3.10 BOILER

A boiler is a closed vessel which generate steam at a desired pressure and temperature by transferring heat produced by burning of fuel to water to change it to steam. The steam produced may be supplied to steam engines or turbines for power generation, industrial process work, heating installations and hot water supply etc. For a safe operation and easy control, boilers are provided with several mountings which will be discussed later on.

According to A.S.M.E. (American Society of Mechanical Engineers) code, a boiler is defined as follow:

"A combination of apparatus for producing, furnishing or recovering heat together with the

apparatus for transferring the heat so made available to water which could be heated and vaporized to steam form."

3.11 REQUIREMENTS OF A GOOD BOILER

A good boiler should be able to fulfill the some conditions given below:

1. It should produce maximum quantity of steam with the minimum fuel consumption.
2. It should be light in weight.
3. It should occupy a small space.
4. It should be capable of quick starting.
5. It should be capable of meeting large variations in load.
6. It should allow easy maintenance.
7. The various joints should be accessible for inspection and as far as possible, the flames should not be made to impinge on the joints.
8. The mud and other deposits should not collect on the heated plates.
9. The boiler components should be transportable without difficulty.
10. Installation of the boiler should be simple.
11. The boiler should be as per the safety regulations laid down in the boiler act.

3.12 FACTORS AFFECTING BOILER SELECTIONS

The selection of type and size of a steam boiler depends upon the following factors:

1. Working pressure of steam
2. Quality of steam required
3. Steam generation rate
4. Fuel and water available
5. Type of fuel to be used
6. Facilities available for eraction
7. Operating and maintenance cost
8. Accessibility for repair, clearing and inspection
9. Comparative initial cost
10. Probable load factor.

3.13 CLASSIFICATION OF BOILER

Boilers are classified on the basis of following:

1. According to the contents in the tube
2. According to the method of firing
3. According to the pressure of steam
4. According to the method of circulation of water
5. According to the axis of shell or drum
6. According to the number of tubes
7. According to the nature of draught
8. According to the use
9. According to boiler shell material

1. According to the Contents in the Tube

According to the contents in the tube, the boilers are classified as

(a) Fire tube boiler and (b) Water tube boiler

(a) *Fire tube boiler:* In fire tube boiler, the hot gases (flue gases) pass through the tubes and water surrounds them. Figure 11(a) shows the principle of operations of a fire tube boiler.
The heat is conducted through the walls of the tubes from the hot gases to the surrounding water.
Examples of the fire tube boilers are Cochran boiler, Lancashire boiler, Cornish boiler and Locomotive boilers.

(b) *Water tube boiler:* In water tube boiler, water flows inside the tubes and the hot flue gases flow outside the tubes.
Figure 11(b) shows the principle of operation of a water tube boiler.
Examples of the water tube boilers are: Babcock and Wilcox boiler, Stirling boiler, La-mont boiler, Benson boiler.

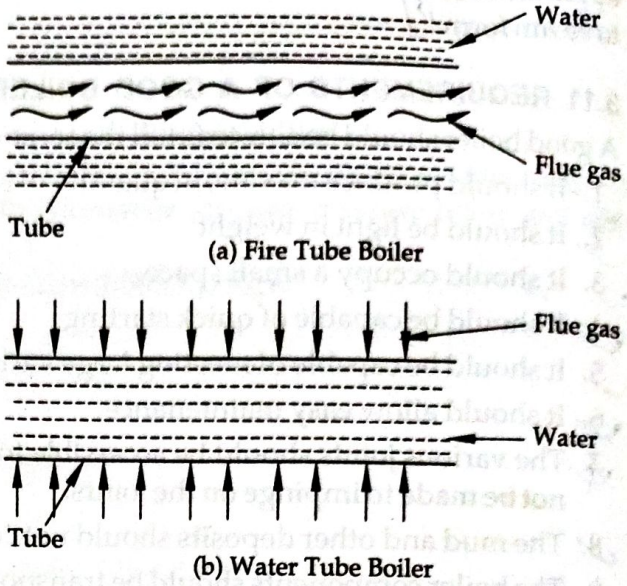

Fig. 11

2. According to the Method of Firing

According to the method of firing boilers are classified as:
(a) Internally fired boiler, and (b) Externally fired boiler

(a) *Internally fired boiler:* In internally fired boilers, the furnace is located inside the boiler shell or drum. Most of the fire tube steam boiler are internally fired.
Examples of internally fired boilers are: Locomotive, Lancashire and Cochran boilers etc.

(b) *Externally fired boiler:* In externally fired boiler, the furnace is located outside the boiler shell or drum.
Examples of the externally fired boilers are: Babcock and Wilcox boiler.

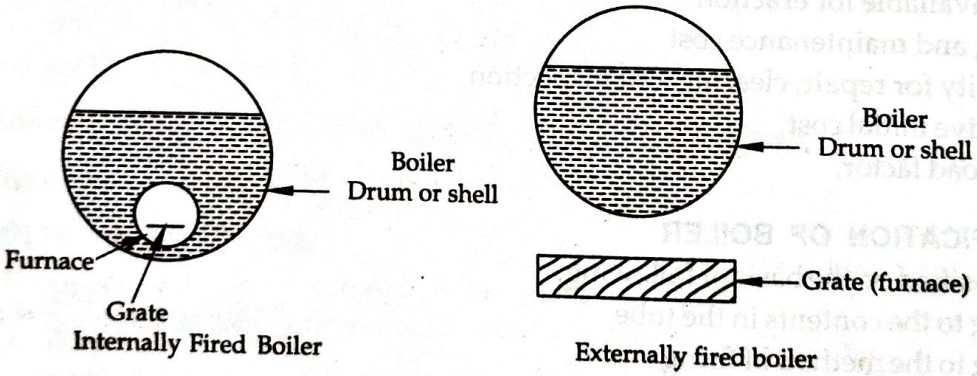

Fig. 12

3. According to the Pressure of Steam

According to the pressure of steam, the boilers are classified as:
(a) Low pressure boilers, and (b) High pressure boilers

(a) *Low pressure boiler:* A boiler which generates steam at a pressure below 80 bar is called low pressure boiler.
Example of low pressure boilers are Cochran, Cornish, Lancashire and Locomotive boilers.

(b) *High pressure boiler:* A boiler which generates steam at a pressure higher than 80 bar is called a high pressure boiler.
Examples of high pressure boilers are: Babcock and Wilcox, Lamont, Velox, Benson boilers etc.

4. According to the Method of Circulation of Water

According to the method of circulation, boilers are classified as:

(a) Natural circulation, and (b) Forced circulation

(a) *Natural circulation:* In natural circulation boiler, circulation of water is due to gravity. Examples of natural circulation boilers are Lancashire, Locomotive, Babcock and Wilcox boilers etc.

(b) *Forced circulation:* In forced circulation boiler, circulation of water by a centrifugal pump driven by some external power.
Examples of forced circulation boilers are: Lamont, Velox and Benson boilers etc.

5. According to the Axis of Shell or Drum

According to the axis of shell or drum, boilers are classified as:

(a) Vertical boilers, and (b) Horizontal boilers

(a) *Vertical boilers:* If the axis of the shell of boiler is vertical so called vertical boilers.
Examples of vertical boiler is Cochran boiler.

(b) *Horizontal boilers:* If the axis of the shell of boiler is horizontal, so called Horizontal boilers.
Examples of horizontal boilers are Lancashire, Locomotive, Babcock and Wilcox boilers.

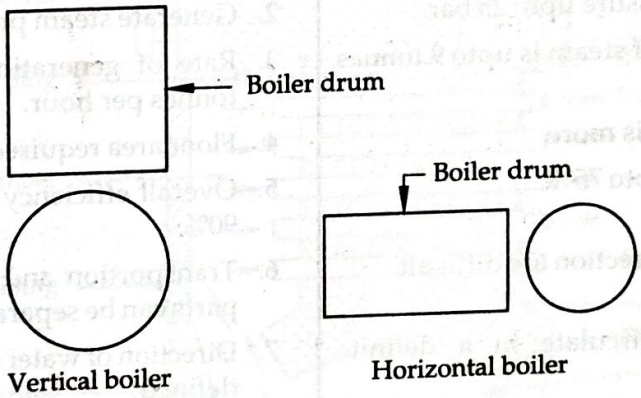

Fig. 13

6. According to the Number of Tubes

According to the number of tubes, boilers are classified as:

(a) Single tube boilers, and (b) Multitubular boiler

(a) *Single tube boilers:* In single tube boilers there is only one fire tube or water tube.
Example of single tube boiler is Cornish boilers.

(b) *Multitubular boilers:* In multitubular boilers there are two or more fire tubes or water tubes.
Examples of multitubular boilers are: Cochran, Babcock and Wilcox, Lancashire and Locomotive boilers etc.

7. According to the Nature of Draught

According to the nature of draught, the boilers are classified as:

(a) Natural draught boilers, and (b) Forced draught boilers

(a) *Natural draught boilers:* In natural draught boiler, draught is produced by natural circulation of air or gas.

(b) *Forced draught boilers:* In forced draught boiler, draught is produced by mechanical means such as fans etc.

8. According to the Use

According to the use, boilers are classified as:

(a) Stationary boilers, and (b) Mobile boilers

(a) *Stationary boilers:* Boilers that are used for stationary plants are called stationary boilers or land boilers.

(b) *Mobile boilers:* Boilers, which are fitted on vehicles that can move from place to place called mobile boilers.
Examples are Marine and Locomotive boilers.

9. According to the Boiler Shell Material

According to the boiler shell material, boilers are classified as:
(a) Cast Iron boilers, and (b) Steel boilers

(a) *Cast Iron boilers:* These boilers are suitable for low pressure boilers.

(b) *Steel boilers:* These boilers are suitable for high pressure boilers.

3.14 COMPARISON OF FIRE TUBE AND WATER TUBE BOILER

Sr. No.	Fire Tube Boiler	Sr. No.	Water Tube Boiler
1.	Hot gases from the furnace pass through the tubes which are surrounded by water.	1.	Water circulates inside the tubes which are surrounded by hot gases from the furnace.
2.	Generate steam pressure upto 25 bar.	2.	Generate steam pressure upto 250 bar.
3.	Rate of generation of steam is upto 9 tonnes per hour.	3.	Rate of generation of steam is upto 450 tonnes per hour.
4.	Floor area required is more.	4.	Floor area required is less.
5.	Overall efficiency upto 75%.	5.	Overall efficiency with economiser is upto 90%.
6.	Transportion and errection are difficult.	6.	Transportion and errection are easy as its parts can be separated.
7.	Water does not circulate in a definite direction.	7.	Direction of water circulation is well defined.
8.	Operating cost is less.	8.	Operating cost is high.
9.	Bursting chances are less.	9.	Bursting chances are more.
10.	Used in large power plants.	10.	Used in process industry.
11.	Can cope sudden increase in load for a shorter period only.	11.	Preferred for widely fluctuating loads.
12.	Greater risk of damage to property in case of bursting.	12.	Bursting does not produce any destruc-tion to the whole boiler.

3.15 COCHRAN BOILER

Cochran boiler is a vertical, multitubular fire tube, internally fired, natural circulation boiler.

Construction

Figure 14 shows a Cochran boiler. It consists of a vertical cylindrical shell having a hemispherical top and furnace is also hemispherical in shape. The fire grate is arranged in the furnace and the ashpit is provided below the grate. A fire door is attached on the fire box. Adjacent to the fire box, the boiler has a combustion chamber which is lined with fire bricks. Smoke or fire tubes are provided with combustion chamber. These tubes are equal in length and arranged in a group with wide space in between them. The ends of these smoke tubes are fitted in the smoke box. The stack or chimney is provided at the top of the smoke box for discharge of the gases to the atmosphere. The furnace is surrounded by water on all sides except at the opening for the fire door and the combustion chamber. The smoke tubes are also completely surrounded by water.