BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) FIFTH YEAR SECOND SEMESTER - 2024

STEAM GENERATORS

Time: 3 hours Marks: 100

Answer any five questions. *Different parts of the same question should be answered together. Assume any relevant data if necessary. Use of Steam tables and charts are allowed.*

1. *Answer the following questions*: 4x5=20

a) What is the function of Fusible plug? Explain its location in the steam boiler.

b) Why indirect method of determining boiler efficiency is more useful than direct method?

c) Describe the functions of the steam drum in a water tube boiler.

d) What are the features of high pressure boiler?

e) Explain the function of Economiser in a steam boiler installation. Discuss its location.

2. a) Explain the construction and working principle of a Benson boiler with the help of a net sketch. 10

b) Explain the working of a Locomotive boiler with the help of a net sketch. 10

3. The following data were obtained during a boiler trial:

Mass of steam = 700 kg/h

Temperature of feed water = 60°C

Steam pressure = 10 bar

Oil consumption = 55 kg/h

CV of oil = 44000 kJ/kg

Dryness fraction of steam = 0.98

Percentage composition of oil by mass:

C = 85%, H2 = 14%, Ash = 1%

Analysis of dry flue gases by volume:

CO_2 = 12.5%, O_2 = 4.5%, N_2 = 83%

Temp. of flue gases leaving the boiler = 350°C

Boiler room temperature = 25°C

Specific heat of flue gases = 1.02 kJ/kg-K

Partial pressure of steam = 0.08 bar

Heating surface area = 21.4 m^2, Specific heat of superheated steam is 2.1 kJ/kg-K.

Find

(a) Equivalent evaporation per kg of fuel from and at 100°C,

(b) Equivalent evaporation per sq. m of heating area,

(c) Thermal efficiency of the boiler,

(d) Heat balance sheet on the basis of 1 kg of fuel and on the percentage basis. 20

4. a) What is blowdown? Why it is needed? 5
   b) What are the factors affecting the selection of a boiler? 5
   c) The following data are provided for a boiler installation fitted with economizer:
   Inlet temperature of flue gases to economiser= 280^0C.
   Outlet temperature of flue gases from economiser=180^0C
   Inlet temperature of water to economiser=60^0C
   Outlet temperature of water from economiser=100^0C
   Partial pressure of vapour in flue gases=0.1 bar
   Steam generated at 8 bar per kg of oil=10 kg
   Assuming that complete combustion of oil take place, calculate approximate mass of air applied per kg of fuel burnt. Take C_p=1.05 kJ/kg ^{0}K for the flue gases. 5
   d) Describe the boiler systems in briefly. 5

5. a) Derive an expression for draught produced in terms of height of chimney, ambient and flue gas temperature, State clearly the assumptions made. 10

   b) Explain with neat sketch of a high steam and low water safety valve. 10

6. a) What are the basic objectives of feed water treatment? 5
   b) What is boiler draught and how it is produced by a chimney? Compare force and induced draught. 5
   c) Explain the functions and working principle of superheater with neat sketch. 10