Swami Keshvanand Institute of Technology, Management & Gramothan,
Ramnagaria, Jagatpura, Jaipur-302017, INDIA
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Recognized by UGC under Section 2(f) of the UGC Act, 1956
Tel. : +91-0141- 5160400Fax: +91-0141-2759555
E-mail: info@skit.ac.in Web: www.skit.ac.in

What is a Boiler?

A boiler is a closed vessel which is used to convert the water into steam. The high pressure steam so generated is used to generate power.

Working Principle of a Boiler

The boiler contains water. The water is heated to its boiling temperature by the use of heat from the furnace. Due to heating of water, it gets converted into high pressure steam. The steam generated is passed through the steam turbines. As the high pressure steam strikes the turbine, it rotates the turbine. A generator is attached to the turbine and the generator also starts to rotate with the turbine and produces electricity.

Different Types of Boiler

Boilers can be classified in different basis but here we are discussing the only important basis of boiler classification.

1. **According to the Contents in the Tubes**

According to the contents in the tubes, the boilers can be classified as fire tube boiler and water tube boiler.

(i) **Fire Tube Boiler:**

In fire tube boiler the fire or hot gas are present inside the tubes and water surrounds these fire tubes. Since fire is inside the tubes and hence it is named as fire tube boiler. The heat from the hot gases is conducted through the walls of the tube to the water.

The examples of the fire tube boiler are: simple vertical boiler, Cochran boiler, Lancashire boiler, Cornish boiler, Locomotive boiler.

(ii). **Water Tube Boiler:**

In water tube boilers, the water is present inside the tubes and the fire or hot gases surrounds these water tubes.

The examples of water tube boilers are: La-Mont boiler, Benson boiler, Babcock and Wilcox boiler.

2. **According to the Number of Tubes**

According to the no of tubes, the boilers are classified as single tube boiler and multitubular boilers.

(i). **Single Tube Boilers**:

The boilers which contain one fire tube or water tube are called as single tube boiler.

The examples of single tube boilers are Cornish boiler and simple vertical boiler.

(ii). **Multitubular Boiler**:

The boilers which has two or more water tube or fire tubes are called multi tubular boilers.

Lancashire boiler, Locomotive boiler, Cochran boiler, Babcock and Wilcox boilers are multitubular boilers.

3. **According to the Position of the Furnace**

According to the position of the furnace, the steam boilers are classified as internally fired boilers and externally fired boilers.

(i). **Internally Fired Boilers**:

The boilers in which the furnace is located inside the boiler shell are called internally fired boilers. Among all the fire tube boilers, most of the boilers are internally fired boilers.

(ii). **Externally Fired Boilers**:

In externally fired boilers, the furnace is located outside the boiler shell. In this the furnace is arranged underneath in brick work setting. Water tube boilers are always externally fired boilers.

4. **According to the Axis of the Shell**

According to the axis of the shell, the boilers are classified as vertical boilers and horizontal boilers.

(i). **Vertical Boilers**:

the in which the axis of the shell is vertical are called vertical boilers. Examples of vertical boilers are: simple vertical boiler and Cochran boiler.

(ii). **Horizontal Boilers**:

when the axis of the shell in a boiler is found horizontal than it is called as horizontal boiler. Lancashire boiler, Babcock and Wilcox boiler and locomotive boilers are examples of horizontal boilers.

5. **According to the Methods of Circulation of Water and Steam**

According to the method of circulation of water and steam, the steam boilers are divided into natural circulation boilers and forced circulation boilers.

(i). **Natural Circulation Boilers**:

In natural circulation boilers, the circulation of water takes place naturally by the convection currents that set ups during the heating of water. In most of the boilers there is a natural circulation of water such as Lancashire boiler, Cochran boiler etc.

(ii). **Forced Circulation Boilers**:

In this type of steam boilers, the water circulation takes place with the help of a centrifugal pump driven by some external power. Here the circulation is forced by some external agency. Forced circulation is used in high pressure boilers such as La-Mont boiler, Loeffler boiler, Benson boiler etc.

6. **According to the use**

According to the use, the boilers are classified as stationary boilers and mobile boilers

(i) **Stationary Boilers**:

These are the boilers which are stationary and cannot be moved from one place to another. Once they are installed, cannot be transported to other destination. These boilers are used in power plants and in industrial process works.

(ii). **Mobile Boilers**:
These are the steam boilers which can be moved from one place to another. Locomotive and marine boilers are mobile boilers.

7. **According to Pressure of steam generated**

1. **Low-pressure boiler**: A boiler which produces steam at a pressure of 15-20 bar is called a low-pressure boiler. This steam is used for process heating.
2. **Medium-pressure boiler**: It has a working pressure of steam from 20 bars to 80 bars and is used for power generation or combined use of power generation and process heating.
3. **High-pressure boiler**: It produces steam at a pressure of more than 80 bars.

BOILER MOUNTINGS AND ACCESSORIES:

Boiler Mountings

These are the fittings, which are necessarily mounted on the boiler itself and mandatorily required for the safe and proper operation of boiler. Various boiler mountings are being discussed here one by one.

1. **Water level indicator**: Water level indicator is fitted outside the boiler shell to indicate the water level in the boiler through a glass tube. In any type of boiler, water should remain at the designed level. If the water falls below the level due to change of phase into steam and simultaneously fresh water does not fill in by some reason, the hot surface may expose to steam only and overheat. This is because the heat transfers co-efficient of steam is very less as compared to water. Due to overheat, damage of tube surface may occur. To avoid this situation, level of water in the boiler needs to be constantly monitored & maintained by boiler operator by keeping watch on water level indicator**.**
2. **Pressure Gauge:** A pressure gauge is used to indicate the pressure of steam in the boiler. It is generally mounted on the front top of the boiler. Pressure gauge is of two types as (i) Bourdon Tube Pressure Gauge (ii) Diaphragm type pressure gauge. Both these gauges have a dial in which a needle moves over a circular scale under the influence of pressure. At atmospheric pressure it gives zero reading. Some gauges indicate only the positive pressure but some are compound and indicate negative pressure or vacuum also. Looking at the gauge, boiler operator can check the safe working pressure of the boiler and can take necessary steps to keep the pressure within safe limits. If pressure increases and crosses the safe limit due to any reason, the boiler shell material may fail and it can burst

causing damage to life and property. Thus it is very important to constantly monitor pressure in a boiler with the help of pressure gauge.

3. **Spring loaded safety valve:** Spring loaded safety valve is a safely mounting fitted on the boiler shell and is essentially required on the boiler shell to safeguard the boiler against high pressure. It is a vital part of boiler and always be in good working condition to protect the boiler from bursting under high pressure and so to save life and property.
4. **Fusible plug:** The function of fusible plug is to protect the boiler from damage due to overheating of boiler tubes by low water level.
5. **Blow-off-cock:** It is a controllable valve opening at the bottom of water space in the boiler and is used to blow off some water from the bottom which carries mud or other sediments settled during the operation of boiler. It is also used to completely empty the water when the boiler is shut off for cleaning purpose or for inspection and repair.
6. **Steam stop valve:** It is fitted over the boiler in between the steam space and steam supply line. Its function is to regulate the steam supply from boiler to the steam line.

Boiler Accessories

Boiler accessories are the components which are attached to the boiler (Not mounted on it) and are essentially for working of boiler and for increasing its efficiency. Various boiler accessories are discussed as below

1. Feed pump

Feed pump is placed nearby the boiler and is used to feed water to boiler working at a high pressure. The job of feed pump is not just put the water in the boiler but as boiler is working at high pressure, discharge pressure of feed pump must be sufficiently higher than this to push the water inside the boiler.

Centrifugal pump is used as a boiler feed pump.

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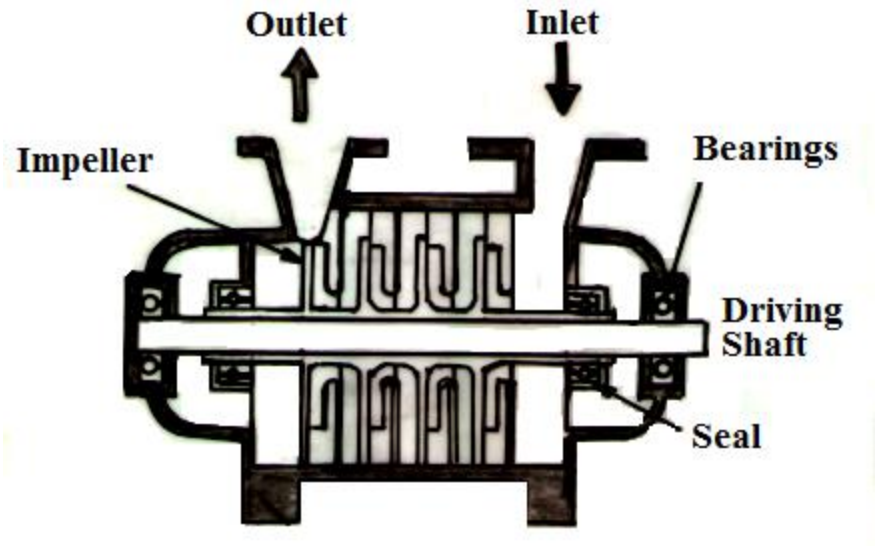
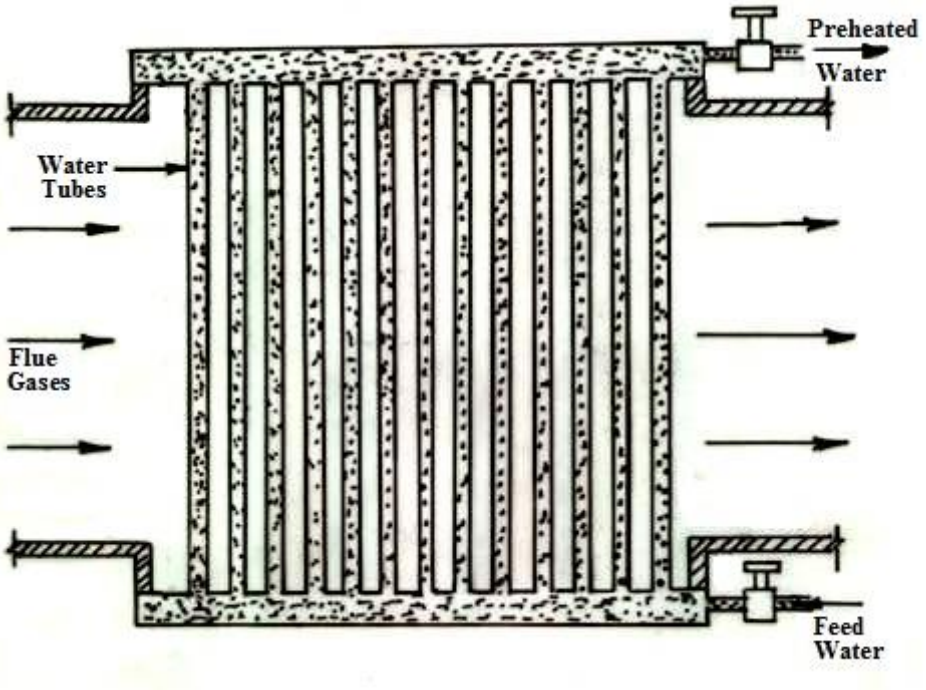


2. Economizer

An economizer is a specially constructed heat exchanger for harnessing the heat energy of outgoing flue gases and utilizing it in preheating of boiler feed water. It saves the heat energy and so the fuel and decreases the operating cost of boiler by increasing its thermal efficiency.



3. Air Pre-heater

The function of air pre-heater is to further utilize the heat of flue gases after coming out of economizer to preheat the air used in furnace or oil burner.

4. Super heater

The function of super heater is to increase the temperature of steam beyond its saturation temperature. It is a type of heat exchanger. Hot flue gases coming out of burner are first directed through super heater before the boiler. The main advantage of superheating of steam comes in power plants, where steam is expanded through a turbine. But in a processing industry superheating is required only to avoid condensation in pipes. Thus super heater has less advantage or use in a processing industry and many times not used but not always.

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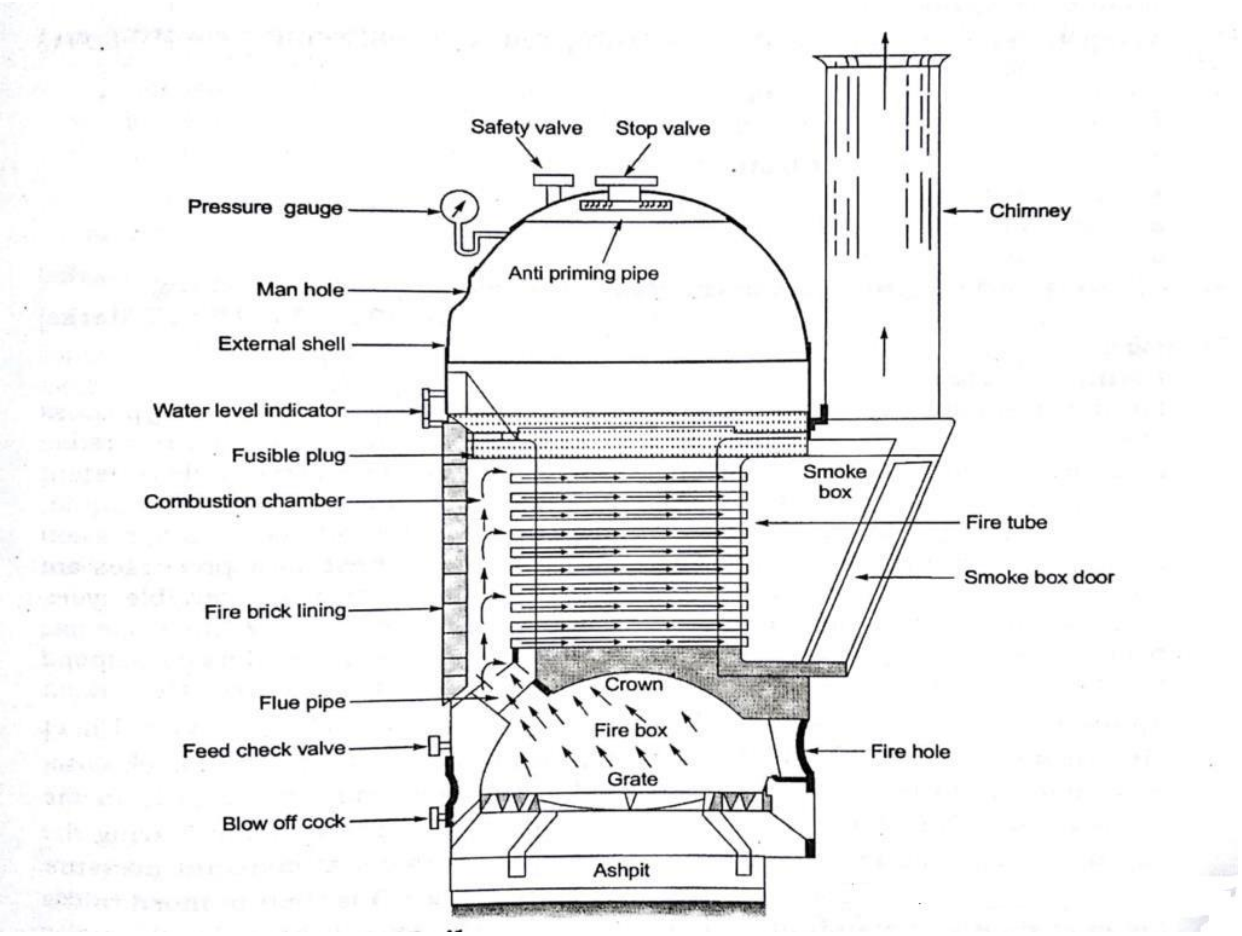
TYPES OF BOILERS

Cochran Boiler

Cochran Boiler is a vertical drum axis, natural circulation, natural draft, low pressure, multi-tubular, solid fuel fired, fire tube boiler with internally fired furnace. It is the modified form of a simple vertical boiler. In this boiler, the fire tubes are placed horizontally. The efficiency of this boiler is much better than the simple vertical boiler.

Main Parts and Construction



1. **Shell**: It has a vertical axis cylindrical drum with a hemispherical dome-type shell at the top.
2. **Grate**: It is the platform on which the solid fuel is burnt.
3. **Combustion Chamber**: The burning of fuel takes place in the combustion chamber.
4. **Fire Tube:** boiler has multi-tubular fire tubes. The hot flue gases from the combustion chamber travels to the smokebox through these fire tubes. The fire tubes helps in the exchange of heat from the hot flue gases to the water.
5. **Fire Hole**: It is the hole provided to fire the fuel inside the furnace.
6. **Furnace**: It lies at the bottom of the boiler. Furnace is the place where all the fuel is burnt. Without furnace, the working of this boiler is not possible.

7. **Chimney**: The chimney is attached to the smokebox. It transfer smoke to the environment. The size of the chimney is small as compared with other boiler.
8. **Fire Brick Lining**: The fire brick lining is present in the combustion chamber and helps in the combustion of the fuel.
9. **Manhole**: A manhole is provided for the cleaning and inspecting of the boiler from inside.
10. **Flue Pipe**: It is a small passage connecting the firebox and combustion chamber. The hot gases enter into the combustion chamber through the flue pipe.

Working

In Cochran boiler first the fuel is inserted into the firebox and placed on the grate. The fuel is ignited through the fire hole provided at the right bottom of the boiler. The fuel is burnt in the firebox, and due to the burning of the fuel, smoke and hot flue gases emerge out. The hot flue gases enter into the combustion chamber. From the combustion chamber, hot gases enter into the fire tubes. The fire tubes are surrounded by water. The hot flue gases inside the tubes exchange the heat from the hot gases to the water. Due to the exchange of heat, the temperature of the water starts increasing and it gets converted into steam. The steam produced rises upward and collected at top of the boiler in the hemispherical dome. An anti- priming pipe is installed at top of the boiler which separates the water from the steam and makes it dry steam. This dry steam is then transferred to the turbines through the steam stop valve.

The hot flue gases and smoke after exchanging heat moves to the smoke box. From the smoke box, the burnt gases and smoke is discharged to the atmosphere through the chimney. Burnt fuel is transferred to the ash pit. Blow off Valve is preset at left bottom of the boiler and is used to blow off the impurities, mud, and sediment from the boiler water.

A fusible plug is also provided at the top of the combustion chamber. When the temperature of the combustion chamber crosses the permissible level, the fusible plug melts and the water through the combustion chamber enters into the furnace of the boiler and stops the fire. In this way, a big fire accident can be prevented to take place and also protects the boiler from damage.

Advantages

1. Low initial installation cost.
2. It requires less floor area.
3. Easy to operate and handle.
4. Transportation of Cochran boiler is easy.
5. It can use all types of fuel.

Disadvantages

1. Low rate of steam generation.
2. Inspection and maintenance is difficult.
3. High room head is required for its installation due to the vertical design.
4. It has limited pressure range.

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Locomotive Boiler

Locomotive boiler is a horizontal drum axis, multi-tubular, natural circulation, artificial draft, forced circulation, mobile, medium pressure, solid fuel fired fire tube boiler with an internally fired furnace. It is used in railway locomotive engines and in marine. It is a mobile boiler and has a high steam generation rate.

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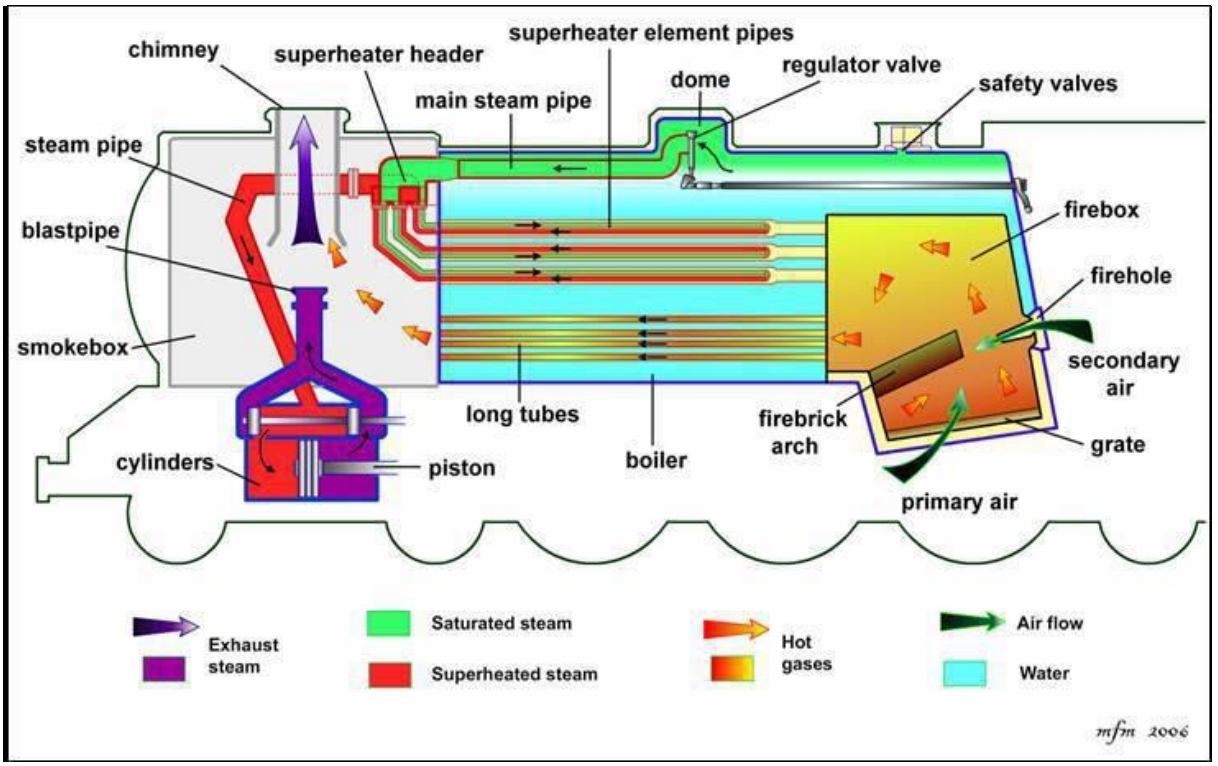
Construction



The construction or main parts of a locomotive boiler are:

1. **Fire hole**: It is a hole provided at the rear end of the boiler. The solid fuel is inserted and ignited into the furnace through this hole.
2. **Furnace**: It is a box in which the burning of the fuel takes place.
3. **Grate**: Grate is a platform on which the solid fuel is kept and burnt.
4. **Fire brick arch**: It is a brick arch placed inclined over the grate. It prevents the entry of the ash, dust and burnt fuel particles into the fire tubes. It provides a way to the hot flue gases to travel a definite path before entering into the fire tubes of the boiler.
5. **Boiler tubes**: They are the fire tubes through which the hot flue gases pass and exchange the heat with the surrounding water.
6. **Smoke box**: According to its name, it is a box in which the smoke of the burnt fuel after passing through the fire tubes gets collected. From there it is exhausted in the environment by the chimney.
7. **Blast pipe**: It is a pipe provided above the steam engine. The exhaust steam passes through this blast pipe. It is used to create an artificial draft that pushes the smoke out through the chimney and creates suction for the hot flue gases. The suction created allows the hot flue gases to move forward through the fire tubes.

8. **Steam pipe**: It is a pipe through which the steam passes. We have two steam pipes; one is the main steam pipe present in between the super-heater header and dome. And the second one is that which connects the super-heater exit end to the steam engine.
9. **Superheater**: It superheats the steam to the desired temperature before entering into the cylinder of the steam engine.
10. **Super heater element pipes**: These are the pipes of superheater through which the steam travels and gets superheated.
11. **Dome**: It is present at the top and contains the regulator for regulating the steam produced through the steam pipe.
12. **Regulator valve**: It is a valve that regulates the steam through the main steam pipe for superheating.
13. **Safety valve**: It is used to maintain the safe working steam pressure in the locomotive boiler. It blows off steam when the pressure of the steam increases above safety level and prevents blasting of the boiler.
14. **Superheater header**: It is the head of the superheater which accepts the steam from the steam pipe.
15. **Chimney**: It is used to throw out the exhaust smoke and gases to the environment. The length of the chimney is very small in this boiler.

Working

In the 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 flue gases. A fire brick arch is provided that makes the flow of hot flue gases to a definite path before entering into the long tubes (fire tubes). It also prevents the entry of burnt solid fuel particles into the fire tubes.

The hot flue gases pass through the long fire tubes and heat the water surrounding them. Due to the heating, the water gets converted into saturated steam and gets collected at the top. The saturated steam from the dome enters into the main steam pipe through the regulator valve. The steam travels in the main steam pipe and reaches to the super-heater header. Form header, the steam enters into super-heater element pipes. Here it is superheated and then the superheated steam enters into the steam pipe of the smoke box.

The steam from the super-heater goes to the cylinder containing piston. The superheated steam made the piston moves within the cylinder. The piston is connected to the wheels of the steam engine and the wheels start rotating.

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 smoke box. The exhaust steam coming out from the blast pipe pushes the smoke out of the boiler through the chimney. Here the smoke cannot escape out from the boiler on its own, so artificial draft is created by exhaust steam coming out from the steam engine. This artificial draft created pushes the smoke out of the smoke box and creates suction for the hot flue gases.

Advantages

It is portable and can be easily transported.
It is capable of meeting sudden and fluctuating demands of steam.
It is a cost-effective boiler.
It has a high steam generation rate.

Disadvantages

It faces the problems of corrosion and scale formation.
Unable to work under heavy load conditions because of overheating problems.
Some of its water spaces are difficult to clean.

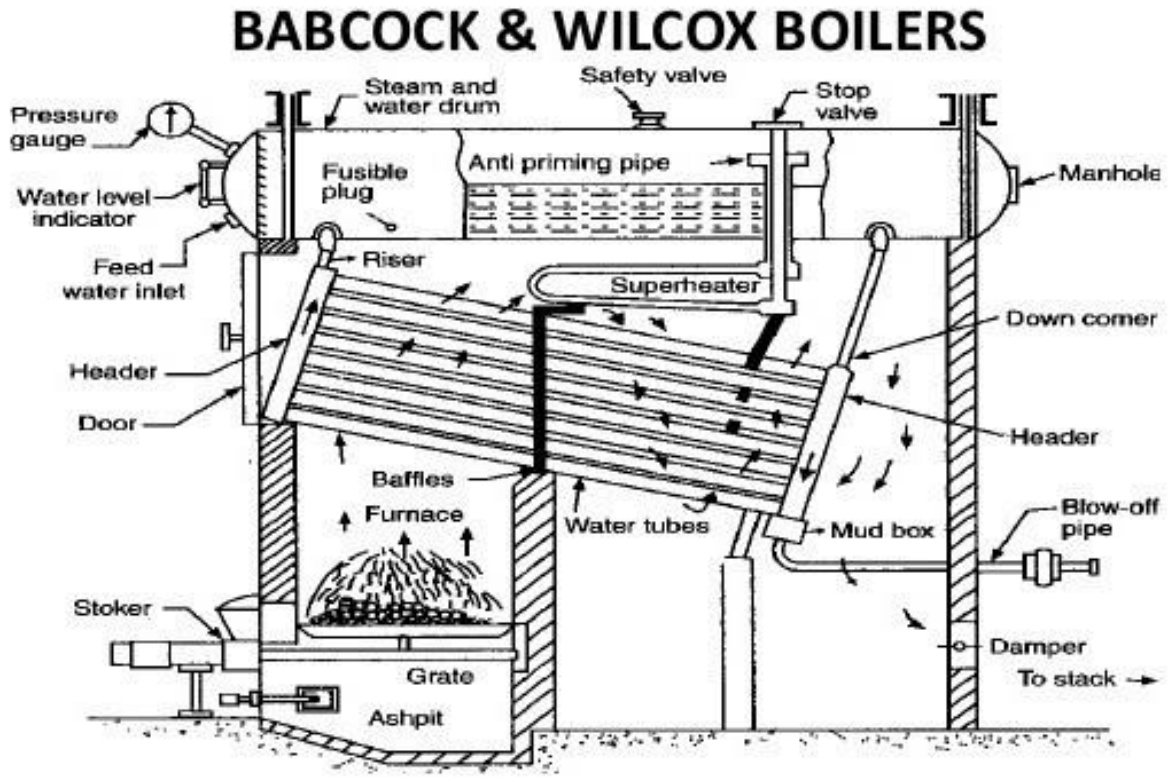
Application

Locomotive boilers are mostly used in railways and marines. The efficiency of this boiler is very less. It cannot work in heavy-load conditions because this leads to the overheating of the boiler and finally gets damage. They are also used in traction engines, steam rollers, portable steam engines, and some other steam road vehicles.

Babcock and Wilcox Boiler

It is a Horizontal drum axis, natural draft, natural circulation, multitubular, stationary, high pressure, solid fuel fired, externally fired water tube boiler.

Construction



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The various main parts of Babcock and Wilcox Boiler are as follows

1. **Drum**: It is horizontal axis drum which contains water and steam.
2. **Down Take Header**: It is present at rear end of the boiler and connects the water tubes to the rear end of the drum. It receives water from the drum.
3. **Up Take Header**: it is present at front end of the boiler and connected to the front end of the drum. It transports the steam from the water tubes to the drum.
4. **Water Tubes**: They are the tubes in which water flows and gets converted into steam. It exchanges the heat from the hot flue gases to the water. It is inclined at angle of 10-15 degree with the horizontal direction. Due to its inclination the water tubes do not completely filled with water and the water and steam separated out easily.
5. **Baffle Plates**: Baffle plates are present in between water tubes and it allows the zigzag motion of hot flue gases from the furnace.
6. **Fire Door**: It is used to ignite the solid fuel in the furnace.
7. **Grate**: It is a base on which the burning of the solid fuel takes place.
8. **Mud Collector**: It is present at the bottom of down take header and used to collect the mud present in the water.
9. **Feed Check Valve**: it is used to fill water into the drum.10. Damper: It regulates the flow of air in the boiler.

The various boiler mounting and accessories used in this type of boiler are:

1. **Superheater**: It increases the temperature of saturated steam to the required temperature before discharging it from steam stop valve.
2. **Pressure Gauge**: It is used to check the pressure of steam within the boiler drum.
3. **Water Level Indicator**: It shows the level of water within the drum.
4. **Safety Valve**: It is a valve which acts when the pressure of steam within the boiler drum increase above the safety level. It opens and releases the extra steam in the environment to maintain the desired pressure within the boiler.

Working

First the water starts to come in the water tubes from drum through down take header. The water present in the inclined water tubes gets heated up by the hot flue gases. The coal burning on the grate produces hot flue gases and it is forced to move in zigzag way with the help of baffle plates. As the hot flue gases come in contact with water tubes, it exchanges the heat with water and converts it into steam. The steam generated is moved upward and through up take header it gets collected at upper side in the boiler drum.

An anti-priming pipe is provided in the drum. This anti-priming pipe filters the water content from the steam and allows only dry steam to enter into super-heater. The super-heater receives the water free steam from the anti-priming pipe. It increases the temperature of steam to desired level and transfers it to the steam stop valve. The superheated steam from the steam stop valve is either collected in a steam drum or made to strike on the steam turbine for electricity generation.

Advantages

1. Steam generation capacity is high. It is about 2000 to 40000 kg/hr.
2. It occupies less space.
3. Replacement of defective tubes is easy.
4. It is the only boiler that is used to generate large quantity of heat in power stations.
5. The draught loss is minimum.
6. Inspection of this types of boiler can be done anytime during its working.

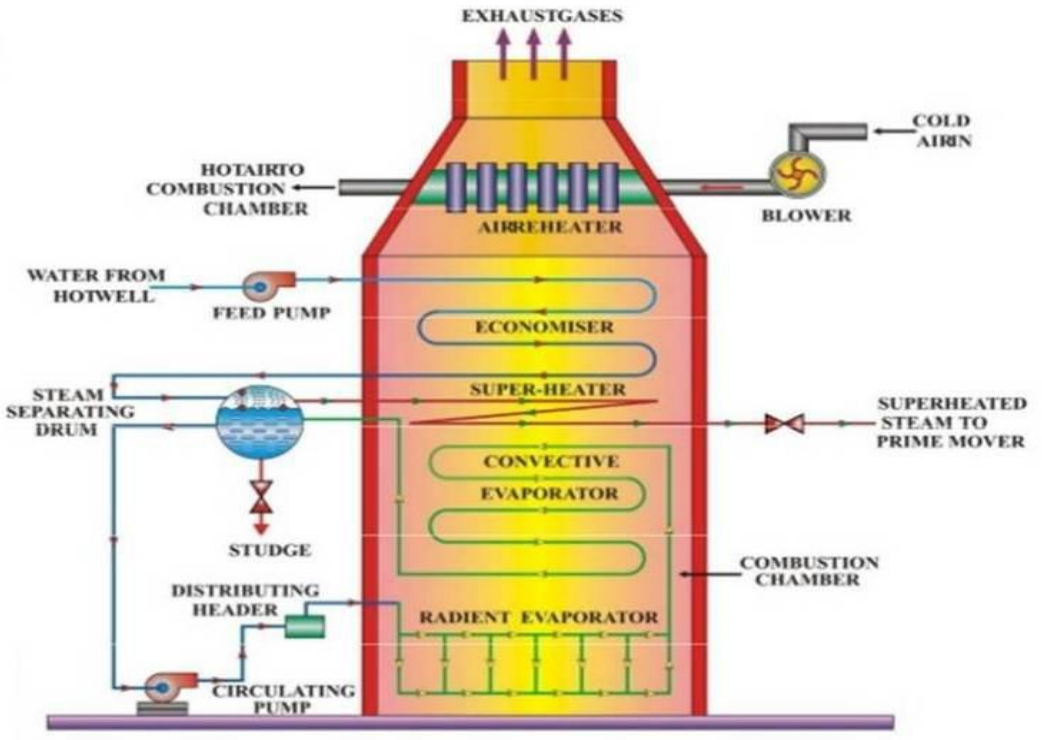
Disadvantages

1. High maintenance cost.
2. It is not much suitable for impure and sedimentary water. In case of impure and sedimentary water, scale may deposit in the tubes and this leads to overheating and bursting of tubes. That's why water treatment is must before feeding into the boiler.
3. Continuously supply of feed water is required for the working. In the case if feed water is not continuously supplied even for a short period of time, the boiler gets overheated. Water level must be carefully watched during the operation of the Babcock and Wilcox boiler.

Lamont Boiler

Lamont Boiler is the first forced convection boiler.It is a high pressure water tube, forced
circulation externally fired. In lamont boiler, external water pump is used to circulate water within water tubes of the boiler. So, pressure of water in the tubes is more as compared with pressure of water in natural circulation boiler.

Construction:



Lamont Boiler

In lamont boiler, air blower is connected to the air preheater and supply air to this. This air preheater is connected to the furnace.
The water feed pump is connected to the economizer which preheats the water in this economizer is connected to steam seperator drum.The Steam seperator drum is connected to the radiant evaporator which is located near combustion chamber and this radiant evaporator is connected to convective evaporator which is present above it.
The steam seperator drum is also connected to the super heater which further heats the air to desired level and then transfer the steam to turine to produce electricity.

These are the main parts of Lamont Boiler:
1. **Feed Pump**: Feed Pump supply water into the boiler from hot well.
2. **Economizer**: Economizer is used to increase the temperature of feed water.
3. **Centrifugal Pump**: Centrifugal pump is used to circulate water inside the Lamont Boiler as it is a forced circulation boiler. The pump is driven by a steam turbine and the steam for this turbine is taken by the boiler. This boiler uses its own steam to drive its pump that circulate water in it.
4. **Steam Seperating Drum**: Role of this part of Lamont Boiler is indicated by its name. It seperates steam from water.
5. **Super Heater**: Steam generated from the evaporator is saturated steam and if used in steam turbine can cause corrosion on the turbine. So the saturated steam is sent to the super heater where it converts into superheated steam and this superheated steam is sent to turbine.
6. **Radiant Evaporator**: Radiant Evaporator heats the water with help of radiation. It is located near furnace.
7. **Convective Evaporator**: Convective Evaporator is located above the Radiant Evaporator. It heats the water by convection process.
8. **Air preheater**: Air preheater is present near the top of the Lamont Boiler. Its main function is to improve thermal efficiency of boiler by preheating the air from coming from the blower and this preheated air is sent to the furnace.
9. **Blower:** It blows the air into the air preheater which further is sent to furnace to increase the efficency of boiler.

Working Of Lamont Boiler:
At first, the air blower will blow air to the air preheater where air is preheated and sent to the furnace to increase the thermal efficiency of the boiler.
On the otherside, the water feed pump circulates the water into the economizer of the boiler. The economizer heat the water to some extent and this water is sent to the steam seperator drum. After the steam seperator drum, this water is forced circulated through the radiant evaporator by the external centrifugal pump which is driven by steam turbine. Radiant evaporator heats the water and convert some portion of water into steam. Water and steam mixture from the radiant evaporator is sent to convective evaporator. In convective evaporator, water is further heated and most of the water converts into saturated steam. Water passes from these two evaporators 10 – 15 times until almost all water converts into saturated steam.
The mixture of saturated steam and water is then sent to steam seperator drum to seperate the steam from water. In the steam seperator drum, the steam is collected at upeer portion of the drum and the remaining water settles down.
This saturated steam present in steam seperator drum cannot be sent to the turbine directly as it will cause corrosion in the turbine. So, the saturated steam is passed through superheater

where the temperature of steam is increased to desired level and saturated steam converts into superheated steam 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 of Lamont Boiler:

1. Lamont Boiler has very flexible and simple design.
2. It has high heat transfer rate.
3. This boiler has high heat transfer rate.
4. It has very high steam generating capacity (about 50 tonnes per hour).

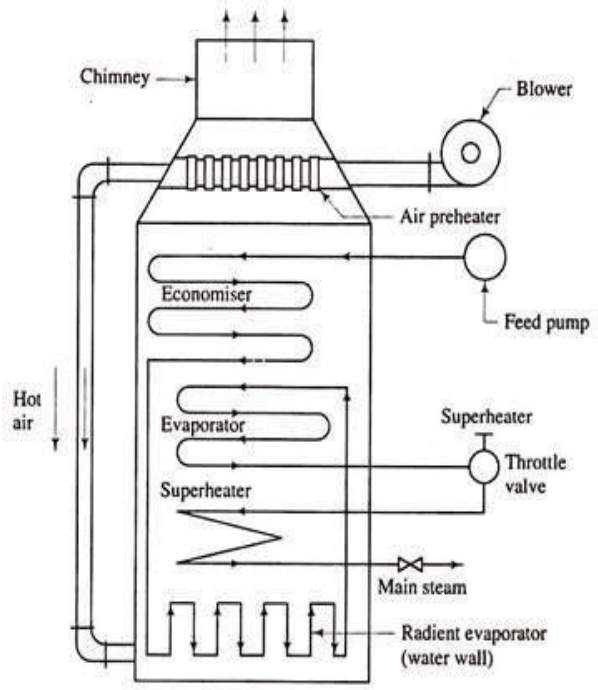
Disadvantages

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

Benson Boiler

Benson Boiler is a high pressure, drum less, supercritical, water tube steam boiler with forced circulation. This boiler is a super critical 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 same. It was Mark Benson who first proposed the idea to compress the water at supercritical pressure before heating into boiler and due to this the latent heat of water reduces to zero. As the latent heat of water reduces to zero the water directly changes into steam without the formation of bubbles.

Construction



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Tel. : +91-0141- 5160400Fax: +91-0141-2759555
E-mail: info@skit.ac.in Web: www.skit.ac.in

The main parts of Benson boiler are:

1. **Air Preheater**: It preheats the air before entering into the furnace. The preheated air increases the burning efficiency of the fuel.
2. **Economiser**: It heats the water to a certain temperature.
3. **Radiant Superheater**: It is super heater which heats the water with radiation produced by the burnt fuel. It raises the temperature to supercritical temperature.
4. **Convection Evaporator**: It evaporates the superheated water and converts them into steam. It does so by the convection mode of heat transfer to the water from the hot flue gases.
5. **Convection Superheater**: It superheats the steam to the desired temperature (nearly 650 degree Celsius).
6. **Furnace**: It is the place where the fuel is burnt.
7. **Feed Pump**: It is used to supply the water inside the boiler at supercritical pressure of 225 bars.

Working Principle

It works on the principle that the pressure of the water is increased to the supercritical pressure (i.e. above critical pressure of 225 bar). When the pressure of water is increased to the super critical 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 tube surface.

Working

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 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 engine to produce the electricity.

Advantages

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

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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/h.

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Difference between fire tube and water tube boiler

FIRE TUBE BOILER	WATER TUBE BOILER
Fire-tube boiler is the boiler in which the fire or hot gas is present inside the tubes and water surrounds these fire tubes	Water-tube boiler is the boiler in which the water is present inside the tubes and fire or hot gases surrounds these fire tubes
They are low or medium pressure boilers and usually operate at pressure of about 25 bar	They are high pressure boilers and usually operate at pressure of about 165 bar
Fire-tube boiler can only work on fluctuating loads for a shorter time	Water-tube boilers work on fluctuating loads all the time.
Due to low pressure in fire-tube boiler the risk of explosion is low.	The risk of explosion is higher due to high pressure.
These boilers are generaly internally fired. Furnace is placed at the one end of fire tube.	These boilers are generally externally fired.
This boiler is difficult to construct. They are usually heavy in weight so difficult in transportation.	This is simple in construction. They are usually lighter in weight so simple in transportation
This boiler occupies large floor area. It occupies less floor area compare to fire	It occupies less floor area compare to fire tube boiler
It required large shell diameter because the fire tube situated inside the shell	It required large shell diameter because the fire tube situated inside the shell
The overall efficiency of fire-tube boiler is up to 75%.	The overall efficiency of water-tube boiler is up to 90% with the economizer.
Fire-tube boiler is simple in design, easy to install and has a low maintenance cost. Operating cost is low.	A water-tube boiler is complex in design, difficult to install and has high maintenance cost. Operating cost is low
Example **Lancashire boiler, Cornish boiler.**	Example **Babcock and Wilcox boiler.**

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