

M.E. MECHANICAL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2018

STEAM GENERATOR

Time: Three hours

(Answer any four questions)

Marks: 100

Different parts of the same question should be answered together. All symbols carry their usual meanings unless otherwise mentioned. Assume any relevant data if necessary.

1. Answer the following questions: 25
 - (a) Explain the merit and demerits of coal-water slurry as a boiler fuel.
 - (b) Why and when the downcomers placed outside the furnace?
 - (c) Why a *CURTAIN* wall is provided in a large capacity pulverised fuel fired furnace?
 - (d) Why indirect method of determining boiler efficiency is more useful than direct method?
 - (e) What do you mean by *swelling index* of coal?
2. a) Draw and explain a typical modern pi-shaped pulverised coal fired steam generator. 25
3. The following are the data collected for a boiler using coal as the fuel. Find out the boiler efficiency by indirect method. Also show boiler heat balance.

Fuel firing rate: 6000 kg/hr, steam generation rate: 22000 kg/hr, steam pressure: 45 kg/cm², steam temperature: 400⁰C, feed water temperature: 95⁰C,
 Flue gas analysis: CO₂ 10.0, CO 1.8, O₂ 7.67, N₂ 80.53; C_p of gas 0.963 kJ/kgK, average flue gas temperature 160⁰C, ambient temperature 27⁰C.
 Fuel analysis: Ash 6.0, carbon 83.00, hydrogen 6.00, oxygen 5.00
 GCV of coal 28 MJ/kg, humidity in ambient air 0.0205 kg/kg of dry air, surface temperature of boiler 70⁰C, wind velocity around the boiler 3.5 m/s, total surface area of boiler 90 m², GCV of bottom ash 3350 kJ/kg, GCV of fly ash 1895 kJ/kg, ratio of bottom ash to fly ash 90:10.

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4. a) What are the functions of a steam drum? 5
 b) What is blowdown? Why it is needed? 5
 c) Explain in brief with neat sketches methods of steam separation in a steam drum. 15
5. a) Why circulation is provided in a boiler? 5
 b) Define circulation ratio. Why the circulation ratio (CR) is maintained 6 to 25? 8
 c) A furnace wall riser, 18m long, 76.5mm OD and 6.1mm thick receives saturated water at 80 bar and 1.2 m/s velocity. Assuming a circulation ratio of 13.5 and a slip ratio of 1.2, determine (i) the pressure head developed, (ii) the void fraction at riser exit, and (iii) the heat transfer rate per unit projected area of the riser tubes. 12