## Unit : 2 . Steam Boilers .

**Introduction :** A closed metallic vessel in which the water is heated and converted in to steam by the application of heat produced by the combustion of fuel is known as steam boiler , it is also known as boiler. A closed vessel is generally made up of steel .In practice the steam is used mainly for two purposes:

i) For power generation and

ii) Process heating.

In power generation , the steam is used to run the steam engine and turbines and as a process steam in textile industries for sizing and bleaching etc.The fuel commonly used in a boiler are coal , oil and gas for producing heat.

**Applications or uses of steam Boiler :**Following are the uses of steam Boilers ,

i) Used for running steam engines and turbines.

ii) Used in process industries like cotton mills, sugar factories , breweries , etc.

iii) Used in producing the hot water for heating installations.

iv) Used for production of steam in textile industries,

**Classification of the steam boilers :**The boilers can be classified in to following :

1.According to the contents in the tube :

a) Fire tube boiler.

b) Water tube boiler.

2. According to the position of the boiler :

a) Internally fired boilers .

b) Externally fired boilers.

3. According to the shell axis :

a) Horizontal boilers.

b) Vertical boilers.

4.According to the number of tubes :

a) Single tube boiler . b) Multi tube boiler .

5. According to the method of circulation of water and steam :

a) Natural circulation . b) Forced circulation .

6. According to the use :

a) Stationary boilers . b) Mobile boilers .

7. According to the source of heat :

a) Coal or liquid or gaseous fuel fired boilers . b) Electrical energy or nuclear energy boilers.

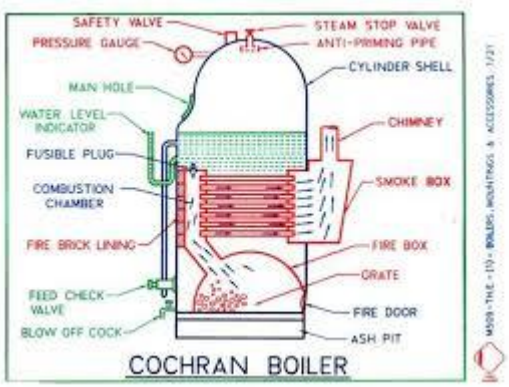
**Functions of the Boiler :**Following are the functions of the boiler :

i) To transfer the heat produced by the combustion of fuel to water to generate the steam .

ii) To supply the steam at the required constant pressure with its quality either dry or superheated.

**Low pressure Boiler :**

**Sketch and Describe the construction and working of a Co-chran boiler .What are its advantages.**




It is a vertical , multitubular, internally fired , natural circulation , fire tube boiler.It has a capaity to produce the steam up to 4000 kg/hr with a maximum pressure of 10 bar , as shown in fig.

The boiler consists of an external cylindrical shell , fire box , combustion chamber , flue tubes , smoke boxand chimney, grate and ash pit. The cylindrical shell gives maximum space and strength to withstand the pressure of steam inside the boiler. The fire box and combustion chamber is connected by a short pipe.The combustion chamber islined with fire bricks from the inside. The flue gases from the combustion chamber flow to the smoke box through number of flue tubes. The gases from the smoke box pass to the atmosphere through a chimney. A manhole near the top is provided for cleaning . At the bottom of a fire box , there is a

grate and the coal is fed through the fire hole. Below the grate there is a space called ash pit provided to collect the ash.

**Working :**Fill the waterto a specified levelin a boiler through feed water pump. Coal is charged in to the grate through the fire hole and fired.The hot gases from the furnace pass to the combustion chamber and from the combustion chamber they pass through the horizontal flue tubes to the smoke box. The gases from the smoke box escape to the atmosphere through the chimney. The hot gases while passing through the flue tubes transfer their heat to the water and gets converted in to steam which accumulates in the steam space. The steam stop valve allows the steam from the boiler to the steam supply pipe . The ash formed during burning is collected in the ash pit provided below the grate , which can be removed periodically .

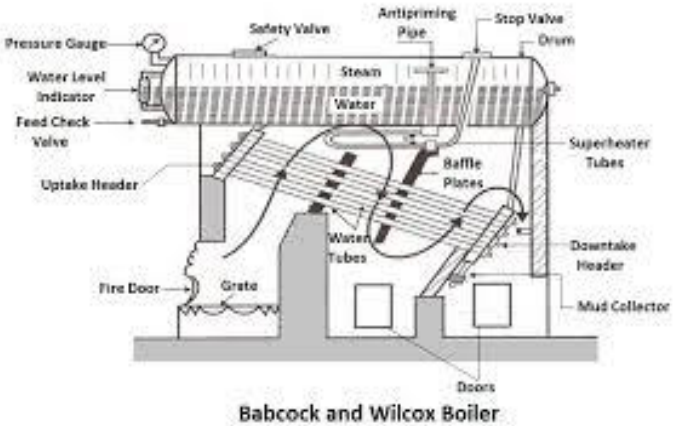
**Advantages of Cochran boiler :**Following are the advantages of Cochran boiler:

1. It is very compact and simple in construction .
2. It requires minimum floor space .
3. Low construction cost.
4. Easy to install and transport.
5. Because of self contained furnace no brick work setting is required.
6. It can operate with any type of fuel.
7. Best suitable for small capacity requirements.

**Disadvantages of Cochran boiler :**

1. It requires high head room space.
2. Its capacity is less.
3. Its vertical design offers great difficulty in cleaning and inspection.

**Bobcock and Wilcox Boiler :Explain with diagram the Bobcock and Wilcox Boiler .**



Babcock and Wilcox Boiler

It is a horizontal , externally fired, natural circulation stationary water tube boiler. It has a capacity to produce the steam up to 450 tonnes per hour with a maximum pressure up to 165 bar as shown in fig. It consists of a steam and water drum , water tubes , chain grate stocker and superheater tubes. The steam and water drum is suspended on steel girders surrounded by fire brick walls.It is connected by a short tubes with uptake header at the back end and downtake header at front end. The water tubes are inclined to the horizontal and connects the uptake header to thedowntake header. A mud box is provided with each downtake header and the mud that settles down is removed. There is a slow moving automatic chain grate on which the coal is fed from the hopper. The boiler is fitted with superheater and one end is connected to steam stop valve mounted over the drum.

**Working :**The water is filled in to the boiler drum through the feed valve and maintaining the constant water level in a boiler.The water circulates from the drum in to the downtake header and through the tubes to the uptake header and again to the drum.The coal is fed to the grate through the fire door and is burnt. The hot flue gases move upwards and passes across the water tubes and superheater tubes up and down in a zig-zag manner due to baffle plates and finally pass out of the boiler through exit door and the chimney.The water in the water tubes gets evaporated and converted in to steam at the uptake header portion which is just below the furnace. The steam separated from the water and is being collected in the upper part of the drum. The water from the drum comes down through the downtake header in to the water tubes and once again it is converted in to the steam. This circulation of water and the generation of the steam is maintained continuously and naturally to establish the required pressue in a boiler

The steam from the steam space in the boiler drum is led in to the superheater tubes where it is superheated and it is regulated through the steam stop valve to run the prime mover. The boiler is mounted with essential mountings such as steam stop valve, pressure gauge , safety valve, water level indicator and feed check valve.

## Water tube boiler & Fire tube boiler :

A high pressure **watertube boiler** (also spelled **water-tube** and **water tube**) is a type of **boiler** in which **water** circulates in **tubes** heated externally by the fire. Fuel is burned inside the furnace, creating hot gas which boils **water** in the steam-generating **tubes**.

A fire-tube boiler is a type of boiler in which hot gases pass from a fire through one or more tubes running through a sealed container of water. The heat of the gases is transferred through the walls of the tubes by thermal conduction, heating the water and ultimately creating steam.

## Advantages and Disadvantages of Water Tube Boiler :

| SL NO | Advantage |
|---|---|
| 1. | The maximum working pressure of the water tube boiler is 250 bar. |
| 2. | Overall efficiency is up to 90% with an economizer. |
| 3. | It requires less floor area for a given output. |
| 4. | Load fluctuation can be easily handled. |
| 5. | The rate of steam generation and the quality of steam for suitable power generation are much better. |
| 6. | This can be used in large power plants. |
| 7. | The direction of water circulation is well defined. |

**Disadvantage:**

| SL NO | Disadvantage |
|---|---|
| 1. | Complex design and High maintenance cost. |
| 2. | A skilled operator is required for operation. |
| 3. | This is used in large power plants and it is uneconomical for use in small industries. |
| 4. | For the same power output, the cost of a water tube boiler is high. |
| 5. | Treatment of feed water is very essential in a water tube boiler as small-scale deposits inside the tube can cause overheating and bursting. |

**Advantages of water tube boiler over fire tube boilers and tank boilers :**Following are the advantages of water tube boiler over fire tube and tank boilers :

1. It can generate the steam pressure up to 165 bar.
2. It can generate the steam pressure up to 450 tonns/hr
3. Less floor area is required for a given power.
4. High overall efficiency.
5. Easy in transportation and errection.
6. It is preferred for widely fluctuating loads.
7. Steam can be generated very rapidly.
8. Suitable for large power plants.
9. Water can be circulated in a definite direction .

10. Bursting of one or two tubes does not affect the boiler function.

**Comparison of Water tube and Fire tube boiler :**

| Sl.No. | Water tube boiler. | Fire tube boiler. |
|---|---|---|
| 1 | **The water circulates inside the tube surrounded by hot flue gases.** | **The hot flue gas circulates inside the tube surrounded by the water.** |
| 2 | **It can generate the steam pressure up to 165 bar.** | **It can generate the steam pressure up to 24.5 bar.** |
| 3 | **It can generate the steam pressure up to 450 tonnes /hr.** | **It can generate the steam pressure up to 9 tonnes /hr.** |
| 4 | **Less floor area is required for a given power.** | **More floor area is required for a same given power.** |
| 5 | **Overall efficiency is 90%** | **Overall efficiency is 75%** |
| 6 | **Transportation and errection is easy.** | **Transportation and errection is difficult.** |
| 7 | **It is preferred for widely fluctuating loads.** | **It is preferred for constant loads .** |
| 8 | **Water circulates in a definite direction.** | **Water does not circulates in a definite direction.** |
| 9 | **The operating cost is high.** | **The operating cost is less.** |
| 10 | **The bursting chances are more.** | **The bursting chances are less.** |
| 11 | **Used for large power plants.** | **Used for small power plants.** |

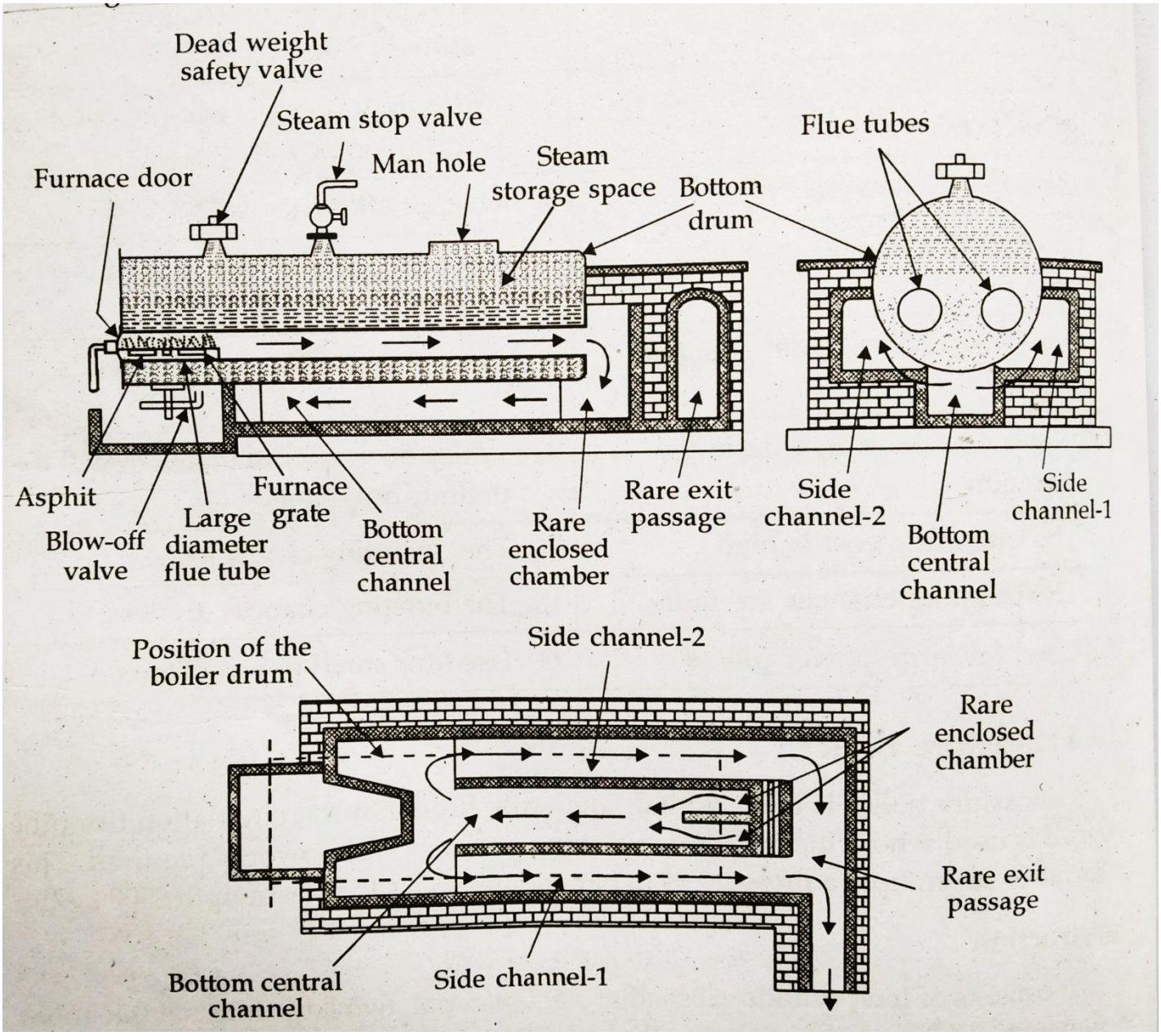
**Lancashire Boiler :** Lancashire boiler is a horizontal , internally fired, natural circulation fire tube boiler. It is used where moderate working pressure and power is required. This boiler raises steam up to a pressure of 15 bar and generates the steam up to 8500 kg/hr.

**Construction :**It consists of cylindrical shell of steel material, two large internal flue tubes fitted inside the boiler shell . In each of these flue tubes two fire grates are provided ,underneath the grate is the ash pit. The boiler shell is filled with water to ¾ th of its volume submerging both the flue tubes. The space remaining above the water surface in the boiler shell is for collecting the steam.

**Working :** When the fuel is charged on the fire grate through the furnace door with the sufficient amount of air. The hot gases produced by the burning of fuel initially passes along the length of the flue tubes through

them from the front end to the rear end of the boiler and during this pass heat transfer takes place from the hot gases to the water through the walls of the flue tubes.

**Lancashire Boiler :**




The flue gases from there , passes downwards and unitein the bottom centralchannel and travel towards front end of the boiler. During this path of the hot gases , theheat transfer takes place from the hot gases to the water through thebottom portion of the boiler shell exposed to the bottom central channel. After this passing along the central channel , the hot gases divide at the front end of the boiler shell and enter in to the side channel 1 and 2 , and in their third run pass through them to the rear end of the boiler. From there the hot

gases reunite in the rear passage and make their exit to the chimney through the rear passage. During this path of the hot gases in the side channels 1 and 2 ,theheat transfer takes place from the hot gases to the water through theside portion of the boiler shell and converts the water in to steam , gets accumulated in to the steam space. The steam accumulated in the steam space is taken out through the steam stop valve.

This boiler is fitted with essential mountings and accessories like, steam stop valve, safety valve, blow off valve, pressure gauge, water level indicator , etc.The super heater is provided at the rear end of the shell. The hot flue gases before they passed in to the bottom central channel heats up the steam in the super heater and convert in to superheated steam. Man holes are provided at the top and bottom of the boiler for cleaning and repair purposes.

**Advantages :**

1. Simple in construction.
2. It requires less brick work.
3. It has higher efficiency.
4. Most of its parts are readily accessible for inspection.
5. It holds a large quantity of water and can meet sudden demands of steam.
6. It is easy to operate.
7. It is reliable and quite suitable for permanent and stationary work.

**Disadvantages :**

1.Due to large diameter of the shell it is subjected to heavy stresses even at moderate pressures.

2.It is not suitable for pressure higher than 17.5 bar

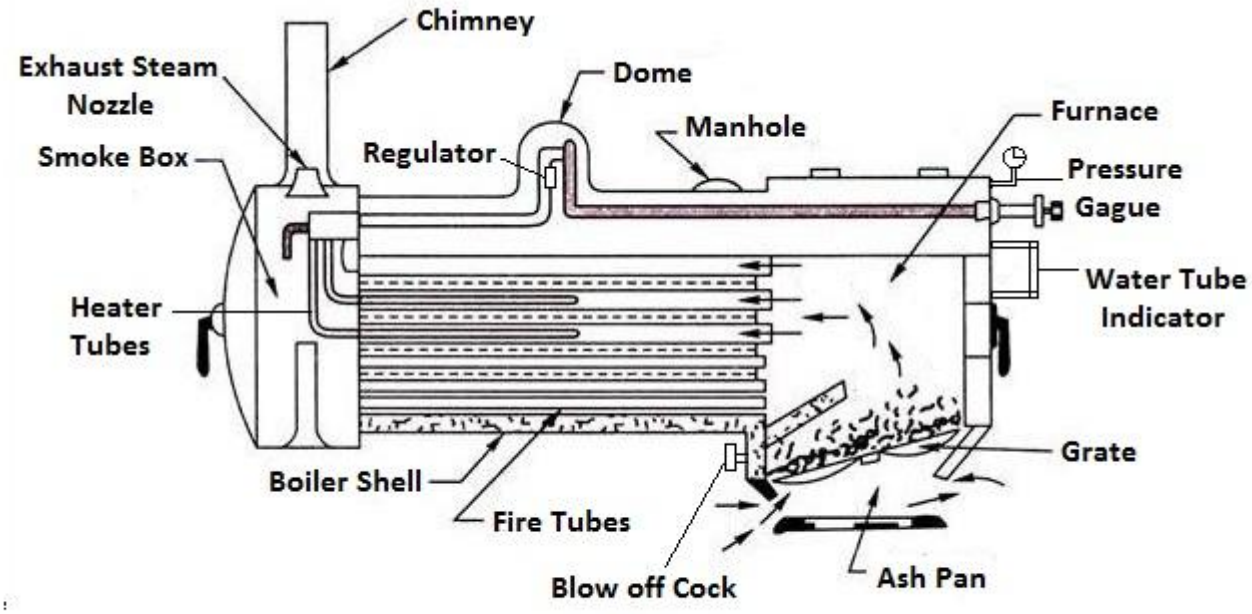
3.Slow steam generation.

**Locomotive boiler :**It is horizontal drum axis, artificial draft, natural circulation, multi-tubular, mobile, forced circulation, medium pressure, solid fuel fired fire tube boiler with the internally fired furnace.

It is used in marine engines and railway locomotive engines. It is a mobile boiler and has a high steam generation rate.

The main construction **parts of a locomotive boiler** are as follows:

1. Fire hole
2. Firebox
3. Grate
4. Fire brick arch
5. Boiler tubes
6. Smokebox
7. Blast pipe
8. Steampipe
9. Dome
10. Superheater element pipe
11. Superheater header
12. Chimney




Locomotive Boiler

**Working of Locomotive Boiler ;**

In a locomotive boiler, first, the solid fuel (coal) is inserted on the grate and is ignited from the fire hole. The burning of the fuel starts and it creates hot exhaust gases. A fire brick arch is provided that makes the flow of It also prevents the entry of burnt of solid fuel particles into the fire tubes.

The hot exhaust gases pass through the long fire tubes and heat the water surrounding them. Due to the heating, water gets transformed into saturated steam and collected at the top. Saturated steam from a dome enters into the steam pipe with the help of a regulator valve. The steam travels in the main steam pipe and reaches to the superheater header. From header, the steam enters into the superheater element pipes.

Here it is superheated and then the superheated steam enters into the steam pipe of the smokebox. The steam from the superheater goes to the cylinder ,where it can be led to the steam engine. The exhaust steam from the cylinder enters into the blast pipe.

The burnt gases and smoke after passing through the fire tubes enter into the smokebox. The exhaust steam coming out from the blast pipe pushes the smoke out of the boiler through the chimney. Like other boilers it is also provided with mountings and accessories for its safe and proper operation.

**Advantages of Locomotive Boiler**

1. It is portable.
2. This boiler is capable of meeting sudden and fluctuating demands of steam.
3. It is a cost-effective boiler.
4. High steam generation rate.
5. It is compact in size and its operation is easy.

**Disadvantages of Locomotive Boiler**

1. It faces the problems of corrosion and scale formation.
2. Unable to work under heavy load conditions because of overheating problems.
3. Some of its water space are difficult to clean.
4. The overall efficiency is less.

**Application of Locomotive Boiler**

1. Locomotive boilers are used in railways and marines.

2. This type of boiler is used in traction engines.

3. This is also used in steam rollers.

4. It is can be used in portable steam engines and some other steam road vehicles.

## Meaning of High Pressure Boilers:

- These are used to increase the efficiency of the plant. These are developed because of rising cost of fuel and restrictions on air pollution. Modern power generation plants generally use high pressure boilers. These high pressure boilers have pressures above 140 bar and the temperature may be up to 540 – 610°C.
- High pressure boilers use both natural and forced circulations. Forced circulation is achieved with the help of centrifugal pumps. By using this forced circulation, because of high velocity of water scale formation in the tubes and boiler drums is reduced.

**Advantages of High Pressure Boilers:**

1. Because of high velocities, tendency of scale formation in the tubes is reduced.

2. Small light weight tubes of better heating surface arrangements can be used. This makes the unit compact and reduces erection time and cost of boiler.

3. Due to forced circulation, for heating of all the parts is uniform, which avoids overheating and development of thermal stresses.

4. There is more flexibility in the arrangement of furnace, tubes and other boiler components.

5. The steam can be raised quickly to meet the variable load requirements.

6. The efficiency of the plant is increased.

7. A very rapid start from cold is possible if an external power supply is available. Hence the boiler can be used for carrying peak loads or standby purposes with hydraulic power stations.

## Advantages and Disadvantages of High pressure boiler over Low pressure Boiler :

**Advantages:**

1. Every part are equally heated, then the danger of over heating is reduced and thermal stress problem is simplified.

2. Heat of combustion is utilized extra efficiently by use of small diameter tube in large number and in many circuits.

3. The tendency of scale formation is eliminated due to high velocity of water through the tubes.

4. Pressurised combustion is used , which decrease rate or firing or fuel thus rising the rate of heat release.

5. Use of high pressure and high temperature steam is inexpensive.

6. Due to compactness less floor space is necessary.

**Disadvantages :**

1.Bubbles are formed at inner face of heating tube, because of which it reduces the heat transfer rate.

2.Tubes are possible to be over heated in case of water flow is insufficient.

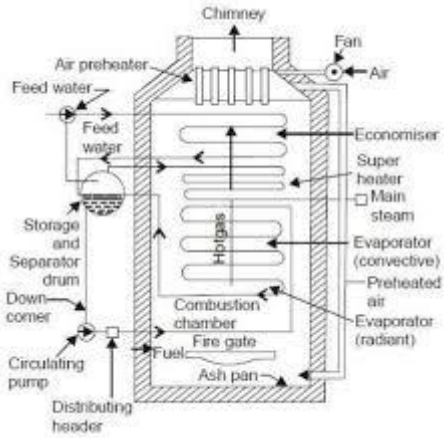
3.It can only function on liquid or gaseous fuels.

## Comparison between High pressure and Low pressure Boiler :

| Sl.No | High pressure boiler | Low pressure boiler |
|---|---|---|
| 1. | The steam is generated at a pressure of 80-300 bars and temperature of $450^0$C to $585^0$C. | In these boilers the pressure does not exceed 160 to 180 bars. |
| 2. | It uses the forced circulation. | It uses the natural circulation. |
| 3. | Function only on liquid or gaseous fuels. | They can function on any fuels. |
| 4. | Require less heat of evaporation. | Require high heat of evaporation. |
| 5. | Higher efficiency. | Lower efficiency. |
| 6. | More compact. | Less compact |
| 7. | Light in weight for a given output. | Heavy in weight for a given output. |

| | | |
|---|---|---|
| 8. | Steam can be raised quickly. | Steam can be raised slowly. |
| 9. | Absence of scaling due to forced circulation. | Scaling troubles due to natural circulation. |
| 10. | These requires small diameter steam separating drum or drum is not at all required. | It requires large diameter drum for holding water and drum. |
| 11. | Improved method of heating. | Conventional method of heating. |

**High Pressure Boiler :**Sketch and describe the construction and working of a La- Mont Boiler.




La-Mont Boiler

Lamont boiler is a high pressure, forced circulation, water tube boiler with internally fired furnace. An external pump is used to circulate the water within small diameter water tubes of the boiler. This boiler was invented by Walter Douglas La-Mont in the year 1925. At that time this boiler was invented to use in ships.

It works on the principle of forced circulation of water within the boiler with the help of centrifugal pump. Its working is totally depends upon the pump. The centrifugal pump circulates the mixture of steam and water through the small diameter tubes of the boiler.

**Working of Lamont Boiler**

- In Lamont boiler, the feed pump circulates the water in the economiser of the boiler. From economiser, water enters into steam separating drum.

- From steam separating drum the mixture of water and steam is forced circulated through the radiant evaporator by an external centrifugal pump. In forced circulation, the pressure of circulation of water through the tubes is more as compared with the natural circulation.
- Radiant evaporator heats the water and changes it into steam. Form radiant evaporator the water-steam mixture passes through the convective evaporator. Here the temperature of the fluid increase and most the water gets converted into saturated steam. And after that the saturated steam enters into the steam separator drum.
- The steam separator drum as names indicate separates the steam from water. The steam gets collected at the upper portion of the drum. From the steam separator drum, steam passes through the superheater. The superheater increases the temperature of the steam to the desired level. And finally, the superheated steam is either transfer to the steam collecting drum or made to strike on the blades of the turbine.
- The working pressure, temperature, and capacity of this boiler is 170 bar, 773 K and 50 tonnes/h.

**Advantages**

(i). It can be easily started.

(ii). High steam generating capacity (about 50 tonnes per hour)

(iii). It has high heat transfer rate.

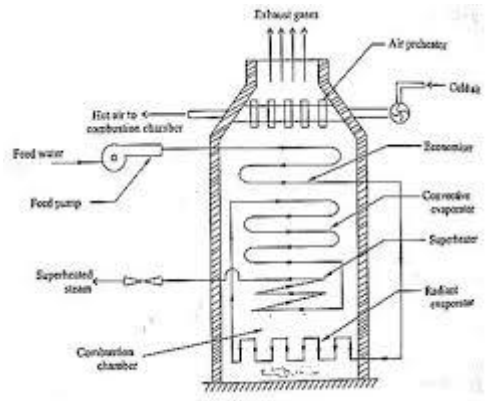
(iv). This boiler can be reassembled with the natural circulation boilers.

(v). Its design is simple.

**Disadvantages**

(i). There is a bubble formation at surfaces of the tubes in this boiler. This reduces the heat transfer rate to the steam.

## Benson Boiler :Sketch and describe the construction and working of a Benson Boiler.




Benson Boiler.

**Benson Boiler** is a high pressure, drumless, supercritical, water tube steam boiler with forced circulation. This boiler was invented in the year 1922 by Mark Benson. This boiler is a supercritical boiler in which the feed water is compressed to a supercritical pressure and this prevents the formation of bubbles in the water tube surface. The bubbles do not form because at supercritical pressure the density of water and steam becomes the same.

**Working Principle**

It works on the principle that the pressure of the water is increased to the supercritical pressure (i.e. above the critical pressure of 225 bar). When the pressure of water is increased to the supercritical level, the latent heat of water becomes Zero and due to this, it directly changes into steam without boiling. And this prevents the formation of bubbles at the tube surface.

**Working of Benson Boiler**

- In Benson Boiler, the feed pump increases the pressure of the water to the supercritical pressure, and then it enters into the economiser.
- From economiser, the water passes to the radiant heater. Here the water receives the heat through radiation and partly gets converted into steam. The temperature raises almost to the supercritical temperature.
- After that mixture of steam and water enters into convective evaporator where it is completely converted into steam and may superheated to some degree. Finally it is passed through the superheater to obtained the desired superheated steam.
- This superheated steam is then used by turbines or engines to produce electricity.

**Advantages**

The various advantages of the boiler are

- It is a drumless boiler and hence the weight of this type of boiler is 20 % less as compared with other types of boiler.
- It is light in weight.
- Occupy smaller floor area for its erection.
- Explosion hazard is almost negligible because of the use of smaller diameter tubes.
- It can be started very easily within 15 minutes.
- It avoids bubble formation due to the supercritical pressure of water.
- Transportation is easy.
- This boiler may achieve thermal efficiency upto 90 %.

**Application**

This supercritical boiler is used in different industries to generate steam for the production of electricity or mechanical power. The average operating pressure, temperature and capacity of benson boiler is 650 degree Celsius, 250 bar and 135 tonnes/hr .

**Boiler mountings and Accessories :**The boiler mounting and accessories are used in steam boilers for its proper, efficient and satisfactory working.

The different boiler mountings and accessories that are installed on the steam boiler are as follows

**Boiler Mountings**

1. Water level indicator ( Water level gauge)
2. Pressure gauge
3. Safety valvesp
4. Stop valve
5. Blow off Valve
6. Feed check valve
7. Fusible plug

**Boiler Accessories**

1. Air pre-heater
2. Superheater
3. Economiser
4. Feed pump
5. Steam trap :

The function of various boiler mountings and accessories are:

**1. Water Level Indicator**

- It is fitted in front of the boiler and generally present two in number.
- It is used to indicate the water level inside the boiler. It shows the instantaneous level of water that is present inside the steam boiler which is necessary for its proper working.

**2. Pressure gauge**

- It is also present in front of the boiler.
- It is used to measure the pressure of the steam inside the boiler.
- The pressure gauges generally used are of Bourden type

**3. Safety Valves**

- Safety valves are attached to the steam boiler chest.
- It is used to prevent explosion due to excessive internal pressure. When the internal pressure inside the boiler exceeds its working pressures than the safety valves blow off the steam and maintains the internal pressure.
- Generally two safety valves are present on a boiler.
- **4. Stop Valve (steam stop valve)**
- It is usually fitted on the highest part of the boiler with the help of a flange.
- The main function of the stop valve is

1. To control the flow of steam from the boiler to the main steam pipe.
2. To completely shut off the steam supply when required.

**5. Blow Off Valve**

- It is fitted at the bottom of the boiler drum.
- The functions of blow-off Valve is

1. To empty the boiler whenever required.
2. To discharge the scale, mud and sediments which gets collected at the bottom of the boiler.

**6. Feed Check Valve**

- It is non-return valve and fitted to a screwed spindle to regulate the lift.
- It is fitted to the shell slightly below the normal water level of the boiler. A boiler must have its spindle lifted before the pump is started.
- It regulates the supply of water which is pumped into the boiler by feed pump.

**7. Fusible Plug**

- It is fitted to the crown plate of the furnace or firebox.
- Its function is to extinguish fire in the furnace when the water level in the boiler falls to an unsafe limit. This avoids the explosion that may take place because of the overheating of the furnace plate.

**Boiler accessories:** the boiler accessories are the integral parts of the boiler. They are used in the boiler to improve its efficiency.

**1. Air preheater**

- It is used to recover heat from the exhaust gases.
- It is installed between the economiser and the chimney.

**2. Superheater**

- It is placed in the path of hot flue gases from the furnace.

- A superheater is an important accessory used in the boiler. Its main function is to increase the temperature of saturated steam without raising its pressure.

**3. Economiser**

- It is used to heat the feedwater by the utilization of heat from the hot fuel gases before it leaves the chimney.
- Aeconomiser improves the economy of the steam boilers.

**4. Feed pump**

- It is used to deliver water to the boiler.

**5. Steam trap :**

Steam trap is used to collect and automatically drain away the water resulted from partial condensation of steam without steam to escape with this condensate through a valve. The valve after draining the condensate is closed. Is presses the leakage of steam from the trap.

**Boiler draught system :**The difference between atmospheric pressure and the pressure existing in the furnace or flue gas passage of a **boiler** is termed as draft. Draft can also be referred to as the difference in pressure in the combustion chamber area which results in the motion of the flue gases and the air flow.

**The object of producing draught in a boiler is:**

(i) To provide sufficient quantity of air for combustion

(ii) To make the resulting hot gases, to flow through the system.

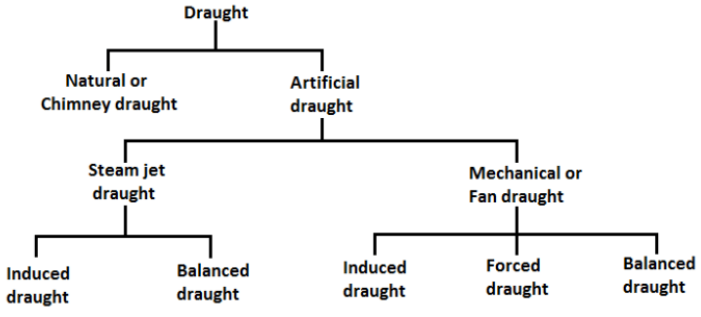
(iii) To discharge these gases to the atmosphere through the chimney.

**Classification of Draught system :**

**The classification of draught is as below:**

(1) Natural draught system.

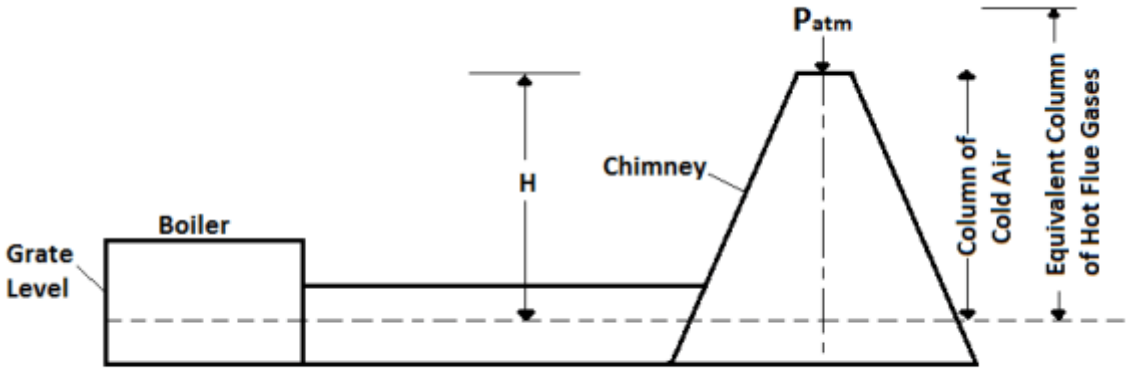
(2) Artificial draught system .




**Classification of Draught**

**Natural Draught System :**

Natural draught system employs a tall chimney as shown in the figure. The chimney is a vertical tubular masonry structure or reinforced concrete. It is formed for enclosing a column of flue gases to produce the draught.




Natural Draught

It removes the gases high enough to prevent air pollution. The draught is produced by this tall chimney due to the temperature difference of hot gases in the chimney and cold external air outside the chimney.

**Advantages of Natural Draught System :**

1. It does not require any external power for producing the draught.
2. The capital investment is less. The maintenance cost is low as there is no mechanical part.
3. Chimney keeps the flue gases at a high place in the atmosphere which prevents the contamination of the atmosphere.
4. It has a long life.

**Disadvantages of Natural DraughtSystem :**

1. The maximum pressure available for producing natural draught by the chimney is hardly 10 to 20 mm of water under the normal atmospheric and flue gas temperatures.
2. The available draught reduces with increases in outside air temperature and for generating enough draught, the exhaust gases have to be discharged at relatively high temperatures resulting in the loss of overall plant efficiency. Thus maximum utilization of Heat is not possible.

**Artificial or Mechanical Draught system :**

The draught required in the actual power plant is sufficiently high (300 mm of water) and to meet high draught requirements, some other system must be used, known as artificial draught. The artificial is produced by a fan and it is known as fan (mechanical) draught. Mechanical draught is preferred for central power stations.

**Advantages of Artificial or Mechanical Draught**

1. It is more economical and its control is easy.
2. The desired value of draught can be produced by mechanical means which cannot produced by means of natural draught.
3. It increases the rate of combustion by which low-grade fuel can also be used.
4. It reduces the smoke level and increases the heat transfer co-efficient no flue gases side thus increases the thermal efficiency of the boiler.
5. In mechanical draught, It saves the energy and the heat of flue gases can be best utilized by it.
6. In this way, it reduces fuel consumption and makes boiler operation cheaper.
7. It reduces the height of chimney which now is only controlled by the requirement of pollution norms.

**Disadvantages of Artificial or Mechanical Draught**

1. The initial cost of mechanical draught system is high.
2. Running cost is also high due to the requirement of electricity but that is easily compensated by the savings in fuel consumption.
3. Maintenance cost is also at a higher rate.
4. Noise level of boiler is also high due to noisy fan/blower etc.

**Types of ArtificialDraught :**

(A) The following are the three types of mechanical or fan draught:

1. Induced draught.
2. Forced draught.and 3. Balanced draught.

**Types of Steam Jet Draught**

(B)The following are the main two types of steam jet draught:

1. Induced steam jet draught.
2. Forced steam jet draught.

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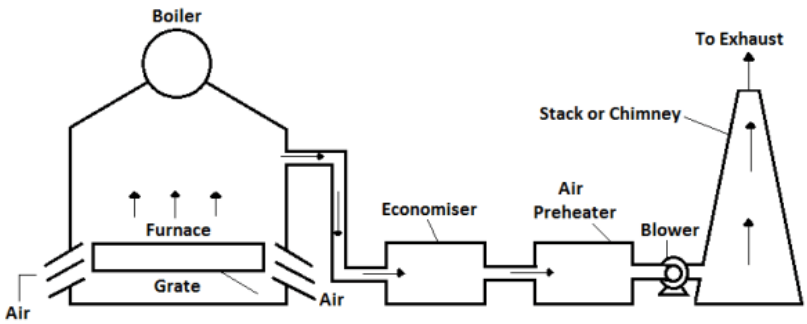
**Mechanical or Fan draught :**The draught, produced by means of a fan or blower, is known as mechanical draught or fan draught. The fan used is, generally, of centrifugal type and is driven by an electric motor. The following are the three types of mechanical or fan draught:

1. Induced draught.
2. Forced draught.and
3. Balanced draught.

**Induced draught:**In induced draught, the blower is placed near the base of the chimney instead of near the grate. The air is absorbed in the system by decreasing the pressure through the system below the atmosphere. The induced draught fan sucks the burned gases from the furnace and the pressure inside the furnace is reduced below atmosphere and includes the atmospheric air to flow through the furnace.

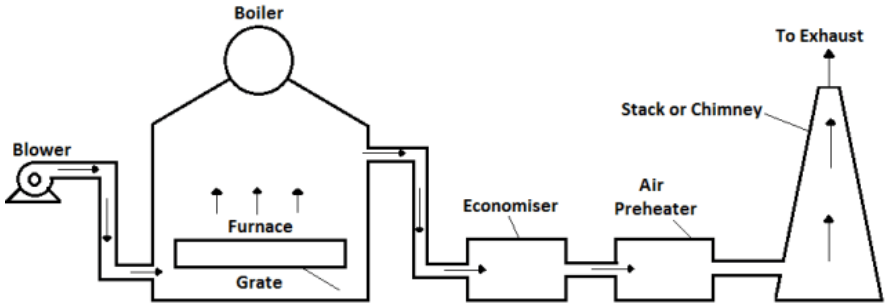



Induced Draught System

The action of the induced draught is related to the action of the chimney. The draught produced is free from the temperature of the hot gases, therefore, the gases may be released as cold as possible after recovering as much heat as possible in air-preheater and economiser.

## 2. Forced Draught :

In a forced draught system, a blower is installed near the base of the boiler and air is forced to pass through the furnace, flues, economiser, air-preheater and to the stack. This draught system is known as positive draught system or forced draught system because the pressure and air are forced to flow through the system

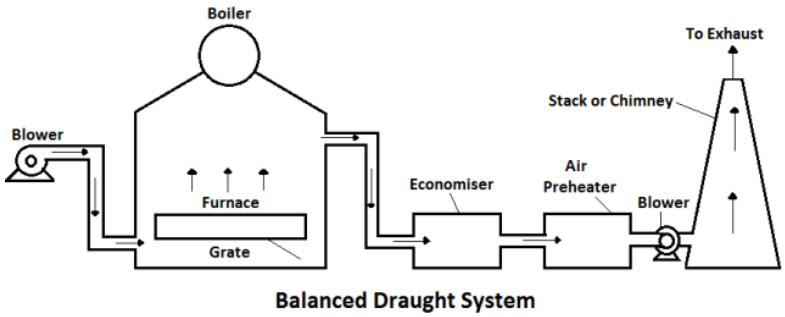



**Forced Draught System**

The arrangement of the system is shown in the figure. A stack or chimney is also in this system as shown in the figure but its function is to discharge gases high in the atmosphere to prevent the contamination. It is not much significant for producing draught, therefore, the height of the chimney may not be very much.

## 3. Balanced Draught :

It is always better to use a combination of forced draught and induced draught instead of forced or induced draught alone. If the forced draught is applied alone, the furnace cannot be opened for firing or inspection because high-pressure air inside the furnace will quickly try to blow out and there is every possibility of blowing out the fire completely and furnace stops.




**Balanced Draught System**

If the induced draught is used alone, then also furnace can not be opened either for firing or inspection because the cold air will try to rush into the furnace as the pressure inside the furnace is under atmospheric pressure. This reduces the effective draught and dilutes the combustion.

Comparison Between Forced Draught and Induced Draught

| ***Forced Draught*** | ***Induced Draught*** |
|---|---|
| Fan or blower is placed before the grate | Fan or blower is placed after the grate |
| The pressure inside the flue gases is slightly more than atmospheric pressure | The pressure inside the flue gases is slightly less than atmospheric pressure |
| Fan requires less power | Fan requires more power |
| The flow of the flue gases through the boiler is more uniform | The flow of the flue gases through the boiler is less uniform |
| The danger of fire in case of leakage of flue gases. | No danger of fire in case of leakage of flue gases. |

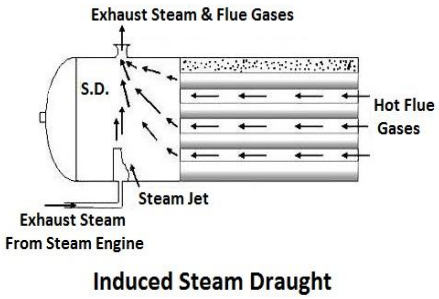
## Types of Steam Jet Draught :

The following are the main two types of steam jet draught:

1. Induced steam jet draught.
2. Forced steam jet draught.

### 1. Induced Steam Jet Draught :

The jet of steam is turned into a smoke box or chimney. The kinetic head of the steam is high but static head is low i.e., it produces a partial vacuum which brings the air through the grate, ash pit, flues and then to motor box and chimney.This type of induced steam jet draught arrangement is used in locomotive boilers.




Induced Steam Draught

Here the steam jet is absorbing the exhaust gases through boiler so it is Induced Steam Jet Draught.

**2. Forced Steam Jet Draught :**

Steam from the boiler after having been throttled to a gauge pressure of 1.5 to 2 bar is supplied to the jet or nozzle installed in the ash pit. The steam rising out of nozzles with a great velocity drags air by the fuel bed, furnace, flue passage and then to the chimney. Here the steam jet is pushing or forcing the air and flue gases to flow through boiler hence it is forced steam jet draught.

**Advantages of Induced Steam Jet Draught**

1. It is quite simple and cheap.
2. The induced steam jet draught has the capability of using low-grade fuels.
3. It occupies very less space.
4. It is quite simple and cheap.
5. The initial cost is low.
6. Maintenance cost is low.
7. Exhaust steam from the steam engine or turbine can be used easily in the steam jet draught.

**Disadvantages of Steam Jet Draught**

1. It can operate only when some steam is generated.
2. Draught produced very low.

## Difference between Natural Draught and Artificial Draught.

| S.No. | Natural Draught | Artificial Draught |
|---|---|---|
| 1 | Initial cost is high | Initial cost is not so high |
| 2 | Natural draught cannot be controlled | Artificial draught is better in control |
| 3 | In natural draught rate of combustion is low | In artificial draught rate of combustion is very high |
| 4 | In the natural draught, low-grade fuel cannot be burnt properly | In the artificial draught low-grade fuel can be used |
| 5 | Natural draught is considerably affected by the atmospheric temperature | Artificial draught is not affected by the atmospheric temperature |
| 6 | Natural draught has lower efficiency | Artificial draught has higher efficiency. |
| 7 | In natural draught, fuel consumption is more | In artificial draught fuel consumption is less |