SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

16AE201/ Aero Engineering Thermodynamics
Unit -4/ VAPOUR POWER CYCLES

SOLVED PROBLEMS – DUAL CYCLE

The compression ratio o f an air standard dual cycle is 12 and the maximum pressure on the cycle is limited to 70bar. Th e pressure and temperature of the cycle at the b eginning of compression process are 1bar a nd 300K. Calculate the thermal efficiency and M ean Effective Pressure. Assume cylinder bore = 250mm, Stroke length = 300mm, Cp=1.005K J/Kg K, Cv=0.718KJ/Kg K.

Given data:

Assume $Q_{s1} = Q_{s2}$
Compression ratio (r) = 12

Maximum pressure (P_3) = (P_4) = 7000 KN/m_2
Temperature (T_1) = 300 K
Diameter (d) = 0.25m
Stroke length (l) = 0.3m

To find:

Dual cycle efficiency (η_{dual})
Mean Effective Pressure (P_m)

Solution:

$$\frac{T2}{T1} = \left[\frac{V2}{V1}\right]^{\gamma-1}$$

$$= [r]^{\gamma-1}$$

$$T2 = 300[12]^{1.4-1}$$

$$T_2 = 810.58K$$

$$\frac{P2}{P1} = \left[\frac{V1}{V2}\right]^{\gamma}$$

$$P2 = [12]^{14} \times 100$$

$$P_2 = 3242.3KN/m^2$$

By process 2-3:

$$\frac{P2}{T2} = \frac{P3}{T3}$$

$$\frac{P3}{P2} = \frac{T3}{T2}$$

$$T3 = \left[\frac{7000}{3242.3}\right] 810.58$$

$$T_3 = 1750K$$

Assuming $Qs_1 = Qs_2$

$$mCv[T3-T2] = mCp[T4-T3]$$

$$0.718\ [1750-810.58] = 1.005\ [T4-1750$$

$$T_4 = 2421.15K$$

By process 4-5:

$$\frac{T4}{T5} = \left[\frac{V5}{V4}\right]^{\gamma-1}$$

$$= \left[\frac{r}{\rho}\right]^{1.4-1}$$

We know that, $\rho = \frac{V4}{V3} = \frac{T4}{T3} = \frac{2421.15}{1750} = 1.38$

$$\frac{T4}{T5} = \left[\frac{12}{1.38}\right]^{0.4}$$

$$T5 = \frac{2421.15}{\left(\frac{12}{1.38}\right)^{0.4}}$$

$$T5 = 1019.3K$$

Heat supplied $Q_s = 2 \times m\, C_v \times [T3 - T2]$

$= 2 \times 1 \times 0.718 \times [1750 - 810.58]$

$Q_s = 1349 KJ/Kg$

Heat rejected $Q_r = m\, C_v\, [T5 - T1]$

Q_r

$= 516.45$ KJ/Kg

$\eta_{dual} = \frac{Q_s - Q_r}{Q_s} = \frac{832.55}{1349} \times 100$

$\eta_{dual} = 61.72\%$

Stroke volume $(V_s) = \frac{\pi}{4} \times d^2 \times l$

$= \frac{\pi}{4} \times 0.25^2 \times 0.3$

$V_s = 0.0147 m^3$

Mean Effective Pressure (P_m) $= W / V_s$

$= 832.58/0.0147$

$P_m = 56535$ KN/m^2