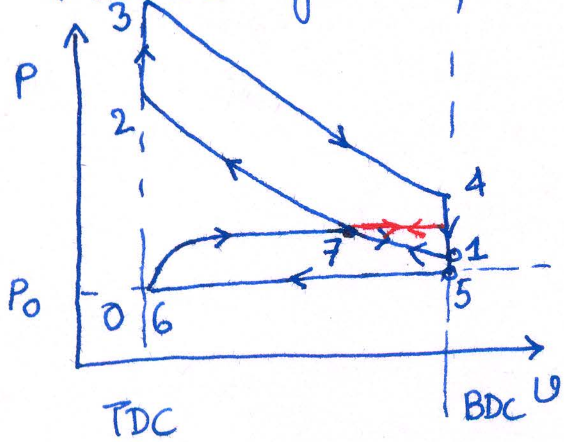

$$r_c = \frac{V_7}{V_2} \approx 8 \qquad \frac{V_4}{V_3} \approx 10$$

0-7-1-7-2-3-4-5-7-6

Unthrottled

## ECS

Miller Cycle




0-7-1-7-2-3-4-5-6

$_{0}W_{7}$

$_{7}W_{2}$

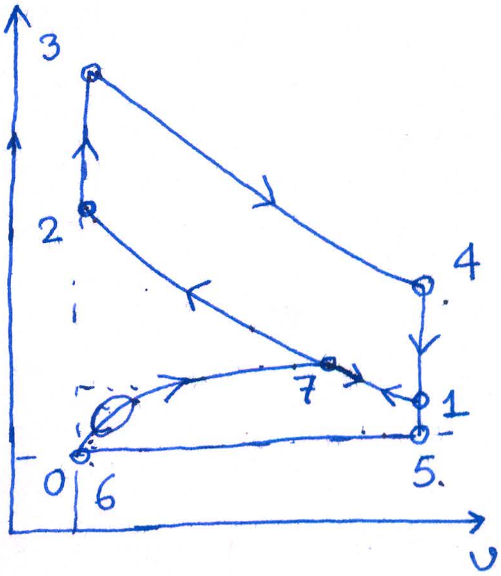
$_{3}W_{4}$

$_{5}W_{6}$

The four-cylinder, 2.5L SI automobile engine is to operate on an air-standard Miller Cycle with early valve closing. It has a compression ratio of 8:1 and an expansion ratio of 10:1. A supercharger is added that gives a cylinder pressure of 160 kPa when the intake valve closes. The temperature is 60°C at this point. The AF ratio is 15 with combustion efficiency $\eta_c = 100\%$. Fuel is isooctane with $Q_{cv} = 44300$ kJ/kg. Exhaust residual is 4% and atmospheric pressure 100 kPa. $\gamma = 1.35$ $R = 0.287$ kJ/kgK.

Calculate:

1. Temperature and pressure at all points in the cycle.
2. Indicated thermal efficiency.
3. " mep.
4. Exhaust temperature.




$$\frac{V_7}{V_2} = 8 \; ; \quad \frac{V_1}{V_2} = 10$$

$$V_s = \frac{2.5}{4} L = 0.625 L$$

$$V_7 = 8 \times V_2$$

$$= 8 \times 0.069 L$$

$$= 0.552 L$$

$$\frac{V_s + V_2}{V_2} = 10$$

$$\frac{V_s}{V_2} + 1 = 10$$

$$\frac{V_s}{V_2} = 9 \Rightarrow V_2 = \frac{V_s}{9} = \frac{0.625}{9} L = 0.069 L$$

$$P_7 V_7 = m_m R T_7$$

$P_7 = 160$ kPa

$V_7 = 0.552 \times 10^{-3}$ $m^3$

$T_7 = 60 + 273 = 333$ K

$R = 0.287$ kJ/kg-K

$$160 \times 0.552 \times 10^{-3} = m_m \times 0.287 \times 333$$

$$m_m = 9.24 \times 10^{-4} \text{ kg}$$

$$\frac{T_2}{T_7} = \left(\frac{V_7}{V_2}\right)^{\gamma-1} = 8^{1.35-1} = 2.07$$

$T_2 = 689.3K$

$$\frac{P_2}{P_7} = \left(\frac{V_7}{V_2}\right)^{\gamma} = 8^{1.35} = 16.56$$

$P_2 = 160 \times 16.56 = 2649.6$ kPa.

Process 2-3 $\quad m_f \times Q_{cv} = m_m \times C_v \times (T_3 - T_2)$

$m_m = m_a + m_f + m_{ex} = 9.24 \times 10^{-4}$

$m_a + m_f = 0.96 \times 9.24 \times 10^{-4}$

$m_f\left(\frac{m_a}{m_f} + 1\right) = 0.96 \times 9.24 \times 10^{-4}$

$m_f (15+1) = 0.96 \times 9.24 \times 10^{-4}$

$m_f = 5.544 \times 10^{-5}$ kg

$Q_{in} = 5.544 \times 10^{-5} \times 44300$ kJ

$= 2.456$ kJ

$C_v = \frac{R}{\gamma - 1} = \frac{0.287}{0.35}$

$= 0.82$

$2.456 = 9.24 \times 10^{-4} \times 0.82 \times (T_3 - 689.3)$

$T_3 - 689.3 = \frac{2658}{0.82} = 3241.5$

$T_3 = \cancel{3347.3\ K}.\ 3930.8$ K

$$\frac{P_3}{P_2} = \frac{T_3}{T_2} = \frac{3930.8}{689.3} = 5.70$$

$P_3 = 15102.7$ kPa

$$\frac{T_4}{T_3} = \left(\frac{V_3}{V_4}\right)^{\gamma-1} = \left(\frac{1}{10}\right)^{0.35} = 0.447$$

$T_4 = 3930.8 \times 0.447 = 1757$ K

$$\frac{P_4}{P_3} = \left(\frac{V_3}{V_4}\right)^{\gamma} = \left(\frac{1}{10}\right)^{1.35} = 0.0447$$

$P_4 = 675$ kPa

$$\frac{T_5}{T_4} = \frac{P_5}{P_4} = \frac{100}{675}$$

$T_5 = 260.3K$

$\underline{\underline{-13^\circ C}}$