

B.E. (ME) Part-III 6th Semester Examinations, 2014

Boiler and Steam Turbine

Branch: Mech. Engg.

Paper Code: ME-602

Time: 3 hrs.

Full Marks: 70

SECOND HALF

Attempt ANY THREE from this half. Use of steam table and Mollier diagram allowed.

1. (a) Deduce the expression for velocity of whirl for a simple impulse turbine stage, assuming symmetric blades and considering a blade friction factor (K_b). From the same get the expression for diagram efficiency.

(b) For a single-stage simple impulse turbine, the mean blade speed is 128 m/s and the nozzle exit velocity of steam is 300 m/s. If the nozzle angle is 20° determine the diagram work and the diagram efficiency neglecting blade friction loss. Assume symmetrical blade angles. [5 + 6]

2. (a) Differentiate between Curtis and Rateau stages in multi-stage impulse turbines. Show that for a three-row Curtis staging with final axial exit, the ratio of diagram works for the first, second and third stages is 5:3:1. Justify why Curtis rows are not usually used beyond two stages.

(b) Define 'Degree of Reaction' for an impulse reaction turbine. For a 50% reaction turbine, the mean blade speed is 100 m/s and the blade speed ratio is 0.56. The nozzle angle is 20° . Find the enthalpy drop in the moving blades and the stage specific work. Assume that the moving and fixed blades have same shape and size. [5 + 6]

3. (a) Briefly describe the internal losses that occur in a steam turbine

(b) Define 'Reheat Factor' for a multistage steam turbine. Explain the same using condition line on a T-s plot. If the Reheat Factor for a multistage steam turbine is 1.06 and the stage efficiency is 86% estimate the internal efficiency of the turbine. [6 + 5]

4. (a) Differentiate between jet condenser and surface condenser. Draw the temperature profiles for condensing steam and cooling water in a surface condenser and define TTD for the same. What is an evaporative condenser?

(b) How does air leakage into the condenser affect its thermal performance? How is the vacuum efficiency defined for a surface condenser? [6 + 5]

FIRST HALF

(Attempt any three questions from this half)

1 (a) Classify draught system of boiler. Deduce the expression of the condition for maximum discharge through its chimney.

(b) A chimney of a boiler is having height of 72 m. If the average temperature of flue gas inside the chimney is 340°C and the minimum temperature of flue gas in chimney for artificial draught system is 122°C , estimate (i) draught produced in N/m^2 , (ii) equivalent height of hot flue gas in meter, (iii) gas temperature at maximum discharge condition, and (iv) efficiency of chimney. The ambient pressure and temperature are 1.013 bar and 28°C . Air-fuel ratio is 12:1. C_p of gases is $1.006 \text{ kJ/kg}\cdot\text{K}$.

2 (a) Draw the flow and T-s diagrams of an ideal regenerative cycle with two open type feed water heaters. Also write the energy balance equations of the said two heaters.

(b) In an ideal reheat regenerative cycle, the steam expands in the high pressure turbine at 100 bar, 520°C . At the exhaust of the said turbine, the condition of steam is dry saturated. It is then reheated to 520°C at constant pressure. After reheating it expands in low pressure turbine to 0.05 bar. A close type heater with cascading arrangement is used as feed water heater at 5 bar. Calculate (i) cycle efficiency, (ii) specific steam consumption, and (iii) heat rate. Use Molier chart and steam table.

3 (a) In case of an economizer, write the full expression used for the computation of its overall heat transfer coefficient. Mention each term of the expression and the relevant physical meaning of the term.

(b) A natural circulation boiler is having height of 18 m. The inner diameter of riser tube is 50 mm. If the riser receives saturated water at 105 bar and velocity of 1.2 m/s, calculate (i) the pressure head developed, (ii) void fraction, (iii) heat absorption rate and (iv) number of riser tubes. Assume that the circulation ratio and slip ratio of the said boiler are 10 and 1.4 respectively and it produces steam at 122 kg/s

4. Write short notes on any three of the following:-

- (a) Reheat cycle
- (b) Balanced draught system
- (c) Radiant superheater
- (d) Air preheater