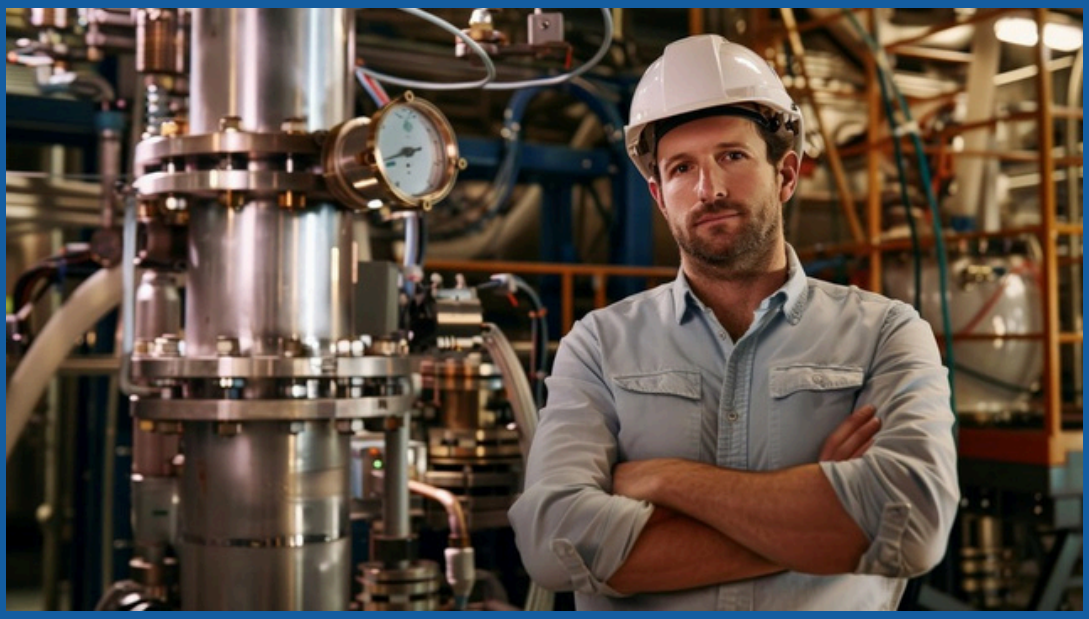
# Study Material For Boiler Operation Engineer (BOE) Exams



Theory, Numerical Problems, MCQs and Boiler Drawing Problems from BOE Exams

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CON 1069

# EXAMINATION BOARD OF BOILERS

**(MAHARASHTRA STATE)**

(Under The Boiler Operation Engineer's Rules, 2011)

**Boiler Technology–I**

17th March 2018

[TIME : 10-00 A.M. TO 1-00 P.M.]

(MAX. MARKS — 100)

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*Instructions to candidates.*— (1) Attempt *five* questions.
(2) Question No. 1 is *compulsory*.
(3) Answer each next main question on a new page.
(4) Answer in brief and to the point attract more marks.
(5) Assume suitable data, if *necessary*.

**Marks**

1. (*a*) Out of the given options select most appropriate option as an answer :- 10

(*i*) An increase in steam pressure of a boiler during start-up from 4 bar (g) to 12 bar (g), will result in decrease of ..... .

(*a*) enthalpy of steam

(*b*) sensible heat of steam

(*c*) specific volume of steam

(*d*) saturation temperature of steam.

(*ii*) Combustible elements in the fuel are ..... .

(*a*) carbon and hydrogen

(*b*) carbon, hydrogen and sulphur

(*c*) carbon, hydrogen and nitrogen

(*d*) carbon, hydrogen and ash.

(*iii*) The two basic properties enable control valves to 'control' are ..... .

(*a*) temperature and pressure

(*b*) temperature and flow rate

(*c*) pressure and valve movement

(*d*) pressure and flow rate.

(*iv*) The basic job of boiler feed water treatment is to overcome the problems of ..... .

(*a*) corrosion

(*b*) scale

(*c*) carryover

(*d*) all the above.

[*Turn over*

**Marks**

(*v*) Dissolved $CO_2$ in boiler feed water when left untreated would result in occurrence of ..... in boiler tubes.

(*a*) scale

(*b*) water side corrosion

(*c*) creep

(*d*) water hammer.

(*vi*) ..... fired steam boiler will have the least evaporation ratio.

(*a*) Bagasse

(*b*) Coal

(*c*) LSHS

(*d*) Natural gas.

(*vii*) Once-through boiler is named as such because ..... .

(*a*) flue gases passes only in one direction

(*b*) steam is sent out only in one direction

(*c*) air is sent through same direction

(*d*) there is no recirculation of water.

(*viii*) Low combustion temperature minimizes ..... in FBC boilers.

(*a*) $NO_x$

(*b*) $SO_x$

(*c*) CO

(*d*) Suspended particulate matter.

(*ix*) ..... is a carbon-neutral fuel.

(*a*) Coal

(*b*) Hydrogen

(*c*) Natural gas

(*d*) Biomass.

(*x*) Proper sizing of steam pipeline helps in minimizing ..... .

(*a*) steam requirement.

(*b*) pressure drop.

(*c*) temperature drop.

(*d*) boiler efficiency.

(*b*) Answer following questions in short :— 10

(*i*) Define Hoop stress. State its formula.

(*ii*) Explain the term - ' Boiler Design Pressure '.

(*iii*) Differentiate between 'conduction' and ' convection ' with example.

(*iv*) A thin cylinder contains fluid at pressure of 3 N/mm$^2$. The inside diameter of the cylinder is 500 mm and the tensile stress in the material is to be limited to 80N/mm$^2$. Determine the wall thickness required.

(*v*) 4 kg of water at 40°C is mixed with 6 kg of water at 100°C in a steady flow process. Determine the temperature of resulting mixture.

**Marks**

2. (*a*) Compare the 'independent' and 'integral' type economizer. 4

(*b*) Why boiler drums are cylindrical in shape ? 5

(*c*) If priming occurs in boiler, what will you do ? 5

(*d*) A steam boiler uses pulverized coal in the furnace. The ultimate analysis of coal by mass as received is as below :— 6

C 78% ; $H_2$ 3% ; $O_2$ 3% ; S 1% ; ash 10% ; and moisture 5%.

Excess air supplied is 30%.

Calculate :—

(*i*) The mass of air to be supplied.

(*ii*) The mass of gaseous product formed per kg of coal burnt.

3. (*a*) Why blow down is necessary for boiler ? 4

(*b*) What do you mean by boiler mountings ? List all the requisite mountings according to the Indian Boiler Regulations. 5

(*c*) What are the advantages of automatic combustion control system ? 5

(*d*) The composition of sample of coal is given below :— 6

C 90% ; $H_2$ 3.5% ; $O_2$ 3.0% ; $N_2$1.0% ; S=0.5% ; the remainder being ash.

Determine :—

(*i*) Theoretical weight of air required for the combustion of 1 kg of fuel.

(*ii*) The composition of dry products of combustion by volume, if 50 % excess air is supplied.

4. (*a*) What may the reasons for abnormally high super-heated steam temperature of boiler operating with constant load ? 4

(*b*) Why natural circulation is limited to subcritical boilers ? What are the advantages of supercritical boilers over subcritical ones ? 5

(*c*) What advantages does an economizer possess over air-preheater ? List the advantages of finned tubes over plain tubes used in the economizer. 5

(*d*) Exhaust steam having a quality of 0.9 enters a surface condenser at an absolute pressure of 0.13 bar and comes out as water at 45°C. The circulating water enters at 30°C and leaves 40°C. 6

Estimate the following :—

(*i*) Quantity of circulating water

(*ii*) Condenser efficiency.

**Marks**

5. (*a*) Describe boiler accident reporting provision given in the Indian Boiler Act. 4

(*b*) List ten interlocks which detect hazardous situation and initiate boiler master fuel trip. 5

(*c*) Write overall process of demineralization. What principal steps are involved in DM plant regeneration cycle ? 5

(*d*) Following observations were made on a boiler plant during one hour performance test :— 6

- Steam pressure = 20 bar absolute
- Steam temperature = 260°C
- Steam generated = 37500 kg.
- Temperature of feed water entering to the economizer = 15°C
- Temperature of feed water leaving economizer = 90°C
- Fuel used = 4400 kg.
- Energy of combustion of fuel= 30000 KJ/kg.
- $C_p$ for superheated steam = 2.1 KJ/kg. K

Based on above data, calculate :—

(*i*) Equivalent evaporation per kg. of fuel

(*ii*) Thermal efficiency of the plant

(*iii*) Percentage heat of the fuel utilized by the economizer.

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

(*a*) Boiler corrosion prevention

(*b*) Boiler steam test

(*c*) RLA study of boiler

(*d*) Boiler registration

(*e*) Impurities in water and their effects on boiler.

CON 1070

# EXAMINATION BOARD OF BOILERS

## (MAHARASHTRA STATE)

(Under The Boiler Operation Engineer's Rules, 2011)

**Boiler Technology–II**

17th March 2018

[TIME : 2-00 P.M. TO 5-00 P.M.]

(MAX. MARKS — 100)

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*Notes.*—(1) Attempt *five* questions.
(2) Question No. 1 is *compulsory*.
(3) Answers in brief and to the point will attract more marks.
(4) Draw neat sketches wherever necessary.

**Marks**

1. (A) State whether the following statements are *true* or *false* :— 10

(*i*) An increase in the steam pressure from 7 kg / $cm^2$ to 10 kg / $cm^2$, will result in a increase of specific volume.

(*ii*) A device used to convert low pressure steam to high pressure steam is called thermo compressor.

(*iii*) Lower excess air resulting in lesser stack loss is not true with respect to improper sizing of coal.

(*iv*) Sulphur is measured in proximate analysis .

(*v*) The density of a substance relative to water is called viscosity.

(*vi*) The head loss due to friction in steam pipe is directly proportional to diameter of pipe.

(*vii*) Carpet loss is associated with storage of furnace oil.

(*viii*) Water softening process reduces TDS but not hardness.

(*ix*) Steam at 4 kg / $cm^2$ has sensible heat of 144 kCal / kg. and latent heat of 510 kCal / kg, if the steam is 90 % dry then the total enthalpy of steam in kCal / kg is 603.

(*x*) The balanced draught furnace is one that is operated with only natural draught.

(B) Define the following terms :— 5

(*i*) Co-generation

(*ii*) Vacuum and condenser efficiency

(*iii*) 'Boiler' as per The Indian Boiler Act, 1923

(*iv*) Degree of super heat

(*v*) Maximum continuous rating.

[*Turn over*

**Marks**

(C) 1. Convert to (any *three*) :— 3

(*a*) 175 MTOE ..... > kCal

(*b*) 175mmwc ..... > PSI

(*c*) 175 kCal ..... > HP

(*d*) 175 m/sec. ..... > km / hr

(*e*) 175 °C ..... > ° F

2. Write long form of following :— 2

(*a*) MEDA

(*b*) ASME

(*c*) LSHS

(*d*) MTOE.

2. (*a*) What are the factors result in carryover in boilers ? 4

(*b*) What safety precaution should be observed in operating and maintaining an automatic burner system ? 5

(*c*) What is a super critical boiler ? and what is basic difference between sub critical and super critical boilers ? 5

(*d*) Estimate the steam flow of dry saturated steam in kg / hr at 16 kg / $cm^2$ (*g*) pressure and steam velocity not to exceed 24 m /sec. Take diameter of steam pipe 150mm. 6

3. (*a*) Define dryness fraction of steam. What are the demerits if steam is used below the dryness fraction of 97-98% ? 4

(*b*) What are the major points affect fuel bill ? Mention four energy saving opportunities in steam system. 5

(*c*) What do you understand by term "Accident" as per The Indian Boiler Act, 1923 ? And what are the responsibilities of boiler owner under The Indian Boiler Act, 1923 ? 5

(*d*) Boiler water tube have following specification 38 mm. OD, 3.25 mm thick, 7 m. length and 78 Nos. of tubes. Calculate total heating surface and total weight of the boiler tube. Take density for boiler tube : 7850 kg / $m^3$. 6

4. (*a*) How nondestructive testing is useful for boilers ? Name at least five nondestructive testing method. 4

(*b*) What are the various requirement and factors affect the performance of pulverized coal burners ? 5

(*c*) What are the different methods of cleaning the fire side soot deposition from the boiler tubes ? 5

**Marks**

(*d*) An coal fired boiler is generating 20 T/ hr steam and operates for 8400 hrs / year. The TDS in boiler feed water was reduced from 500 ppm. to 200 ppm. The maximum permissible limit of TDS in the boiler is 3000 ppm. and make of water is 12 %. Temperature of the blow down water is 178°C and boiler feed water temperature is 47°C. GCV of coal is 5500 kCal / kg and efficiency of the boiler is 78 %. Calculate the savings in coal per annum due to reduction in the blow down. 6

5. (*a*) What are the boiler operational factors affecting quality of steam ? 4

(*b*) What are the different types of siphon used on steam pressure gauges ?
Draw a neat sketches of any two type. 5

(*c*) What are the types of steam flow meters ? State advantages and disadvantages of orifice plate steam flow meters . 5

(*d*) A plant proposes to install an air pre heater to preheat combustion air from 30°C to 170°C in the existing boiler. The performance parameters are as given below :— 6

| | |
|---|---|
| Fuel used | : Biomass |
| Bio mass firing rate | : 26 TPH |
| Sulphur in fuel | : 0.1 % |
| Flue gas temperature | : 300°C |
| Air requirement | : 4.3 kg/kg of fuel |
| Sp. Heat of combustion air | : 0.24 kCal / kg°C |
| Sp. Heat of flue gas | : 0.23 kCal/kg°C |

Estimate the following.—

(*i*) Quantity of flue gas assuming negligible ash content in the fuel

(*ii*) Heat transferred to combustion air

(*iii*) Exit flue gas temperature and whether it is acceptable.

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

(*a*) Improving Boiler availability 5

(*b*) Improper air venting through steam supply line and its adverse effects. 5

(*c*) Various factors influences for excessive coal consumption in coal fired boilers of thermal power plant. 5

(*d*) Types of steam separators 5

(*e*) Do's and don't for boiler chimney. 5

CON 1071

# EXAMINATION BOARD OF BOILERS

**(MAHARASHTRA STATE)**

(Under The Boiler Operation Engineer's Rules, 2011)

**Engineering Drawing**

18th March 2018

[TIME : 10-00 A.M. TO 1-00 P.M.]

(MAX. MARKS — 100)

*Instructions to candidates.*— (1) Attempt any *five* questions.
(2) All Question carry *equal* marks.
(3) Figures to the right indicates *full* marks.
(4) Assume suitably missing data if any.

**Marks**

1. (*a*) Draw neat and proportionate sketch of the reflex type boiler water level gauge glass assembly. Name the internal parts :— 5

   (*b*) Draw process instrumentation symbols for following type of valves :— 5

   (*i*) Gate valve

   (*ii*) Globe valve

   (*iii*) Check valve

   (*iv*) Control valve

   (*v*) Safety valve.

   (*c*) Draw schematic free hand sketch of the following :— 10

   (*i*) Socket weld elbow

   (*ii*) Socket weld raised face flange

   (*iii*) Welding neck raised face flange

   (*iv*) Concentric reducer

   (*v*) Boiler feed water pump coupling.

2. A Pictorial view of an object is shown in Figure No. 1. Use first angle method and draw the following views :—

   (*i*) Front view 5

   (*ii*) Top view 5

   (*iii*) Side view 5

   (*iv*) Indicate all essential dimensions. 5

   The arrow indicates direction to obtain view from the front.

[*Turn over*

**Marks**

3. (*a*) Draw proportionate free hand sketch of the wet scrubber used for removing $SO_2$ and name the internal parts. 5

(*b*) List and draw the type of welding joints (any *five*). 5

(*c*) Draw systematic free hand sketch of ball float steam trap and name the internal parts. 5

(*d*) Draw a schematic sketch of the rack and pinion type intermittent blow down valve. 5

4. (*a*) Fig. No. 2 shows the front view, plan and side view of an object. Draw isometric projection looking in the direction of the arrow A. 15

(*b*) Draw a logic flow diagram for boiler master fuel trips system interlocks. 5

5. Draw neat and proportionate free hand sketch of the following and name the internal parts :—

(*a*) Steam stop valve 10

(*b*) Spring loaded safety valve 10

6. Draw typical schematic general arrangement (GA) drawing for the following with showing all equipment incorporated in between. (any *one*) 20

(*a*) Coal based steam power plant.

(*b*) RLNG based steam power plant

(*c*) Bagasse based co-generation plant.

Fig. No. 1

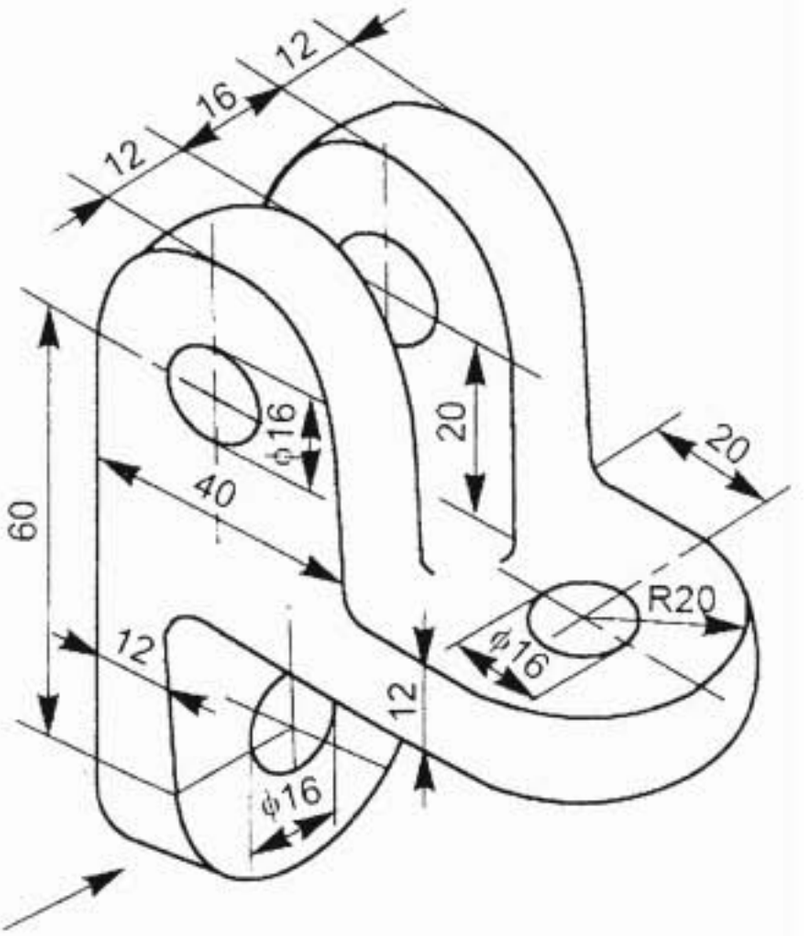


Fig. No. 2

