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Second Semester M.Tech. Degree Examination, June/July 2014
Advanced Power Plant Cycle

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer any FIVE full questions.
2. Use of thermodynamic data hand book and steam tables with Mollier chart permitted.

1.
 - a. Discuss the effect of reducing the condenser pressure on thermal efficiency of power plant. (04 Marks)
 - b. What do you mean by thermodynamic mean temperature? Discuss the effect of mean temperature on the thermal efficiency. (06 Marks)
 - c. In a steam power plant feed water enters at 140°C and leaves as dry saturated liquid from an economizer. Steam leaves the boiler drum as 0.98 dry at 60 bar and exits super heater at 450°C. A coal with a calorific value of 25.2 MJ/kg, with the rate of evaporation of steam as 8.5 kg/kg of coal with an air fuel ratio as 15:1 by mass. Neglecting all the losses estimate the heat transfer/kg of fuel in each component and efficiency of the steam generator. Also calculate the percentage of total heat absorption in economizer, boiler and super heater. Take $C_p = 1.005 \text{ kJ/kg K}$ for air and $C_p = 4.2 \text{ kJ/kg K}$ for water. (10 Marks)

2.
 - a. What are the desirable characteristics of ideal working fluid of a vapour power cycle? (04 Marks)
 - b. With the help of schematic and T-S diagram, explain the working of a gas turbine-steam turbine power plant. (04 Marks)
 - c. In a cogeneration binary cycle, superheated steam enters the turbine with mass flow rate of 5kg/s at 40 bar, 440°C and expands isentropically to 1.5 bar. Half of the flow is extracted at 1.5 bar and used for industrial purpose heating. The remaining steam passes through a heat exchanger which serves as the boiler of refrigerant -12 cycle and condenser for steam cycle. The condensate leaves the heat exchanger as saturated liquid at 1 bar where it is combined with the return flow from the industrial purpose (process) at 60°C and 1 bar before being pumped isentropically to the steam generator. The refrigerant - 12 cycle and saturated liquid leaving the condenser at 9 bar. Determine: i) The rate of heat transfer in the steam generator; ii) The net power output of the binary cycle; iii) Rate of heat transfer to the industrial purpose (process). (12 Marks)

3.
 - a. What are the properties of coal used in power plants? (07 Marks)
 - b. With the help of schematic explain the underground coal gasification. (06 Marks)
 - c. Propane gas is reacted with air to give the dry products of combustion of CO₂ 11.5%, O₂ 2.7% and CO 0.7%. What is the percentage of excess air used? (07 Marks)

4.
 - a. With the help of sketches explain the concentration of gases near the burning surface for moderate and high temperature. (08 Marks)
 - b. With the help of neat sketch explain circulating fluidized bed combustion. (12 Marks)

- 5 a. Write a note on modern water tube boiler with the help of sketches. (10 Marks)
b. A spray type de super heater is supplied with water at 60°C. It is connected to steam line carrying 200 t/h of the steam @ 3.5 bar. Calculate the amount of water that must be sprayed per hour to maintain steam at 400°C, when the boiler load causes steam to leave at 450°C. (10 Marks)
- 6 a. With the help of T-S diagram, explain whether the condenser pressure can reach absolute zero pressure, if not why? (06 Marks)
b. With the help of a neat sketch, explain the working of a wet cooling tower. (08 Marks)
c. Steam enters the condenser at 35°C. The condenser vacuum is 70cm of mercury when the barometer reads 755mm of Hg. Determine the vacuum efficiency. Estimate the mass of air present in the condenser per kg of steam. (06 Marks)
- 7 a. What do you understand by Neutron life cycle? Show the events of nuclear fission neutrons for U-235. (06 Marks)
b. With the help of schematic explain boiling water reactor? (08 Marks)
c. A reactor is operating at a low power of 1W. If then becomes supercritical with $k_{eff} = 1.0015$. The average neutron life is 0.0001s for prompt neutrons. Determine the reactor power level at the end of 1s. (06 Marks)
- 8 a. What are advantages of water power plants? (06 Marks)
b. Discuss the essential element of hydroelectric power plant. (06 Marks)
c. A Pelton wheel has to be designed for the following specifications. Power to be developed = 6000 kW. Net head available = 300m. Speed = 550 rpm. Ratio of jet to wheel diameter = 1/10. Hydraulic efficiency = 85% Coefficient of velocity $C_r = 0.98$ and speed ratio is 0.46. Find: i) Number of jets; ii) Diameter of the each jet; iii) Wheel diameter; iv) Quantity of water required. (08 Marks)

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