

STEAM BOILERS

A steam generator or a boiler is defined as a closed vessel in which water is converted into steam by burning of fuel in presence of air at desired temperature, pressure and at desired mass flow rate.

Function of a boiler

The steam generated is employed for the following purposes

- Used in steam turbines to develop electrical energy
- Used to run steam engines
- In the textile industries, sugar mills or in chemical industries as a cogeneration plant
- Heating the buildings in cold weather
- Producing hot water for hot water supply

Classification of Boilers

The different ways to classify the boilers are as follows

1. According to location of boiler shell axis

- a) Horizontal
- b) vertical
- c) Inclined boilers.

When the axis of the boiler shell is horizontal the boiler is called **horizontal boiler**.

Example: Lancashire boiler, Locomotive boiler, Babcock and Wilcox boiler etc.

If the axis is vertical, the boiler is called **vertical boiler**

Example: Cochran boiler.

If the axis of the boiler is inclined, it is known as **inclined boiler**.

2. According to the flow medium inside the tubes

- a) Fire tube
- b) Water tube boilers.

The boiler in which hot flue gases are inside the tubes and water is surrounding the tubes are called **fire tube boilers**.

Example: Lancashire, locomotive, Cochran and Cornish boilers

When water is inside the tubes and the hot gases are outside, the boiler is called **water tube boiler**.

Example: Simple vertical boiler, Babcock and Wilcox boiler.

3. According to Boiler Pressure

According to pressure of the steam raised the boilers are classified as follows;

- a) Low pressure (3.5 - 10 bar)
- b) Medium pressure (10-25 bar)
- c) High pressure boilers(> 25 bar)

Examples

Low pressure: Cochran and Cornish boiler

Medium pressure: Lancashire and Locomotive boiler

High pressure: Babcock and Wilcox boiler.

4. According to the draft used

- a) Natural draft
- b) Artificial draft boilers

Boilers need supply of air for combustion of fuel. If the circulation of air is provided with the help of a chimney, the boiler is known as **natural draft boiler**. When either a forced draft fan or an induced draft fan or both are used to provide the flow of air the boiler is called **artificial draft boiler**.

Examples

Natural draft boiler: Simple vertical boiler, Lancashire boiler.

Artificial draft boiler: Babcock and Wilcox boiler, Locomotive boiler.

5. According to Method of water circulation

- a) Natural circulation
- b) Forced circulation

If the circulation of water takes place due to difference in density caused by temperature of water, the boiler is called **natural circulation boiler**. When the circulation is done with the help of a pump the boiler is known as **forced circulation boiler**.

Examples

Natural circulation: Babcock & Wilcox boiler, Lancashire boiler

Forced circulation: Velox boiler, Lamont boiler, Loffler boiler

6. According to Furnace position

- a) Internally fired
- b) Externally fired boilers

When the furnace of the boiler is inside its drum or shell, the boiler is called **internally fired boiler**. If the furnace is outside the drum the boiler is called **externally fired boiler**.

Examples

Internally fired boiler: Simple vertical boiler Lancashire boiler, Cochran boiler

Externally fired boiler: Babcock and Wilcox boiler

7. According to type of fuel used

- a) Solid
- b) Liquid
- c) Gaseous
- d) Electrical
- e) Nuclear energy fuel boilers

The boiler in which heat energy is obtained by the combustion of solid fuel like coal or lignite is known as **solid fuel boiler**. A boiler using liquid or gaseous fuel for burning is known as **liquid or gaseous fuel boiler**. Boilers in which electrical or nuclear energy is used for generation of heat are respectively called as **electrical energy headed boilers** and **nuclear energy heated boiler**.

8. According to number of Tubes

- a) Single-tube
- b) Multi-tube boiler

A boiler having only one fire tube or water tube is called a **single tube boiler**. The boiler having two or more, fire or water tubes is called **multi tube boiler**.

Examples

Single tube boiler: Cornish boiler, Vertical boiler.

Multi-tube boiler: Lancashire boiler, Locomotive boiler, Babcock and Wilcox boiler.

9. According to Boiler Mobility

- a) Stationary
- b) Portable
- c) Marine boilers

When the boiler is fixed at one location and cannot be transported easily it is known as **stationary boiler**. If the boiler can be moved from one location to another it is known as a **portable or mobile boiler**. The boilers which can work on the surface of water are called **marine boilers**.

Examples

Stationary: Lancashire, Babcock and Wilcox boiler, vertical boiler

Portable: Locomotive boiler.

Marine: Marine boilers

Specification of a Boiler

- ❖ Size of drum (Diameter and length)
- ❖ Rate of steam generation(kg/hr)
- ❖ Heating surface (Square meters)
- ❖ Working pressure (bar)
- ❖ No. of tubes / drum

- ❖ Type of boiler
- ❖ Manufacturer of boiler
- ❖ Initial cost
- ❖ Quality of steam
- ❖ Repair and inspection facility

Comparison between water-tube and fire tube boilers

S no.	Particulars	Fire tube boilers	Water tube boilers
1.	Mode of firing	Internally fired	Externally fired
2.	Rate of steam production	lower	Higher
3.	construction	Difficult	Simple
4.	transportation	Difficult	Simple
5.	Treatment of water	Not so necessary	More necessary
6.	Operating pressure	Limited to 16 bar	Under high pressure as 100 bar
7.	Floor area	More floor area	Less floor area
8.	Shell diameter	Large for same power	Small same power
9.	explosion	Less	More
10.	Risk of bursting	lesser	More risk

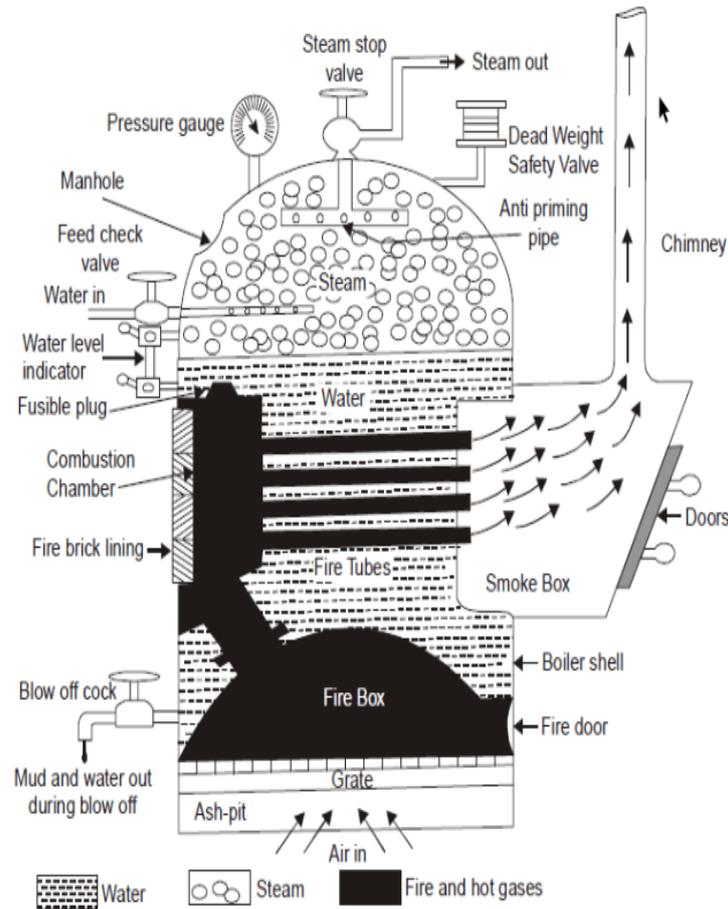
COCHRAN BOILER

It is a Vertical drum axis, natural circulation, natural draft, multi tubular, low pressure, solid fuel fired fire tube boiler with internally located furnace.

Constructional details: It consists of ;

- *Shell:* It is hemispherical on the top, where space is provided for steam.
- *Crate:* It is placed at the bottom of the furnace where coal is burnt.
- *Fire box:* It is also dome-shaped like the shell so that the gases can be deflected back till they are passed out through the flue pipe to the combustion chamber.
- *Flue pipe:* It is a short passage connecting the fire box with the combustion chamber.
- *Fire tubes:* A number of horizontal fire tubes are provided
- *Combustion chamber:* It is lined with fire bricks on the side of the shell to prevent overheating of the boiler. Hot gases enter the fire tubes from the flue pipe through the combustion chamber.
- *Chimney:* It is provided for the exit of the flue gases to the atmosphere from the smoke box.
- *Man-hole:* It is provided for inspection and repair of the interior of the boiler shell.

Normal size of a Cochran boiler is given by;
 Shell diameter – 2.75 meters and Height of the shell – 6 meters.



Working of the Cochran boiler: Coal is fed into the grate through the fire hole and burnt. Ash formed during burning is collected in the ash pit provided just below the grate and then it is removed manually. The hot gases from the grate pass through the flue pipe to the combustion chamber. The hot gases from the combustion chamber flow through the horizontal fire tubes and transfer the heat to the water by convection. The flue gases coming out of fire tubes pass through the smoke box and are exhausted to the atmosphere through the chimney. Smoke box is provided with a door for cleaning the fire tubes and smoke box.

Advantages of Cochran Boiler

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

Disadvantages of Cochran Boiler

- Low rate of steam generation.
- Inspection and maintenance is difficult.

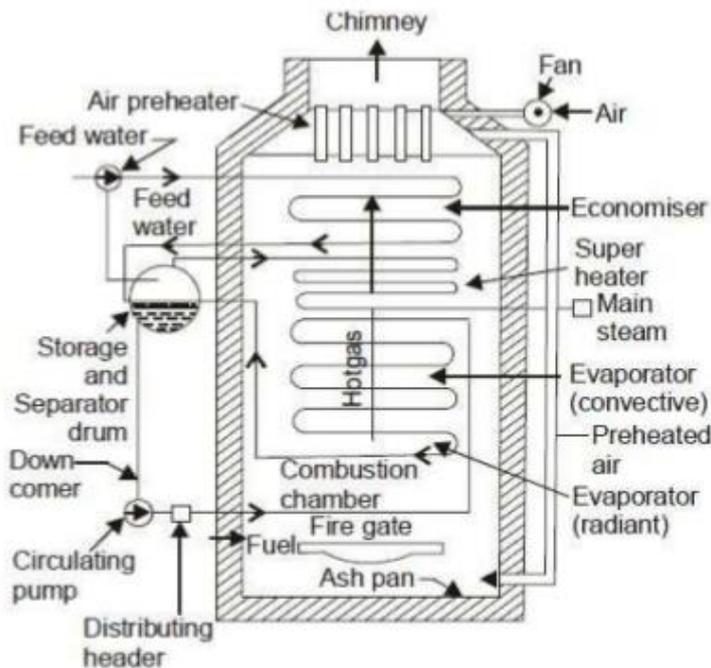
- High room head is required for its installation due to the vertical design.
- It has limited pressure range.

Applications of Cochran Boiler

- ❖ Variety of process applications in industries
- ❖ Chemical processing divisions
- ❖ Pulp and Paper manufacturing plants
- ❖ Refining units

LA MONT BOILER

La Mont 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 works on basic principle of forced convection. If the water is circulating by a pump inside the tube, the heat transfer rate from gas to the water is increases. It is the basic principle of it.

Working

- In Lamont boiler, the feed pump circulates the water in the economiser of the boiler. The economiser heats the water to some degree. 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. From 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 indicates separates the steam from water. The steam gets collected at the upper portion of the drum. From steam separator drum, steam passes through the super heater. The super heater 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/hour.

Advantages:

1. It is a high pressure boiler.
2. It is flexible in design.
3. This boiler can be reassembled into natural circulation boiler.
4. It can be easily started.
5. It has high steam generation capacity of about 50 tonnes/ hour.
6. This boiler has higher heat transfer rate.

Disadvantages:

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