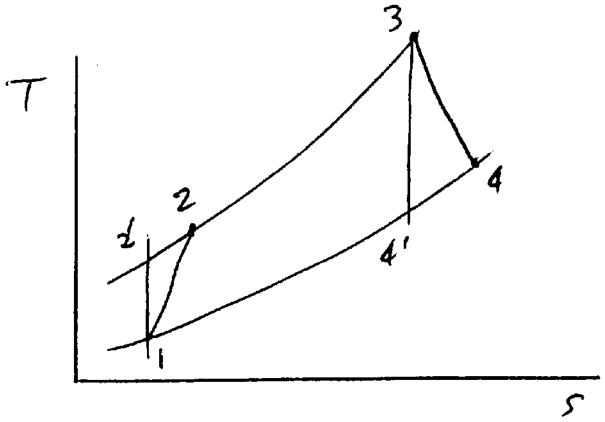
Qu. 7



$\frac{p_2}{p_1} = 6$

$T_1 = 290\ K$

$T_3 = 1070\ K$

NB: $\gamma = \frac{c_p}{c_p - R}$

$\frac{T_{2'}}{T_1} = r_p^{\frac{\gamma-1}{\gamma}} \quad \therefore T_{2'} = 290 \times 6^{\frac{1.395-1}{1.395}} = 481.8\ K \quad \left[\gamma_a = \frac{1013}{1013-287} = 1.395\ (6)\right]$

$\frac{T_{2'}-T_1}{T_2-T_1} = 0.87 \quad \therefore \frac{481.8-290}{T_2-290} = 0.87$ whence $\underline{T_2 = 510.5\ K}$

$\frac{T_3}{T_{4'}} = r_p^{\frac{\gamma-1}{\gamma}} \quad \therefore T_{4'} = \frac{1070}{6^{\frac{1.334-1}{1.334}}} = \underline{682.9\ K} \quad \left[\gamma_g = \frac{1145}{1145-287} = 1.334\ (3)\right]$

$\frac{T_3-T_4}{T_3-T_{4'}} = 0.87 \quad \frac{1070-T_4}{1070-682.9} = 0.87$ whence $\underline{T_4 = 733.2\ K}$

Net output power $= \eta_{mech}$ (Turbine Power − Compressor Power)

$\dot{W} = \eta_{mech}\, \dot{m} \left[c_{pg}(T_3 - T_4) - c_{pa}(T_2 - T_1) \right]$

or $w = 0.99\left[1145(1070-733.2) - 1013(510.5-290)\right]$

$= 160\ 647\ J/kg$

or $\underline{\underline{w = 160.6\ kJ/kg}}$

$\eta_{th} = \frac{w}{c_p(T_3 - T_2)}$

$= \frac{160\ 647}{1126\ (1070 - 510.5)}$

$= \underline{\underline{0.255 \text{ or } 25.5\%}}$