DIRECTORATE OF STEAM BOILERS

(MAHARASHTRA STATE)

Examination for certificate of proficiency as a Boiler Operation Engineer

(Under Boiler Operation Rules, 2021)

Boiler Technology - I

25th February 2023

(TIME : 10-00 A.M. TO 1-00 P.M.)

(Max. Marks—100)

Instructions to Candidates:—

(1) Attempt any *five* questions.

(2) Question No. 1 is *Compulsory*.

(3) Draw neat sketches wherever *necessary* for correct explanations.

(4) Answer in brief and to the correct point will attract full *Marks*.

(5) All questions carries equal *Marks*.

(6) Figures to the right indicate *Marks*.

Marks

1. (A) Choose the correct options and complete the following statements :— 10

    (a) For Boiler water treatment chemical dozing with small discharge at high pressure, pump preferred is ....

        (i) Centrifugal

        (ii) Axial flow

        (iii) Propeller

        (iv) Reciprocating.

    (b) High percentage of Carbon Mono-oxide presence in the flue gas of the Boiler is an indication of ....

        (i) Complete combustion

        (ii) Good control of Pollutants

        (iii) Low Excess Air

        (iv) High Excess Air.

    (c) In a Boiler, the biggest heat loss is due to ....

        (i) Moisture in fuel

        (ii) Dry flue gases

        (iii) Radiation and Convection

        (iv) Unburnt Carbon.

    (d) The Latent heat of vaporization at critical point is ....

        (i) Less than zero

        (ii) Greater than zero

        (iii) Equal to zero

        (iv) None of the above.

(e) A bimetallic strip is used in which of following traps.

    (i) Inverted Bucket

    (ii) Thermostatic

    (iii) Float type

    (iv) Thermodynamic.

(f) The difference between Mean solid velocity and Gas velocity in FBC Boiler is called ....

    (i) Settling velocity

    (ii) Fluidisation velocity

    (iii) Slip velocity

    (iv) None of the above.

(g) Steam at $6Kg/cm^2$ (ab) has a sensible heat of 159 Kcal/Kg and latent heat is 498.5 Kcal/Kg. If the steam is 95% dry then the total Enthalpy is ....

    (i) 625 Kcal/Kg

    (ii) 650 Kcal/Kg

    (iii) 553 Kcal/Kg

    (iv) 633 Kcal/Kg.

(h) The operating Excess air percentage is high in ....

    (i) Spreader stoker coal fired boiler

    (ii) Oil fired boiler

    (iii) Bagasse fired boiler

    (iv) Wood fired boiler.

(i) If Excess Air is 15.38 % in FO fired Boiler, the % O_2 in flue gases is ....

    (i) 4.2%

    (ii) 2.8%

    (iii) 1.4%

    (iv) 3.6%.

(j) Attemperation is done to ....

    (i) Control of steam pressure

    (ii) Control of Steam temp

    (iii) Control of feed water silica

    (iv) None of the above.

(B) Explain the following terms in brief :—   10

(i) 3 T's applied for complete combustion

(ii) Natural and Forced circulation of Boiler

(iii) Foaming and Priming

(iv) Critical pressure and Dryness fraction

(v) Vacuum Efficiency of Condenser.

2. (a) What are the comparative advantages and disadvantages of fire tube and water tube Boilers ? **Marks** 4

(b) What are the classifications of pulverized coal burners and oil burners. 5

(c) Explain 3 element Drum Level Control. 5

(d) A Boiler with an output of 80 Kg/sec of Steam at pressure 100 Kg/cm^2 (g) and 500°C temp has an Efficiency of 85% and it operates at full load. Feed water enters the Boiler at 160°C. Given - CV of Coal - 4600 Kcal/Kg, Sulphur content = 0.35%, Ash content = 40%, Efficiency of ESP =99.5%. 6

Calculate.—

(i) The SO$_2$ Emission through stack in Kg/Hr

(ii) Particulate Emission through stack in Kg/Hr.

3. (a) What are the factors to be considered for proper selection of water treatment plant ? 4

(b) What are the merits and demerits of Artificial draught over Natural draught ? 5

(c) What do you understand by the terms Boiler mounting and accessories ? Name important mountings and accessories. 5

(d) A 5000 Kg/Hr Boiler operates at 10.5 Kg/cm^2 (g) and has maximum allowable TDS of 3500 ppm. Calculate Blowdown rate in Kg/Hr. 6

If the same Boiler is operated with manual blowdown and assuming that Boiler water TDS is maintained at 2500 ppm. Assume Boiler feedwater TDS is 300 ppm and feedwater temp is 300°C.

Calculate Energy loss due to Excess blowdown.

4. (a) List out various factors which improves Boiler Performance. 4

(b) List out the Energy conservation opportunities in Boiler system. 5

(c) Explain Mechanical Deaeration and Chemical Deaeration. 5

(d) The following data was obtained during a test on two boilers working under similar conditions, except that the draught in first boiler was produced by an induced draught fan and in second by a forced draught fan :— 6

*Air supplied /Kg of fuel =19 Kg

*Density of air =1.205 Kg /m^3

*Density of flue gas at specified temperature =0.769 Kg /m^3

*Combustion rate =150 Kg of fuel/hr, Draught produced =75 mmwc

*Efficiency of fan in both cases =50 %

*Calculate BHP of fan in each case.

[*Turn over*

Marks

5. (a) What are the factors involved in selecting Thermal Insulation material ?   4

    (b) What are the various methods available to control the excess air in a Boiler ?   5

    (c) What are the different methods to control Superheat temp of Steam ?   5

    (d) Steam with a Dryness fraction of 0.9 at 8 Kg/cm^2 (ab) passes through a reducing valve to a pressure of 3 Kg/cm^2 (ab). What is the Dryness fraction at downstream of valve ?   6

6. Write short notes on (any *four*) :—   20

    (a) Factors to be taken into account in the design consideration of Boiler.

    (b) Principle of flue gas analysis by Orsat.

    (c) Sources and Effects of Air leakages in Steam condenser.

    (d) Steps involved in Boiler tube replacement after failure.

    (e) Wet mode operation of Supercritical Boiler.