

Candidates, Please Do Not Write Anything on the Question Paper  
NO. \_\_\_\_\_

ROLL

## GOVT. WOMEN ENGINEERING COLLEGE AJMER

### MODEL QUESTION PAPER – 2018

Class	:	B.TECH. 3 <sup>RD</sup> YEAR	Semester	:	VI
Branch	:	MECHANICAL ENGINEERING			
Subject	:	STEAM ENGINEERING			

Time : 1 HOUR  
20

Max. Marks:

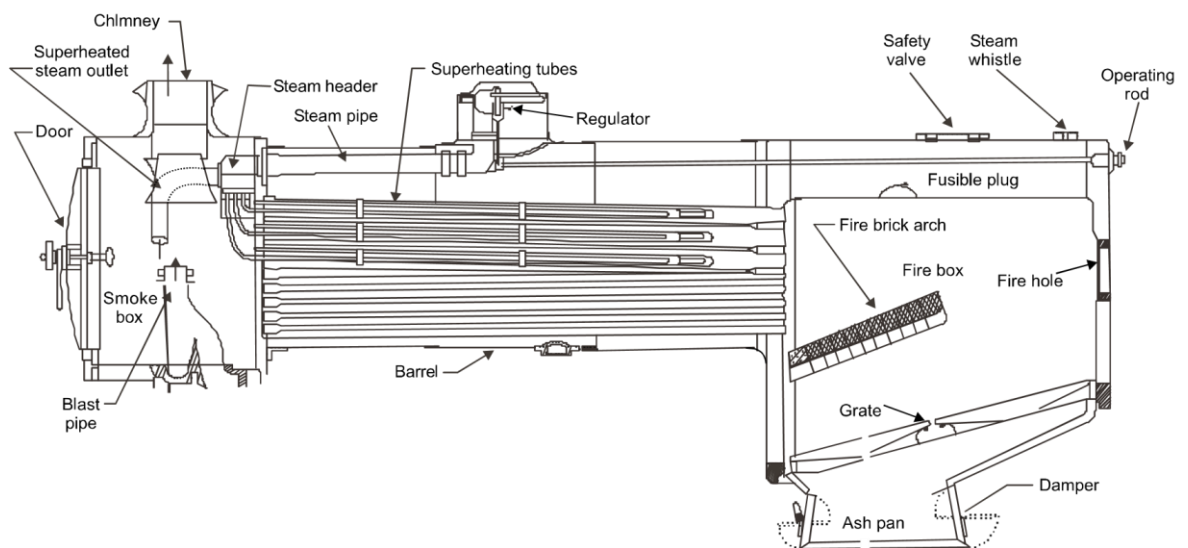
Note: Attempt all the questions.

1. Attempt **any one** of the following questions.  
(6X1=6)
  - a) Explain working and construction of Locomotive boiler with neat sketch.
  - b) Explain working and construction of Cornish boiler with neat sketch.
2. Attempt **any one** of the following questions.  
(6X1=6)
  - a) Explain working of high pressure boiler with neat sketch.
  - b) Explain working of air preheater with neat sketch.
3. Attempt **any one** of the following questions.  
(6X1=6)
  - a) Write down the classification of boiler.
  - b) Explain working of fusible plug and water level indicator.
4. Explain different types of draught.  
(2X1=2)

Q 1 a) Explain working and construction of Locomotive boiler with neat sketch.

Ans)

- a) These boilers were invented for getting steam to run a steam engine used in locomotives. These are fire tube type of boilers. It has basically three parts i.e. smoke box, shell and fire box. Figure 11.10 shows a general arrangement in locomotive boiler.
- b) Inside *fire box* the fuel (coal) is burnt over the *grate*. For feeding fuel the *fire hole* is used. Hot gases produced in fire box are diverted by *fire brick arch* and enter into the *fire tubes* surrounded with water. Steam produced gets collected in a steam drum fitted on top of the shell. Arrangement for super heating is there in these boilers.
- c) As shown the wet steam goes through inlet headers of superheater and after passing through tubes, it returns to the outlet header of superheater and is taken out for steam engine.
- d) A very large door is provided at the end of smoke box so as to facilitate cleaning and maintenance of complete boiler.
- e) As it is a moving boiler, therefore, its chimney is completely eliminated. For expelling the burnt gases (draught) the exhaust steam coming out from steam engine is being used. Thus it is an artificial draught used in these boilers for expelling burnt gases.



Q 1 b) Explain working and construction of Cornish boiler with neat sketch.

Ans ) This is a horizontal fire tube boiler having single flue gas tube. General arrangement is very similar to Lancashire boiler. Water surrounds the flue gas tube in the shell. Hot flue gases after passing through the tube are divided into two portions at the end of boiler and pass through side flue passages to reach upto the front of boiler and then enter into bottom flue gas passage for escaping out through chimney after traversing the entire length of bottom passage. Hot gases thus traverse complete length of passage from end to end of boiler thrice i.e. through main flue gas tube, side flues and bottom flues. Heat transfer is more from side flues than bottom flue due to sedimentation in bottom. These boilers are generally capable of producing steam up to the rate of 1350 kg/hr and maximum steam pressure up to 12 bar. Shell is generally of length 4 to 7 m and diameter 1.2 to 1.8 m.

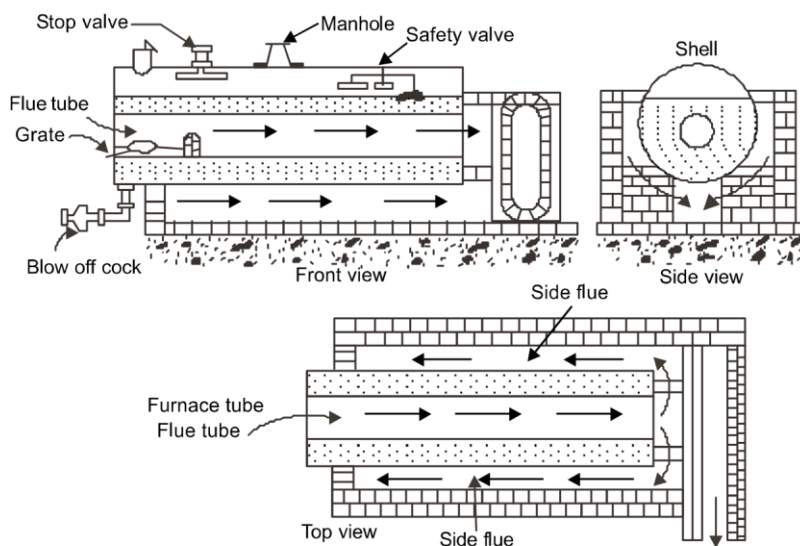


Fig. 11.9 Cornish boiler

Q2a) Explain working of high pressure boiler with neat sketch.

Ans ) **BENSON BOILER**

It is a water tube boiler capable of generating steam at supercritical pressure. Figure 11.15. shows the schematic of Benson boiler. Mark benson, 1922 conceived the idea of generating steam at supercritical pressure in which water flashes into vapour without any latent heat requirement. Above critical point the water transforms into steam in the absence of boiling and without any change in volume i.e. same density. Contrary to the bubble formation on tube surface impairing heat transfer in the normal pressure boilers, the supercritical steam generation does not have bubble formation and pulsations etc. due to it. Steam generation also occurs very quickly in these boilers. As the pressure and temperatures have to be more than critical point, so material of construction should be strong enough to withstand thermal stresses. Feed pump has to be of large capacity as pressure inside is quite high, which also lowers the plant efficiency due to large negative work requirement. Benson boilers generally have steam generation pressure more than critical pressure and steaming rate of about 130–135 tons/hr. Thermal efficiency of these boilers is of the order of 90%.

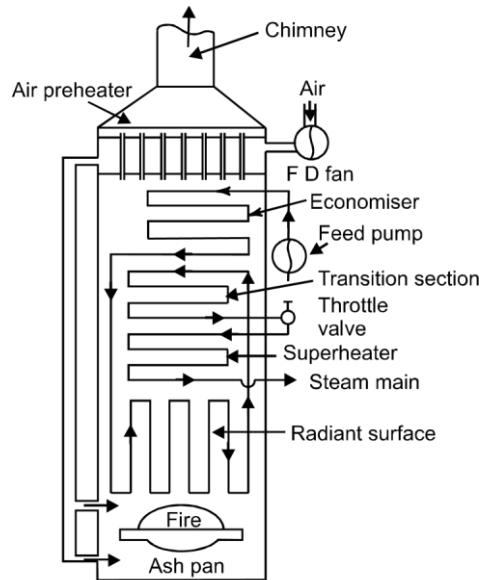


Fig. 11.15 Benson boiler

Q2b) Explain working of air preheater with neat sketch.

Ans 2b)

**Air preheater:**

- It is used for recovering the heat going along with exhaust gases by the air before being sent to furnace.
- Heat is recovered by passing exhaust gases through an air to air heat exchanger as shown in Fig.
- Air preheaters are generally placed after economizer and before chimney.
- Air when preheated before supply to furnace/combustion chamber helps in achieving ‘faster rate of combustion’, ‘possibility of burning inferior quality coal/fuel’ and ‘increased rate of evaporation from boiler’ etc.
- Air preheaters are of tubular type, plate type and regenerative type.
- This classification of air preheaters bases upon the kind of arrangement used for heat exchange between two fluids.
- Generally, tubular type air preheater are generally used in small boilers.
- Tubular air preheater has hot flue gases passing inside tubes and air blown over these tubes.

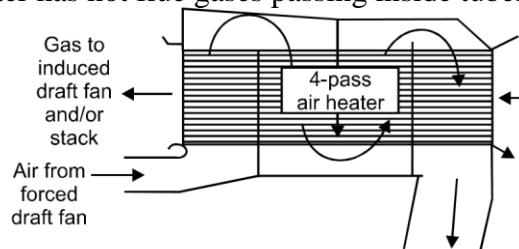


Fig. 11.33 Tubular air preheater

- In case of plate type air preheater there are number of plates having air and flue gases flowing through alternative spacings.
- In regenerative type air preheater there is a wire mesh rotor which is alternatively heated and cooled by the hot flue gases and air to be used for combustion.

Q3a) Write down the classification of boiler.

Ans 3a)

### **TYPES OF BOILERS**

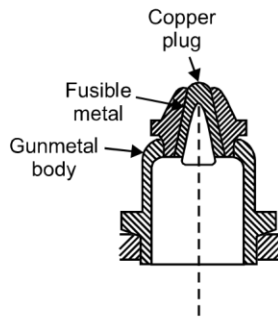
- (a) Based upon the orientation/axis of the shell:
  - (i) *Vertical boiler*
  - (ii) *Horizontal boiler*
  - (iii) *Inclined boiler*
- (b) Based upon utility of boiler:
  - (i) *Stationery boiler*
  - (ii) *Portable boiler*
- (c) Based on type of firing employed:
  - (i) Externally fired boilers  
(furnace is outside the boiler unit. Such as Lancashire boiler, Locomotive boiler.)
  - (ii) Internally fired boilers  
(furnace is within the boiler unit. Such as Cochran boiler, Babcock Wilcox boiler.)
- (d) Based upon the tube content
  - (i) *Fire tube boilers*, such boilers have the hot gases inside the tube and water is outside surrounding them. (Cornish boiler, Cochran boiler, Lancashire boiler, Locomotive boiler etc.)
  - (ii) *Water tube boilers*, such boilers have water flowing inside the tubes and hot gases surround them. (Babcock-Wilcox boiler, Stirling boiler, La-Mont boiler, Benson boiler etc.)
- (e) Based on type of fuel used
  - (i) *Liquid fuel fired boilers*, such as oil-fired boilers etc.
  - (ii) *Gas fired boilers*, such as natural gas fired boilers etc.
- (f) Based on circulation:
  - (i) *Natural circulation boilers*, in which the circulation of water/steam is caused by the density difference which is due to the temperature variation.
  - (ii) *Forced circulation boilers*, in which the circulation of water/steam is caused by a pump i.e. externally assisted circulation.
- (g) Based on extent of firing:
  - (ii) *Unfired boilers*, in which heat is provided by some other source except fuel firing such as hot flue gases etc.
  - (iii) *Supplementary fired boilers*, in which a portion of heat is provided by fuel firing and remaining by some other source.

Q3b ) Explain working of fusible plug and water level indicator.

Ans 3b)

#### ***Fusible plug:***

- It is a safety device used for preventing the level of water from going down below a critical point and thus avoid overheating.
- Fusible plug is mounted at crown plate of combustion chamber.

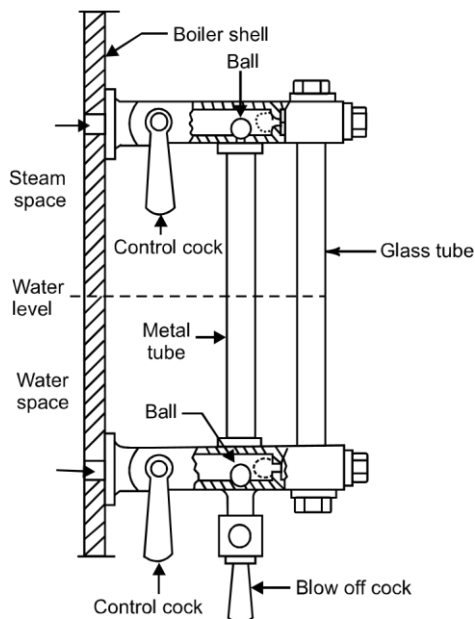


○ **Fig. 11.27** *Fusible plug*

- Fusible plug has gun metal body and a copper plug put with fusible metal at interface of copper plug and gun metal body.
- As water level goes down the heat available from furnace could not be completely utilized for steam formation and so the overheating may cause melting of fusible metal.
- Fusible metal is a low melting point metal.
- Thus, upon melting of lining the copper plug falls down and water falls from this opening onto furnace and thus quenches fire.

### Water level indicator:

- It is used for knowing the level of water in boiler as water level inside boiler should not go below a certain limit.
- General arrangement is shown in Fig. with the different parts in it.
- It has two tubes one is front glass tube while other is metal tube.
- Water level is seen through glass tube which is made strong enough to withstand high steam pressure and temperature.
- Two control cocks are provided for regulating steam and water passage from boiler to glass tube.
- For blow off purpose a blowing cock is also provided as shown.
- In case of breakage of glass tube the possibility of accident is prevented by providing two balls.
- As glass tube breaks the rush of water and steam carries the two balls with it and closes the openings for glass tube, thus water and steam flowing out can be prevented.
- Number of other types of water level indicators are also available.



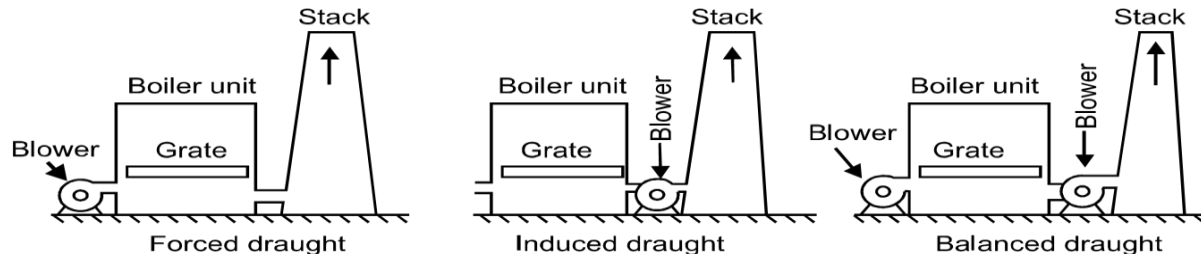
**Fig. 11.24** *Water level indicator*

Q4) Explain different types of draught.

Ans )

## MECHANICAL DRAUGHT

Mechanical draught produced using fans, blowers etc. could be of forced type, induced type or the combination of the two.



**Fig. 11.37** Mechanical draught

(i) *Forced draught:*

- It is the arrangement in which high pressure air is delivered to the furnace so as to force flue gases out through stack.
- Air under pressure may be fed to stokers or grate for which a fan/blower is put at the bottom of furnace.
- As due to pressurised air the pressure inside furnace becomes more than atmospheric pressure so it should be properly sealed, otherwise gas may leak through the cracks in setting into the boiler unit.
- Also the flames from furnace may flare out upon opening the fire door, so it should be equipped with dampers to shut off air supply when furnace doors are opened.
- It is obvious from here that the fan in case of forced draught shall handle fresh atmospheric air.

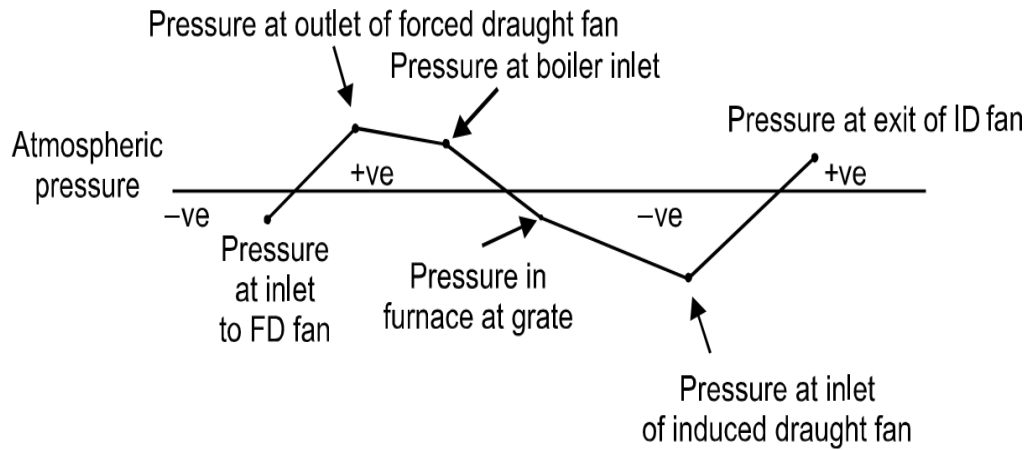
(ii) *Induced draught:*

- Induced draught is the one in which the suction created on furnace side draws flue gases and throws them out through small chimney/stack.
- Fan is located at base of chimney in induced draught so as to reduce pressure at fuel bed below atmospheric pressure. The fan in induced draught shall handle hot flue gases.
- Power required to drive the fan/blower in case of induced draught is less than that in case of forced draught fan.

(iii) *Balanced draught:*

- Sometimes it is seen that forced draught or induced draught alone is not suitable for boiler unit due to their own inherent limitations.
- In these situations, a combination of forced draught and induced draught is being used.
- Such combined arrangement for draught is called balanced draught.
- Here both forced draught fan/blower and induced draught fan/blower are employed.

- Forced draught fan ensures complete supply of air for proper combustion after overcoming all resistances while induced draught fan takes care of post combustion resistances, thus ensuring complete removal of flue gases.
- Pressure variation in balanced draught shows the pressure values through out boiler unit.



**Fig. 11.38** *Pressure variation in balanced draught*