



Experiment No: 1

TITLE:- Introduction to Boilers.

Apparatus:- Model and charts of different boilers.

Theory:-

Boiler:- A steam boiler is a closed vessel in which steam is produced with pressure from water by combustion of fuel.

Classification of Boiler:

Boilers are classified on the basis of following-

1. According to contents in the Tube:

a) Fire tube boiler: In fire tube boilers, the flue gases pass through the tube and water surround them.

B).Water tube boiler: In water tube boiler, water flows inside the tubes and the hot flue gases flow outside the tubes.

2. According to the pressure of steam:

A).Low pressure boiler: A boiler which generates steam at a pressure of below 80 bars is called low pressure boiler. Example-Cochran boiler, Lancashire boiler etc.

B).High pressure boiler: A boiler which generates steam at a pressure higher than 80 bar is called high pressure boiler. Example- Babcock and Wilcox boiler etc.

3. According to method of circulation of water:

A).Natural Circulation: In natural circulation boiler, circulation of water due to gravity or the circulation of water takes place by natural convection current produced by the application of heat, example-Babcock and Wilcox boiler, Lancashire boiler etc.

B).Forced Circulation: In the forced circulation boiler, circulation of water by a pump to increase the circulation. Example-Lamont boiler etc.

4. According to the Position of the furnace:

A).Internally fired boilers: In this, the furnace is located inside the boiler shell. Example-Cochran, Locomotive and Lancashire boilers.

B).Externally fired boilers: In this, the furnace is located outside the boiler shell. Example-Babcock and Wilcox boiler etc.

5. According to the axis of shell:

A).Vertical boilers: If the axis of the shell of boiler is vertical so the boiler is called



as vertical boiler.

B). Horizontal boilers: If the axis of the shell of boiler is horizontal so the boiler is called as Horizontal boilers.

C). Inclined boilers: If the axis of the shell of boiler is Inclined so the boiler is called as Inclined boiler.

BOILER TERMINOLOGIES

Shell: The shell of a boiler is made up of one or more steel plates bent into a cylindrical form and riveted or welded together. The shell is closed at the ends by means of flat or curved plates called boiler heads. The purpose of the shell is to store water for heating. A shell along with a boiler head is called a boiler drum.

Settings: Settings are made of brickwork and forms walls of the furnace and combustion chamber. In case of Lancashire boiler, it provides support to it and also forms passage for the hot flue gases. It also confines the heat to the boiler shell.

Grate: It is made up of iron bars placed at a distance upon which solid fuel is burnt. The space between the bars allows the air to pass through it for supporting combustion of fuel. It also allows the ashes to fall down.

Furnace: The furnace is the space above the grate and below the boiler shell in which the combustion of fuel takes place. In the furnace the combustion of volatile matter takes place.

Water Space: The water space is the volume occupied by water in the shell.

Steam Space: The steam space is the remaining volume of the shell not occupied by water and tubes.

Heating Surface: It is that surface of the boiler which is exposed to hot flue gases.

Mountings: In accordance with the Indian Boiler Regulation Act, the mountings are the essential items to be fitted on the boiler for its safe working, like safety valve, water level indicator, fusible plug, etc.

Accessories: Accessories are the items used along with the boiler for improving its efficiency and performance. Some of the accessories used along with a boiler are economizer, air pre-heater, super-heater, etc.

Working Pressure

It is the pressure of the steam generated inside the boiler.



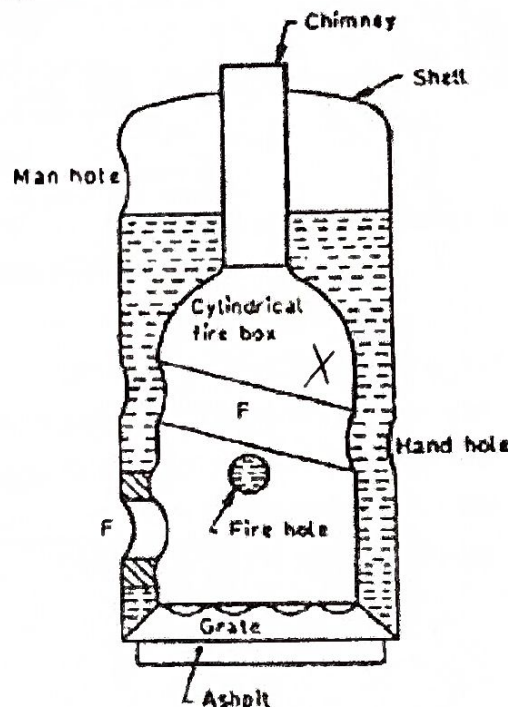
Experiment No: 2

TITLE:-To study the working and construction details of water tube boilers (Simple Vertical Boiler and Babcock & Wilcox Boiler).

Apparatus:- Demonstration model and charts of Simple Vertical Boiler and Babcock & Wilcox Boiler.

Theory:-

A simple vertical boiler is an internally fired, water-tube boiler. Its construction is simple and does not require heavy foundation. It requires very small floor area. The constructional details of a Simple Vertical Boiler are as follows:



Cylindrical shell:

The shell is vertical and it is attached to the bottom of the furnace. Greater portion of the shell is full of water which surrounds the furnace also. Remaining portion is steam space. The shell may be of about 1.25 metres diameter and 2.0 metres height.

Cross-tubes:

One or more cross tubes are either riveted or flanged to the furnace to increase the heating surface and to improve the water circulation.

Furnace (or fire box):

Combustion of coal takes place in the furnace (fire box).

Grate:

It is placed at the bottom of fire box and coal is fed on it for burning.

**Fire door:**

Coal is fed to the grate through the fire door.

Chimney (or stack):

The chimney (stack) passes from the top of the firebox through the top of the shell.

Manhole:

It is provided on the top of the shell to enable a man to enter into it and inspect and repair the boiler from inside it. It is also, meant for cleaning the interior of the boiler shell and exterior of the combustion chamber and stack (chimney).

Hand holes:

These are provided in the shell opposite to the ends of each cross tube for cleaning the cross tube.

Ashpit:

It is provide for collecting the ash deposit, which can be removed away at intervals.

Working:

The fuel (coal) is fed into the grate through the fire hole and is burnt. The ashpit placed below the grate collect the ashes of the burning fuel. The combustion gas flows from the furnace, passes around the cross tubes and escapes to the atmosphere through the chimney. Water goes by natural circulation due to convection currents, from the lower end of the cross tube and comes out from the higher end. The working pressure of the simple vertical boiler does not exceed 70 N/cm^2 .

The following mountings are fitted in the boiler:

1. **Pressure gauge:** it indicates the pressure of the steam inside the boiler.
2. **Water gauge** (water level indicator): this indicates the water level in the boiler.
3. **Safety valve:** it prevents an increase of steam pressure in the boiler above its design pressure.
4. **Steam stop valve:** it regulates the flow of steam supply to requirements.

BABCOCK AND WILCOX BOILER:

Babcock and Wilcox boiler is a horizontal shell, multitubular, water tube, externally fired, natural circulation boiler.

Construction: Figure shows the details of a Babcock and Wilcox water tube boiler. It



consists of a drum mounted at the top and connected by upper header and down take header. A large number of water tubes connect the uptake and down take headers. The water tubes are inclined at an angle of 5 to 15 degrees to promote water circulation. The heating surface of the unit is the outer surface of the tubes and half of the cylindrical surface of the water drum which is exposed to flue gases.

Below the uptake header the furnace of the boiler is arranged. The coal is fed to the chain grate stoker through the fire door. There is a bridge wall deflector which deflects the combustion gases upwards. Baffles are arranged across the water tubes to act as deflectors for the flue gases and to provide them with gas passes.

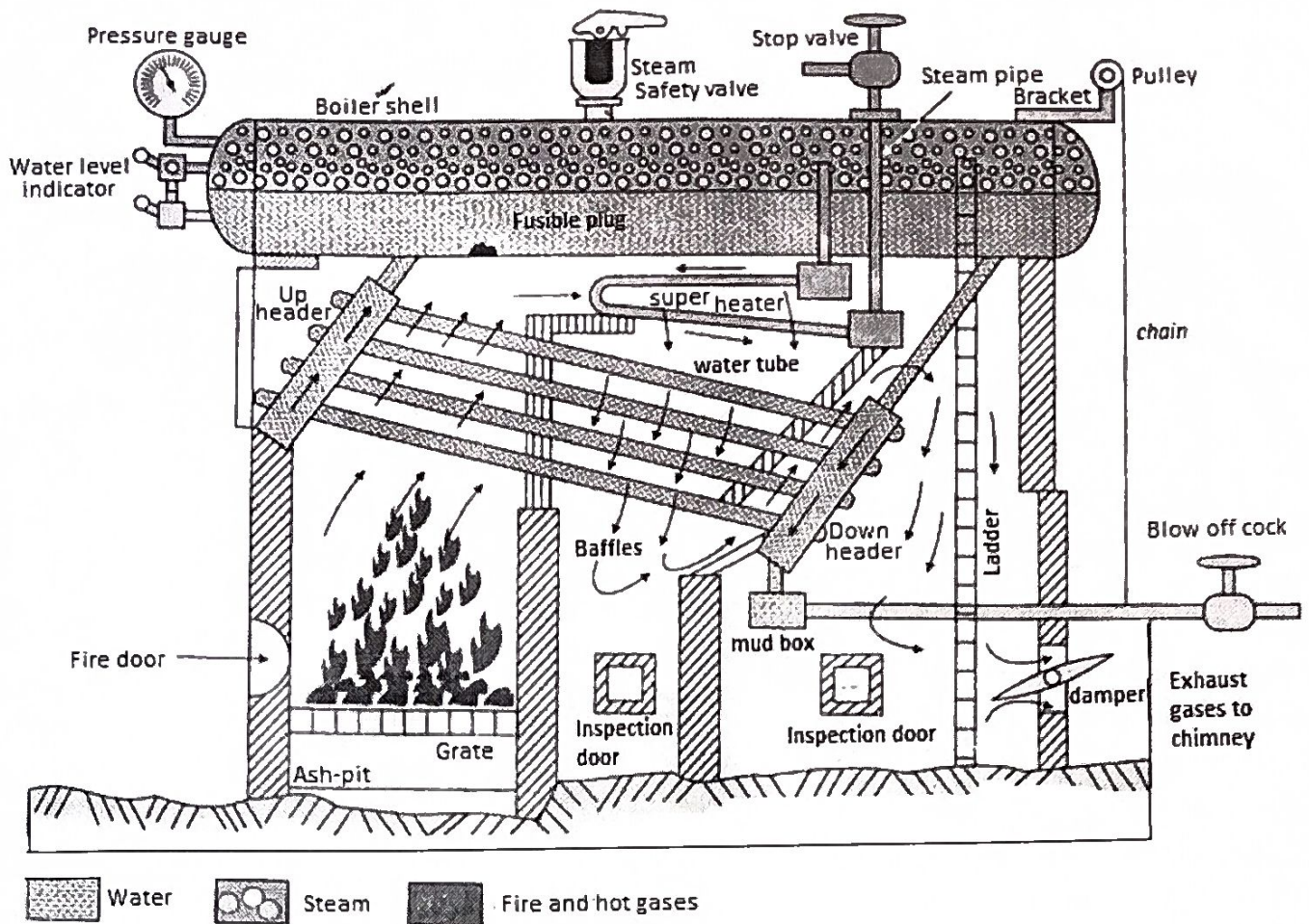
Here, two baffles are arranged which provide three passes of the flue gases. A chimney is provided for the exit of the gases. A damper is placed at the inlet of the chimney to regulate the draught. There are superheating tubes for producing superheated steam. Connections are provided for other mounting and accessories.

Working:

The hot combustion gases produced by burning of fuel on the grater rise upwards and are deflected by the bridge wall deflector to pass over the front portion of water tubes and drum. By this way they complete the first pass. With the provision of baffles they are deflected downwards and complete the second pass. Again, with the provision of baffles they rise upwards and complete the third pass and finally come out through the chimney. During their travel they give heat to water and steam is formed. The flow path of the combustion gases is shown by the arrows outside the tubes. The circulation of water in the boiler is due to natural circulation set-up by convective currents (due to gravity). Feed water is supplied by a feed check valve.

The hottest water and stem rise from the tubes to the uptake header and then through the riser it enters the boiler drum. The steam vapours escape through the upper half of the drum. The cold water flows from the drum to the rear header and thus the cycle is completed.

To get superheated steam, the steam accumulated in the steam space is allowed to enter into the super heater tubes which are placed above the water tubes. The flue gases passing over the flue tubes produce superheated steam. The steam thus superheated is finally supplied to the user through a steam stop valve.



Babcock and Wilcox Boiler

Specification of Babcock and Wilcox Boiler:

Diameter of the drum	→	1.22 m to 1.83 m
Length of the drum	→	6.096 to 9.144 m
Size of watertubes	→	7.62 to 10.16 cm
Size of super heater tube	→	3.84 to 5.71 cm
Working pressure	→	100bar
Steaming capacity (Maximum)	→	40,000Kg/hr
Efficiency	→	60 to 80%