



Using of steam tables and steam chart are allowed (يسمح باستخدام جداول وخريطة البخار)

Answer the following questions:

Question No. 1: (25 Marks)

- A. Discuss the different methods which are used to improve Rankine cycle efficiency (show on T-S diagram).
- B. List the characteristics of a working fluid most suitable for vapor power cycles.
- C. Consider a steam power plant that operates on an ideal reheat–regenerative Rankine cycle with one open feedwater heater, one closed feedwater heater, and one reheater. Steam enters the turbine at 15 MPa and 600°C and is condensed in the condenser at a pressure of 10 kPa. Some steam is extracted from the turbine at 4 MPa for the closed feedwater heater, and the remaining steam is reheated at the same pressure to 600°C. The extracted steam is completely condensed in the heater and is pumped to 15 MPa before it mixes with the feedwater at the same pressure. Steam for the open feedwater heater is extracted from the low-pressure turbine at a pressure of 0.5 MPa. Determine the fractions of steam extracted from the turbine as well as the thermal efficiency of the cycle.

Question No. 2: (20 Marks)

- A. Compare between water tube boiler and fire tube boiler, with drawing.
- B. What are the purposes of conducting trial on a boiler? and what is the boiler trial measurements?
- C. During a boiler trial, the following data were recorded:

Temperature of feed water	50 °C
Mass of feed water	650 kg/h
Steam pressure	15 bar
Fuel used	55 kg/h
HHV of fuel	44100 kJ/kg
Temperature of flue gasses	300 °C
Room temperature	30 °C
Heating surface of the boiler	19 m ²
Ultimate analysis of dry coal	C = 85%, H ₂ = 13%, Ash = 2%
The volumetric analysis of dry flue gasses	CO ₂ = 12.5%, O ₂ = 4.5%, N ₂ = 83%
C _p (dry flue gases)	1.09 kJ/kg C



Find: (1) The equivalent evaporation per 1 kg of fuel and also per m² of heating surface area per hour.

(2) Efficiency of the boiler.

(3) Draw up the heat balance sheet on the basis of 1 kg of coal fired.

Question No. 3: (30 Marks)

A. What are the advantages of the condenser in a steam power plant? **Draw** and name the elements of a steam condensing plant.

B. Compare between surface condenser and jet condenser with net sketch.

C. A steam turbine of 18000 kW capacity requires 5 kg of steam per hour per kW. The quantity of air leakage into the condenser is 1 kg per 1000 kg of steam used by the turbine. The vacuum in the condenser is 70 cm of Hg where the barometer reads 76 cm of Hg. The temperature at the suction of the air pump is 30 °C. **Find:**

(1) The capacity of the air pump required per minute.

(2) The mass of water vapour carried by air in kg per hour.

(3) The quantity of cooling water required per minute in kg if the rise in temperature of the water is limited to 8 C. the quality of steam entering the condenser is 0.9 dry and there is no under-cooling in the condenser.

D. Steam at 12 bar & 2910 kJ/kg is expanded in a convergent divergent nozzle to a back pressure of 1 bar. At the throat the steam is at 6.6 bar & 2785 kJ/kg and exit with specific enthalpy of 2505 kJ/kg. **Determine** the necessary throat and exit dimension of the nozzle if the mass flow rate of steam is 600 kg/h.

All the best,
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