

**DIRECTORATE OF STEAM BOILERS****(MAHARASHTRA STATE)****EXAMINATION FOR CERTIFICATE OF PROFICIENCY  
AS A BOILER OPERATION ENGINEER**

(Under Boiler Operation Rules, 2021)

**Boiler Technology - II**

8th March 2025

(TIME : 2-30 P.M. TO 5-30 P.M.)

(Max. Marks—100)

**Instructions to Candidates :—**

- (1) Attempt any **five** questions.
- (2) Question No. 1 is **Compulsory**.
- (3) All questions carry **equal** Marks.
- (4) Draw neat sketches wherever **necessary** for correct explanations.
- (5) Answer in brief and to the correct point will attract **full** Marks.
- (6) Figure to the right indicates **full** Marks.
- (7) Assume suitable missing data, if any.

- |   | <b>Marks</b> |
|---|--------------|
| 1. (a) State whether the following statements are <b>true</b> or <b>false</b> :—  | (10 x 1)     |
| (1) For boilers operating at high pressures, radiant heat transfer accounts for a larger percentage of the total heat transfer compared to conduction and convection. |              |
| (2) SO <sub>2</sub> emission in FBC boiler fired with high sulfur coal are controlled by adding Calcium Oxide to the Bed.   |              |
| (3) The best steam for indirect heating in most industrial processes is as dry as possible.   |              |
| (4) Superheated steam is used in LRSB.  |              |
| (5) In a boiler maximum pressure is seen in the drum, not in economizer.  |              |
| (6) The draft caused solely by the difference in weight between the column of hot gas inside chimney and column of outside air is known as induced draft.             |              |
| (7) Abrasiveness Index gives Hardness of Coal and Caking Index is a measure of Binding property of Coal.  |              |
| (8) One kg of CO needs 1.57 kg of O <sub>2</sub> and produces 2.57 kg of CO <sub>2</sub> .  |              |
| (9) An increase in Steam Pressure from 7 kg/cm <sup>2</sup> to 10 kg/cm <sup>2</sup> will result in an increase in Specific volume.                                   |              |
| (10) Inverted Bucket Steam Trap operates on the principle of difference in temp between Steam and Condensate.   |              |
| (b) Define the following terms :—   | (5 x 1)      |
| (1) pH and Conductivity.  |              |
| (2) Ash fusion temperature of coal.   |              |
| (3) Variable pressure operation in super critical boiler.   |              |
| (4) Specific Heat.  |              |
| (5) Steam pipe as per the Boiler Act, 1923.   |              |

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- (c) Convert the following terms :— (5 x 1)
- (1) Evaporation of 976 kg of Water / Hr to ..... Boiler HP.
  - (2) 800 watts to ..... joules/sec.
  - (3) 125° F to ..... ° C.
  - (4) 167 mm of Hg to ..... mm of Water Column.
  - (5) 1 PPM to ..... mg/L.
2. (a) Discuss the steps involved in commissioning a new 100 TPH water tube boiler. 4
- (b) Discuss about furnace safe guard supervisory system. 5
- (c) What are the common causes of boiler tube leakages, and how can they be effectively prevented? 5
- (d) The coal fired Boiler data was measured at hourly intervals as given below :— 6
- Quantity of steam generated : 8 TPH,
  - Stem pressure : 10 kg/cm<sup>2</sup> (g). Steam temperature : 180° C,
  - Enthalpy of steam (dry saturated) at 10 kg/cm<sup>2</sup> : 665 Kcal/kg,
  - Feed water temperature : 85 ° C,
  - Enthalpy of feed water : 85 Kcal/Kg,
  - Quantity of Coal consumed : 1.6 TPH,
  - GCV of Coal : 4000 Kcal/Kg,
  - Calculate the Boiler efficiency and Evaporation ratio.
3. (a) Explain the working, advantages and limitations of Orsat Apparatus. 4
- (b) What are the precautions to be taken before starting the Fire in the Boiler? 5
- (c) Explain the importance and methods of Wet and Dry preservation of Boiler. 5
- (d) Boiler critical parameters, Fuel analysis and Flue gas analysis are given below :— 6
- Boiler Capacity – 20 TPH
  - Steam Pressure – 66 kg/cm<sup>2</sup>
  - O<sub>2</sub> in flue gas – 9%
  - Average flue gas temp – 180° C
  - Air ambient temp – 29.3° C
  - Mass of Dry flue gas – 12.7 kg/kg of coal
  - Fuel Analysis –  
Carbon – 53.65%, Hydrogen – 3.25%, Nitrogen – 1.11%,  
Oxygen – 8.68%, Sulphur – 0.34%, Moisture – 14.43 %,  
Ash content – 18.54%.
  - GCV of coal – 4291 Kcal/Kg.

**Calculate :**

- (1) Theoretical air required for complete combustion.
- (2) Calculate % of Excess air supplied and actual mass of air.
- (3) Calculate % Heat loss in Dry flue gas.  
(Assume  $C_p = 0.24 \text{ Kcal/Kg.}^\circ \text{C}$ )
- (4) % Heat loss due to  $H_2$  in fuel. (Assume  $C_p = 0.45 \text{ Kcal/Kg.}^\circ \text{C}$ )
- (5) Boiler efficiency by indirect method, assuming the total of other losses like losses due to moisture in fuel and air, losses due to partial conversion of C to CO and losses due to unburnt in fly ash and bottom ash and losses due to radiation are approximately about 4%.

4. (a) Explain L.P. and H.P. dozing system of Boilers. 4
- (b) Explain the procedure to start Bagasse fired water tube boilers from cold condition. 5
- (c) Discuss the steam blowing procedure in high pressure Boiler. 5
- (d) A boiler fitted with a forced draught has the following particulars: 6
  - Mass of air required : 18 kg/kg of Fuel,
  - Mass of fuel used : 1400 Kg/Hr,
  - Temperature outside air :  $40^\circ \text{C}$ ,
  - Temperature of chimney gas :  $170^\circ \text{C}$ ,
  - Draught pressure : 40 mm of water,
  - Efficiency of fan : 70%

Determine the power required to drive the fan in HP. If the boiler is equipped with induced draught fan instead of forced draught fan with same efficiency what will be the power required driving it ?

5. (a) Explain Annual Shutdown of PF Boilers or Off-season Maintenance of Sugar Industry Boiler. 4
- (b) Describe Type of Boiler furnaces used in Bagasse fired Boilers. 5
- (c) How HRSGs are different from conventional boilers ? 5
- (d) Calculate the pressure drop in meters when pipe diameter is increased from 250 mm to 350 mm for the same flow for a length of 1000 meters, water velocity is 2 m/s in the 250 mm diameter pipe and friction factor is 0.005. 6
6. Write short notes (any *four*) :— (5 x 4)
  - (a) Flue gas desulphurization (FGD) – process and technology
  - (b) Energy conservation opportunities in steam system
  - (c) Attemperator
  - (d) Bed slumping in AFBC boilers its causes and effects
  - (e) Flash steam recovery.