

ASSIGNMENT: THE STEAM PLANT AND BOILER EFFICIENCY

Q1. In a Rankine cycle, the steam at the inlet to the turbine is saturated at a pressure of 30 bars and the exhaust pressure is 0.26 bars. Assuming a flow rate of 10kg/s determine the:

- (i) Pump work
- (ii) Turbine Power
- (iii) Rankine efficiency
- (iv) Condenser heat flow
- (v) Dryness at the end of expansion

Q2. Dry and saturated steam enters and leaves a steam engine at 12 bar and 0.1 bar respectively. The steam consumption of the engine is 24 tonnes per shift of 8 hours while developing 236kW. Estimate the Rankine efficiency and Thermal efficiency of the engine.

Q3. Superheated steam having a degree of superheat of 118°C and a pressure of 19 bar is supplied to a steam turbine. If the exhaust pressure is 0.08 bar and the expansion of the steam takes place isentropically, calculate:

- (i) The Heat Supplied
- (ii) The Heat Rejected
- (iii) Net Work Done
- (iv) Thermal Efficiency
- (v) Specific steam consumption

Take: C_p for superheated steam = 2.0934 kJ/kgK

Q4. A surface condenser is designed to handle 10,000 kg of steam per hour. The steam enters at 0.08 bar and 0.9 dryness and the condensate leaves at the corresponding saturation temperature. If the pressure is constant throughout the condenser and the cooling water temperature rise is limited to 10°C, estimate the cooling water flow rate per hour.

Q5. The cooling tower in a power plant consists of ten big fans. The quantity of cooling water circulated through the tower is 1000kg/min and it is cooled from 35°C DBT and 25°C WBT. The air leaves the tower at 30°C and 90% R.H. Find:

- (i) The quantity of air handled per fan per minute.
- (ii) The quantity of make-up water per hour neglecting the loss due to carry over and heat losses.

Q6. A small size cooling tower is designed to cool 400kg of water per minute. The water enters the tower at 43.5°C. The air enters the tower at 18.5°C and 60% R.H. and leaves the tower at 27°C and in saturated condition. The motor driven fan forces 600m³ of air per minute through the tower while using 4kW of power. Determine:

- (i) Temperature of the water coming out of the tower.
- (ii) Make-up water required per hour

Q7. A boiler delivers 4600kg steam/hr at a pressure of 0.8 kN/m² with a dryness fraction of 0.96. The temperature of the feed water into the boiler is 45.8°C. If the coal used for firing the boiler has a calorific value of 32,000 kJ/kg and is used at a rate of 650kg/hr, determine:

- (i) The thermal efficiency of the boiler
- (ii) Equivalent evaporation of the boiler in kg/coal
- (iii) The new coal consumption in kg/hr and hence the saving in coal in kg, obtained by fitting an economiser which raises the feed water temperature to 100°C and helps to increase the thermal efficiency by 6%, all other conditions remaining the same.

Submit Q3 and Q6 as Assignment