Boiler: Definition, Types, Applications, Necessity, and Fuel Used [With PDF]

www.pandianprabu.weebly.com

Page Contents

What is Boiler?

A steam boiler or steam generator is a closed vessel in which water is heated, vaporized and converted into steam at a pressure higher than atmospheric pressure.

A Boiler is the biggest and most critical part of a thermal power plant.

Definition of Boiler according to IBR Act 1923 (Indian Boiler Regulation), A steam boiler means any closed vessel exceeding **22.75 liters** in capacity and which is used expressively for generating steam under pressure.

Applications of Boiler:

We use a boiler for:

- *Operating steam engines.*
- *Operating steam turbines.*
- *Operating reciprocating pumps.*
- *Industrial process work in chemical engineering.*
- *For producing hot water required to be supplied to room in very cold areas.*
- *In thermal power stations.*
- *The heat content of the steam is large and thus it is suitable for process heating in many industries like sugar mills, textile mills, dairy industry and also in chemical industries.*

Definition of some useful terms used in Boiler:

- **Boiler shell:** The boiler shell consists of a hollow cylindrical body made up of steel plates riveted or welded together.
- **Furnace:** Furnace is that part of the boiler in which the fuel is conveniently burned to produce heat. This heat is utilized in generating steam in the boiler.
- **Grate:** The grate is a space on which the fuel is burnt. It consist of a combination of several cast-iron bars so arranged that the fuel may be placed on it. Some space is always provided in between two consecutive bars so that may flow to the fuel from below the great and ashes may drop into the ash pit provided beneath the Grate. Grate may be circular or rectangular in shape.
- **Grate area:** The area of the great upon which the fuel burns is called great area. Grate area is always measured in square meters.
- **Heating surface:** The heating surface is the surface of a boiler which is exposed to hot gases on one side and water of the other.
- **Water space and steam space:** Water space is the volume of the boiler which is occupied by water. The remaining space is called steam space because it is needed for storage of steam in the boiler until it id s drawn off through the steam pipe.
- **Flue gases:** Flue gases are hot gases produced due to the combination of fuel in the boiler furnace. Flue gas usually contains water vapor (H2O), Carbon dioxide (CO2), Carbon monoxide (CO), Nitrogen (N2). Flue gas includes complete and incomplete products of combustion of fuels.

Classifications or Types of Boiler:

There are large number of boiler designs, but they may be classified according to the following ways:

According to the circulation of gases:

1. **Fire-tube boiler**
2. **Water-tube boiler**

Fire-tube boiler:

Fire tube boilers are those boilers in which hot gases produced by the combination of fuel in the boiler furnace while on their way to chimney pass through a number of tubes (called fuel tubes or smoke tubes) which are immersed in water.

Heat is transferred from the hot gasses to water through the walls of tubes.

Example of fire tube boilers are **Cochran boiler, locomotive boiler** etc.

Fire tubes boilers are also known as a **smoke tube boiler**.

Water-tube boiler:

Water-tube boilers are those boilers in which water flows through a number of tubes (called water tubes) and the hot gases produced by the combustion of fuel in the boiler furnace while on their way to chimney pass surrounding the tubes.

The heat from the hot gases is transferred to the water through the walls of the water tubes.

Examples of water tube boilers are **Bab-cock and Wilcox boiler, Benson boiler,** etc.

According to Circulation of water:

1. **Free circulation**
2. **Forced circulation**

Free circulation:

In any water heating vessel heat is transmitted from one place to another not by condition but by convection because water is a bad conductor of heat.

Let vessel containing water be heated at its bottom, as the water in the bottom portion is heated therefore its density becomes reduced in comparison to the density of water in the upper portion of the vessel, as a result, the less dense water at the bottom portion of the vessel rise up and comparatively more dense and cold water at the upper portion of the vessel comes down to take its place and thus a convection current is set up in the water until temperature off all water becomes the same.

The method of circulation of water described above is known as free circulation.

In boilers like **Lancashire, Babcock, and Wilcox,** etc. free circulation of water takes place.

Advantages of free circulation:

The advantages of free circulation are:

1. Free circulation of water helps to maintain a uniform temperature true everywhere within the boiler so that unequal expansion of various parts of the boiler is prevented.
2. Free circulation of water facilities the escape of steam from the heating surface as soon as it formed. If steam does not escape quickly after its formation the boilerplates do not remain constantly in touch with water and as a result, these plates may be overheated.

Forced Circulation:

In forced circulation, pumps are used to maintains the continuous flow of water in the boiler. In such a case, the circulation of water takes place due to pressure created by the pump.

The forced circulation system is adopted in more high pressure, high capacity boilers of all of which are water tube type boiler.

Advantages of forced circulation:

The advantages of forced circulation are:

1. The rate of heat transfer from the flue gases to the water higher.
2. Tubes having comparatively smaller diameters can be used. This reduces the overall weight of the boiler.
3. The number of boiler drums required may be reduced.
4. less scale formation in the boilers is required.
5. Steam can be quickly generated.
6. The fluctuation of load can be easily met without taking the help of any complicated controlled device.
7. Chance of overheating of the boilerplates in minimum.
8. Weight per unit mass of steam generated is less.

According to the number of tubes used:

According to the number of tubes, Boilers may be classified as:

1. **Single tube boiler**
2. **Multi-tube boiler**

Single tube boiler:

Cornish boiler may be termed as a single tumbler boiler because it has only one flue tube.

Multi-tube boiler:

Cochran boiler may be termed as multi-tube boiler because it has a number of flue tubes.

According to the nature of use:

According to nature use, boilers are classified as

1. **Stationary boilers**
2. **locomotive boilers**
3. **Marine boilers.**

Stationary boilers:

For the generation of thermal power and for process work (in chemical, sager and textile industries) boilers used are called stationary boiler.

Locomotive boilers:

Boilers used in locomotive steam engines are called locomotive boilers.

Marine boilers:

Boilers used in steamships are called marine boilers.

According to the nature of the fuels used:

According to the nature of the fuel used boiler may be:

1. **Fuel-fired**
2. **Gas fired**
3. **Liquid fuel fired**
4. **Electrically fired**
5. **Nuclear fired**

NOTE: Babcock and Wilcox boilers use solid or gaseous fuel.
Volex boilers use oil fuel.

According to the pressure of the boiler:

1. **High-pressure boiler**
2. **Medium-pressure boiler**
3. **Low-pressure boiler**

High-pressure boiler:

The pressure of the boiler **above 80 bar**.

Medium-pressure boiler:

It has a working pressure of steam **from 20 bar to 80 bar**. It is used for power generation or process heating.

Low-pressure boiler:

This type of boiler produces steam **at 15-20 bar** pressure. This is used for process heating.

According to the position of the axis of the boiler shell:

According to the position of the axis of the boiler shell, boilers are classified as:

1. **Vertical boiler**
2. **Horizontal boiler**

Vertical boiler:

If the boiler axis is vertical, it is called a vertical boiler. For example, **Cochran boiler**.

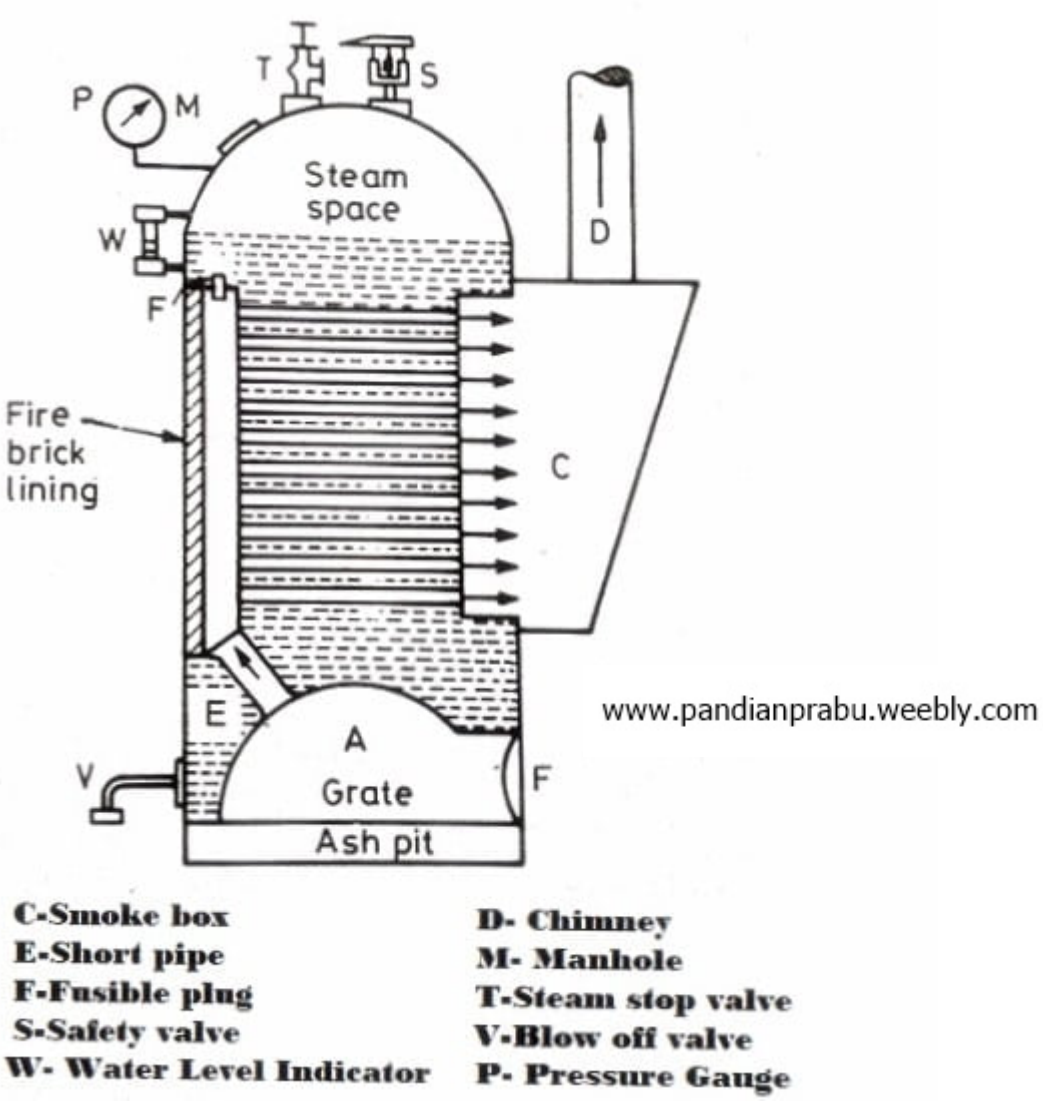
Horizontal boiler:

If the boiler axis is horizontal, it is called a horizontal boiler.

For example, **Lancashire boiler**.

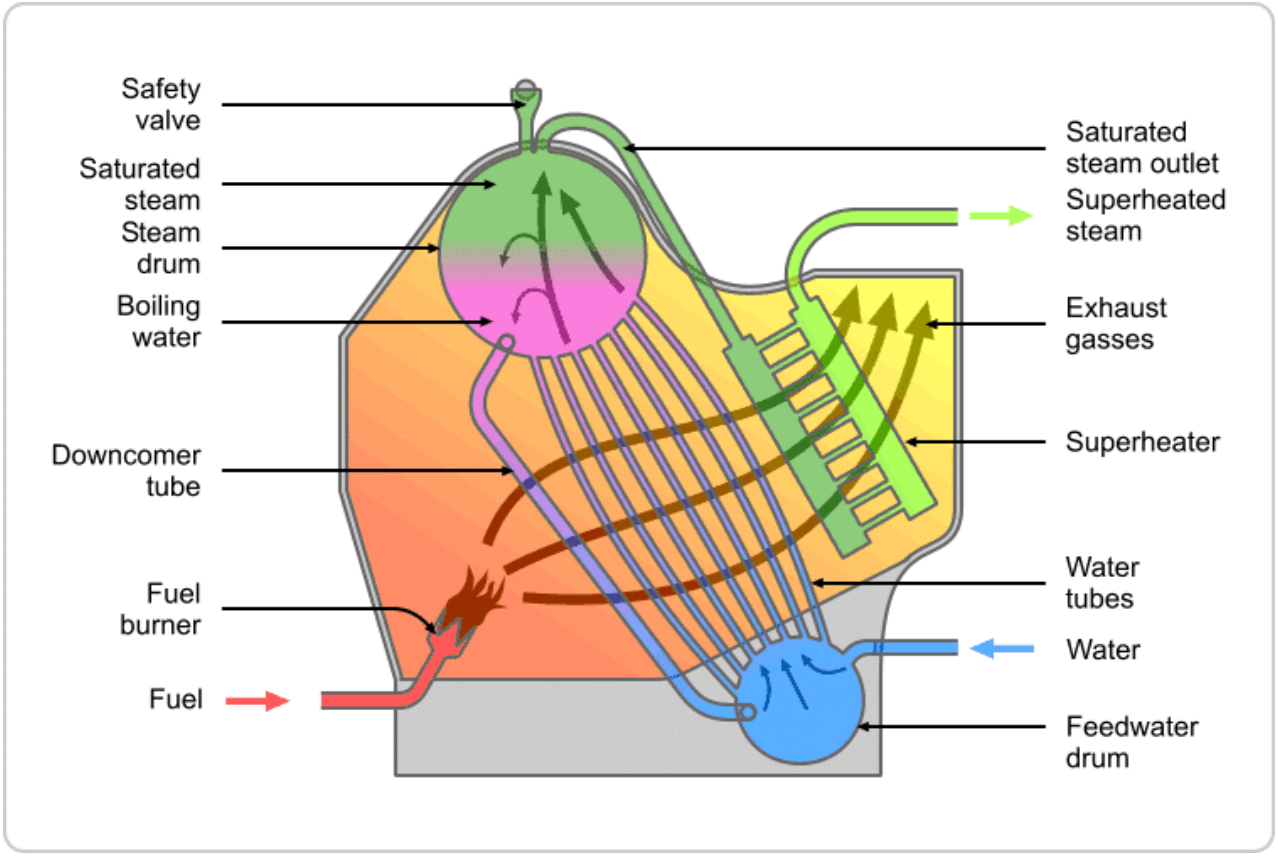
So this are the classifications of the Boiler, now see the schematic diagram of a Boilers.

Fire Tube Boiler Schematic Diagram:



FIRE TUBE BOILER

Water Tube Boiler Schematic Diagram:



No machine-readable author provided. Emoscopes assumed (based on copyright claims). [CC BY-SA 2.5], via Wikimedia Commons

Types of Fuel Used in Boiler:

I have been categorized the fuel in three formats:

Solid Fuels:

Wood, Coal, Briquettes (a block of compressed coal dust), Pet Coke, Rice Husk.

Liquid Fuels:

LDO (Light Diesel Oil), Furnace oil.

Gaseous Fuels:

LPG (Liquified Petroleum Gas), LNG (Liquified Natural Gas), PNG (Piped Natural Gas) can be used to carry out the combustion for a specific purpose.

The Necessity of Boiler:

The most common function for any boiler, whether it is an industrial or residential boiler, is to serve as the central heating mechanism for a home, business facility, hospital, commercial complex, etc.

No matter what setting they are used in, boilers operate with the same basic functions and mechanisms that work together to create a contained, heat-generating combustion process.

Boilers draw natural gas from gas lines running through our streets and use this gas to fuel the combustion process for heat creation and distribution throughout a building.

The boiler system relies on a burner to initiate the combustion process, and then heat in the form of steam or hot water moves through the system using pumps, radiators, and heat exchangers.

Boiler manufacturers are making use of rapidly improving technology to build equipment that is cost-efficient, environmentally friendly, and powerful.