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B.Tech. (Sem. - 3rd)

APPLIED THERMODYNAMICS - I

SUBJECT CODE : ME - 209

Paper ID : [A0805]

[Note : Please fill subject code and paper ID on OMR]

Time : 03 Hours Maximum Marks : 60

Instruction to Candidates:

1) Section - A is **Compulsory**.
2) Attempt any **Four** questions from Section - B.
3) Attempt any **Two** questions from Section - C.

Section - A

(10 × 2 = 20)

a) Show the critical point and triple point on any property diagram and define them.

b) Differentiate between LCV and HCV.

c) What is a fusible plug? Why it is used?

d) What are once through boilers? How they differ from drum boilers?

e) How is degree of reaction defined? What is a 50% reaction turbine?

f) Why does the effectiveness of a Curtis stage decrease as the number of rows of moving blades increases?

g) What do you understand by 'critical pressure ratio' and 'choked flow'.

h) What do you understand by throttle governing and nozzle governing?

i) Explain the effect of regeneration on steam cycle output and efficiency.

j) When is multi-stage compression used for air? What are its advantages?

Section - B

(4 × 5 = 2

Q2) The following readings were taken during a test on a surface condens
Mean condenser temperature = 35°C, hot well temperature = 30°C, condens
vacuum = 69 cm Hg, barometer reading = 76 cm Hg, condensa
collected = 16 kg/min. Cooling water enters at 20°C and leaves at 32.5°
flow rate being 37,500 kg/h. Calculate.

(a) Mass of air present per cubic metre of condenser.

(b) Quality of steam at condenser inlet.

(c) Vacuum efficiency and.

(d) condenser efficiency.

Q3) With the help of neat sketch discuss the working of Babcock and Wilc
boiler. List the advantages of water tube boiler over fire tube boiler.

Q4) The composition of coal on gravimetric analysis is given below.
C = 65%, H_2 = 5%, O_2 = 5%, Moisture = 17%, remaining is ash conter
The composition of flue gas on the basis of volume is given as follows;
CO_2 = 15%, CO = 0.28%, O_2 = 10%, rest is N_2.
Calculate the minimum air required to burn 1kg of fuel, mass of air actual
supplied per kg of fuel.

Q5) Calculate the throat and exit diameters of a convergent -divergent nozz
which will discharge 820 kg of steam per hour from a pressure of 8 b
superheated to 220°C into a chamber having a pressure of 1.05 bar. Frictio
loss in the diverging part of the nozzle may be taken as 0.15 of the tot
isentropic enthalpy drop.

Q6) The equivalent evaporation of a boiler is found to be 22500 kg/h. Steam
produced at 20 bar pressure and 250°C. The feed water temperature is 36°C
1850 kg of coal/h having a calorific value of 30,000 kJ/kg is utilized. Estimat
actual evaporation of the boiler in kg/h and efficiency.

Section - C

(2 × 10 = 20

Q7) In a reheat cycle steam at 550°C expands in an HP turbine till it become
saturated vapour. It is reheated at constant pressure to 400°C and the
expands in a L.P. turbine to 40°C. If the moisture content at turbine exhaus
is given to be 14.67%. Find out.

(a) The reheat pressure

(b) The pressure of steam at inlet to the h.p. turbine

(c) The net work output/kg and

(d) The cycle efficiency. Assume all process to be ideal.

5 m^3 of free air per minute at 1.01 bar and 18°C is compressed by a single stage double acting compressor to 8 bar. Speed = 300 rpm. Pressure and temperature of air at the end of suction stroke are 0.98 bar and 30°C. L/D = 1.2. Clearance ratio is 0.04. Estimate the power required to operate the compressor, volumetric efficiency and cylinder diameter. Assume η_m = 88%, index of compression = 1.3.

The velocity of steam entering a simple impulse turbine is 1000 m/s, and the nozzle angle is 20°. The mean peripheral velocity of blades is 400 m/s and the blades are symmetrical. If the steam is to enter the blades without shock, what will be the blade angles?

(a) Neglecting the friction effects on the blades, calculate the tangential force on the blades and the diagram power for a mass flow of 0.75 kg/s. estimate also axial thrust and diagram efficiency.

(b) If the relative velocity at exit is reduced by friction to 80% of that at inlet, estimate the axial thrust, diagram power and diagram efficiency.

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