(c) Why are downcomers fewer in number and bigger in diameter while risers are more in number and smaller in diameter?

(d) What are boiler mountings and accessories? Give at least three examples for each with their function. 4+3+3+4=14

8. (a) Steam which is initially dry and saturated at an absolute temperature T_1 expands in a turbine to an absolute temperature T_2, the stage efficiency being η_s. Assuming a very large number of stages and that the condition curve on the T-s chart is a straight line, show that the reheat factor,

$$RF = \frac{T_1 + T_2}{2T_2 + \eta_s(T_1 - T_2)}$$

(b) What are the chief methods of steam turbine governing? Why is nozzle control governing not employed in reaction turbine? 10+4=14

9. Write short notes on the following : 5+5+4=14

(a) Pulverized coal firing system

(b) Steam temperature control

(c) Cooling towers or draught (or draft) system

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B.Tech 5th Semester Exam., 2018

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.*

1. Choose the correct alternative from any *seven* of the following : 2×7=14

(a) The state of a wet vapour can be completely specified by its

(i) pressure

(ii) temperature

(iii) pressure and dryness fraction

(iv) pressure and temperature

(b) At critical point, the enthalpy of vaporization is

(i) zero

(ii) dependent on temperature only

(iii) maximum

(iv) minimum

(c) Saturated liquid at a high pressure p_1 having enthalpy of saturated liquid 1000 kJ/kg is throttled to a lower pressure p_2. At pressure p_2, the enthalpy of saturated liquid and that of saturated vapour is 800 kJ/kg and 2800 kJ/kg respectively. The dryness fraction of the vapour after throttling process is

(i) 18/28

(ii) 0·85

(iii) 0·1

(iv) 0·66

(d) Which of the following equipments is a boiler accessory?

(i) Stop valve

(ii) Feed-water pump

(iii) Fusible plug

(iv) Blow of cock

(e) When steam flows over moving blades of an impulse turbine

(i) pressure drops and velocity increases

(ii) pressure remains constant and velocity decreases

(iii) both pressure and velocity remain constant

(iv) both pressure and velocity decreases

(f) In a simple impulse turbine, the nozzle angle at entrance is 30°. For maximum diagram efficiency, the blade speed ratio is

(i) 0·259

(ii) 0·75

(iii) 0·5

(iv) 0·433

(g) Deaeration of feed water is done to reduce

(i) necessity of priming in feed pumps

(ii) mass of water to be handled

(iii) corrosion caused by dissolved oxygen

(iv) amount of heat required to convert water into steam

(h) Efficiency of a nozzle governed turbine is affected mainly by losses due to

(i) partial admission

(ii) throttling

(iii) inter-stage pressure drop

(iv) condensation in last stages

(i) In a single-stage impulse turbine, the maximum blading efficiency is obtained when

(i) $\rho = \cos\alpha$

(ii) $\rho = \cos^2\alpha$

(iii) $\rho = \frac{\cos\alpha}{2}$

(iv) $\rho = \frac{1+\cos\alpha}{2}$

when α is the nozzle angle and ρ is the blade speed ratio.

(j) The inlet and outlet temperatures of cooling water being supplied to a condenser are 30 °C and 40 °C respectively. If 51 °C is the saturation temperature corresponding to condenser pressure, the condenser efficiency will be

(i) 0·9

(ii) 0·47

(iii) 0·19

(iv) 0·68

2. (a) What are the different ideal processes of a vapour power cycle? Draw the *T*-*s* and *h*-*s* diagram of Rankine cycle.

(b) A steam turbine receives steam at pressure 20 bar and superheated by 88·6 °C (degree of superheat). The exhaust pressure is 0·07 bar and expansion of steam takes place isentropically. Using steam table only, calculate the following :

(i) Heat supplied, assume that the feed pump supplies water to the boiler at 20 bar

(ii) Heat rejected

(iii) Work done by the turbine

(iv) Net work done

(v) Thermal efficiency

(vi) Theoretical steam consumption in kg/kWh 6+8=14

3. (a) Name the different methods by which the mean temperature of heat addition can be increased. Why is the ideal regenerative cycle not practicable?

(b) A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550 °C expands through the high pressure turbine.

It is reheated at a constant pressure of 40 bar to 550 °C and expands through the low pressure turbine to a condenser at 0·1 bar. Draw *T-s* and *h-s* diagrams showing the pressure and temperature. Find *(i)* quality of steam; *(ii)* cycle efficiency; *(iii)* steam rate in kg/kWh. 6+8=14

4. *(a)* What do you mean by critical pressure ratio? Show that the mass flow rate per unit area in a nozzle flow can be represented as

$$\frac{\dot{m}}{A_2} = \sqrt{\left(2\frac{n}{n-1}\frac{p_1}{v_1}\left[\left(\frac{p_2}{p_1}\right)^{2/n} - \left(\frac{p_2}{p_1}\right)^{(n+1)/n}\right]\right)}$$

where p and v denote the pressure and specific volume and n denotes polytropic index.

(b) Steam expands in a set of nozzles from 10 bar, 300 °C to 1 bar. The convergent parts of the nozzles are sharp and frictionless. In the divergent parts, the friction loss may be taken as 0·15 of the isentropic enthalpy drop. If the steam flow rate is 1 kg/s and the initial velocity of steam is negligible, find the minimum area of the nozzles. 8+6=14

5. *(a)* Why are steam turbines compounded? What are the different methods of compounding?

(b) Show that the diagram work per unit mass of steam for maximum blading efficiency of a 50% reaction stage is u^2, where u is the mean blade velocity. 4+10=14

6. *(a)* What is the difference between impulse and reaction turbine?

(b) Explain the state point locus of an impulse turbine with the help of an *h-s* diagram.

(c) Steam issues from the nozzles of a de Laval turbine with a velocity of 1200 m/s. The nozzle angle is 20°, the mean blade velocity is 400 m/s, and the inlet and outlet angles of blade are equal. The mass of steam flowing through turbine per hour is 900 kg. Calculate *(i)* the blade angles, *(ii)* the relative velocity of steam entering the blades, *(iii)* the tangential force on the blades, *(iv)* the power developed and *(v)* the blade efficiency. Assume that blade velocity coefficient (K) = 0·8. 4+4+6=14

7. *(a)* Explain in detail, what will be the variation in exit steam temperature with the increase in load in convective and radiant superheater.

(b) What are the functions of the steam drum in a water tube boiler?