Code : 021512

B.Tech 5th Semester Special Exam., 2020

STEAM POWER SYSTEM

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

(iv) Use of Steam Table and Mollier Chart is permissible in the examination.

1. Choose the correct/best answer from the following (any *seven*) : 2×7=14

(a) Which of the following is a boiler mounting?

(i) Feed pump

(ii) Water level gauge

(iii) Economizer

(iv) Superheater

(b) Draught produced by chimney is described as

(i) induced draught

(ii) natural draught

(iii) forced draught

(iv) balanced draught

(c) The impurities are removed from boiler with the help of

(i) safety pump

(ii) stop valve

(iii) blowoff cock

(iv) fusible plug

(d) Which of the following is not true for steam nozzles?

(i) In convergent nozzle, there is divergent after throat

(ii) Convergent-divergent nozzle has higher expansion ratio

(iii) Convergent-divergent nozzle produces steam at higher velocities as compared to a convergent nozzle

(iv) All of the above

(e) In reaction turbines, the axial thrust is due to

(i) pressure drop across the rotor

(ii) change in axial velocity

(iii) Both (i) and (ii)

(iv) None of the above

(f) In pressure velocity compounding

(i) moving blades are used

(ii) fixed nozzles are used

(iii) fixed blades are used

(iv) All of the above

(g) The critical pressure ratio of a convergent nozzle is defined as the ratio of

(i) outlet pressure to inlet pressure of nozzle

(ii) inlet pressure to outlet pressure of nozzle

(iii) outlet pressure to inlet pressure only when mass flow rate is c

(iv) outlet pressure to inlet pressure only when mass flow rate per unit area is minimum

(h) Reheat factor in steam turbines depends on

(i) exit pressure only

(ii) stage efficiency only

(iii) initial pressures and temperature only

(iv) All of the above

(i) Which of the following components on the boiler is used to recover the waste heat of the flue gases for heating feed water?

(i) Preheater

(ii) Superheater

(iii) Fusible plug

(iv) Economizer

(j) The function of which of the following fittings is to extinguish boiler furnace fire in case of water level falling below safe level?

(i) Fusible plug

(ii) Safety valve

(iii) Blowoff cock

(iv) Feed check valve

2. *(a)* What do you mean by reheating of steam? Is it essential to reheat at optimum pressure? Justify the answer. 6

(b) What are the functions of preheaters, economizers and superheaters? Where is reheater located? Draw a schematic diagram also. 8

3. *(a)* Why is there a need of makeup feed water treatment? Describe the treatment of feed water in brief. 6

(b) Calculate inlet, throat and exit diameters of a convergent-divergent nozzle for the following data : 8

Initial steam pressure = 15 bar

Initial steam temperature = 350 °C

Final steam pressure = 1·5 bar

Quantity of steam = 2 kg/s

Initial steam velocity = 20 m/s

4. *(a)* What is circulation? Differentiate between natural and forced circulation boiler. 6

(b) In a stage of an impulse-reaction turbine operating with half-degree reaction, the fixed and moving blades are of identical section and the outlet

angle is 18°. The absolute velocity of discharge from the moving blades is 40 m/s in a direction 110° to the direction of motion of blades, and the change of velocity produced by the moving blades is parallel to that direction. Draw the velocity diagram and find *(i)* mean velocity of blades and *(ii)* ratio of blade velocity to the velocity of efflux from the fixed blades. 8

5. *(a)* Discuss the effects of friction on the performance of nozzles. Show these effects in T-s and h-s diagrams. 6

(b) The discs of 85 cm mean diameters, in the high pressure cylinder of a two-cylinder steam turbine of 40000 kW output, rotate at the speed of 1600 r.p.m. Estimate the disc friction power in the first stage for the steam conditions : 8

Steam pressure = 28 bar

Steam superheat = 180 °C

Steam specific volume = 0·11 m^3/kg

6. *(a)* Differentiate between impulse and reaction turbine. Show the pressure and velocity distribution. 6

(b) The following data is related to a single-pass surface condenser :

Specific steam consumption = 3·8 kg/K-Wh
Plant output = 120
Quality of steam at the turbine exhaust = 0·88
Pressure in the condenser = 0·05 bar
Temperature of inlet circulating water = 25 °C
Temperature of outlet circulating water = 33 °C
Velocity of circulating water = 1·8 m/s
Tube outside diameter = 25 mm
Tube thickness = 1·25 mm
Overall heat transfer coefficient = 3000 W/m^2-K

By drawing the system and showing the process on T-s diagram, calculate—

(i) the volume flow rate of circulating water required;

(ii) heat transfer surface area;

(iii) the length of tubes;

(iv) the number of tubes. 8

7. (a) What are the functions of condenser in steam power plant? Classify condensers. 6

(b) The steam velocity at inlet to the first stage of a turbine having two-row velocity compounded impulse wheel is 600 m/s and the mean blade velocity is 120 m/s. The nozzle angle is 16° and the exit angles for the first row of moving blades, the fixed blades, and the second row of moving blades are 18°, 21° and 35° respectively. Find the blade inlet angles for each row. Find also for each row of moving blades, the driving force and the axial thrust on the wheel for a mass flow rate of 1 kg/s of steam. Find the diagram efficiency for the wheel and the diagram power. What is the maximum possible diagram efficiency for a given inlet velocity and nozzle angle? Take $K = 0·9$ for all blades. 8

8. (a) What are the advantages of induced and forced draught cooling tower? Which are preferred under what conditions? 6

(b) A steam generator comprises of evaporator (boiler), superheater, economizer and air preheater. The feed water enters the economizer at 40 °C. Air enters the preheater at 30 °C and leaves at 150 °C. The steam is generated in the steam drum at 100 bar,

0·99 dry and leaves the super-heater at 500 °C. The fuel used is oil, having calorific value 42 MJ/kg. The evaporation rate is 10 kg steam per kg of fuel and the air-fuel ratio is 20 : 1 by mass. Neglecting heat losses and pressure drops, calculate the heat transfer per kg of fuel in each component and steam generator plant efficiency. 8

9. (a) Discuss the advantages and disadvantages of reheating in steam power plants. Discuss the necessity of adopting reheat cycle with high steam pressure. 6

(b) The isentropic heat drop in given stage of a multi-stage impulse turbine is 33·5 kJ/kg of steam. The nozzle outlet angle is 20°. The efficiency of the nozzle, defined as the ratio of the actual gain in kinetic energy in the nozzle to the adiabatic (isentropic) heat drop is 90 percent. The mean diameter of the blade is 95·5 cm and the revolution per minute is 3000. The carryover factor is 0·88. Blades are equiangular with a velocity coefficient of 0·87. Calculate the steam velocity at the outlet of the nozzle, blade angles and gross stage efficiency. 8

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