Boiler Draught and its Classification | Thermodynamics

Draught is the pressure difference which is necessary to draw the required quantity of air for combustion and to remove the flue gases out of the system.

Thus the object of producing draught in a boiler is:

(i) To provide sufficient quantity of air for combustion

(ii) To make the resulting hot gases, to flow through the system

(iii) To discharge these gases to the atmosphere through the chimney.

Usually this drought (pressure difference) in boiler is of small magnitude and is measured in mm of water column by means of draught gauge/manometer.

The amount of draught depends upon:

(i) Nature and depth of fuel on the grate.

(ii) Design of combustion chamber/firebox.

(iii) Rate of combustion required.

(iv) Resistance offered in the system due to baffles, tubes, superheater, economiser, air pre–heater, etc.

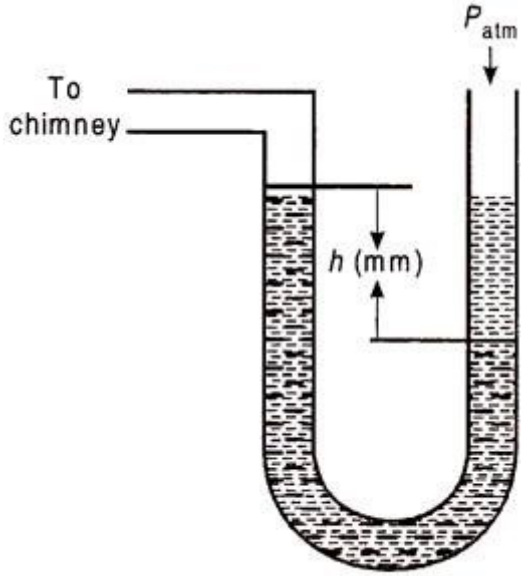

Fig. 11.22

Classification of Boiler Draught:

Draught is broadly classified into 2-types:

1. Natural or Chimney Draught:

In this case the amount of draught directly depends upon the height of chimney. It is produced due to the difference in densities between the column of hot gases in the chimney and a similar column of cold air outside the chimney.

Let us first consider the case when fires are not lighted.

Let, the atmospheric pressure at grate level be P_1 and P_2 be the atmospheric pressure at an altitude H. The pressure P_2 is lower than the pressure P_1 because with the altitude pressure goes on decreasing.

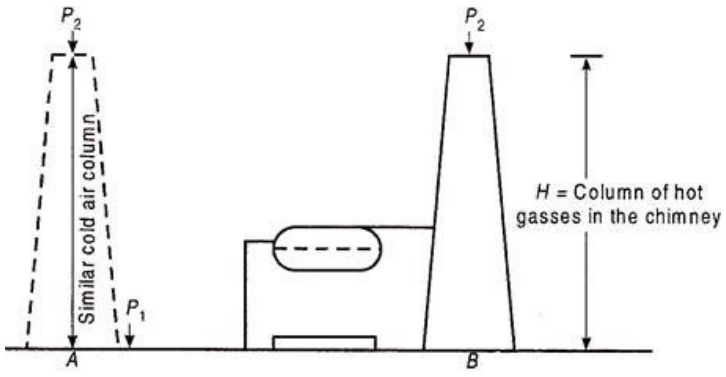

Fig. 11.23

Now let us consider the case when fires are lighted and the chimney is full of hot gases. Under these circumstances, the pressure at the base of the chimney is the sum of pressure P_2 at the top and the pressure due to hot gas column H. But pressure P_1 at grate is the sum of pressure P_2 and the pressure due to similar cold column of air H.

Since, ρ cold air > ρ hot gases

i.e., $P_A > P_B$

∴ P_2 + Pressure due to cold column H > P_2 + Pressure due to hot column H.

∴ Pressure at grate due to cold column > Pressure at the chimney base due to hot column H.

This difference is called static draught and because of the pressure difference, (draught) air will rush to the combustion chamber, where combustion of air and fuel takes place and hot gases are generated. Then these hot gases because of draught, flow through the system and finally they are exhausted to the atmosphere through the chimney.

Advantages of Natural Draught:

i. Easy to construct.

ii. No power is required for producing the draught.

iii. Long life of chimney.

iv. No maintenance is required.

Disadvantages:

i. Tall chimney is required.

ii. Poor efficiency.

iii. Decreases with increase in outside temperature.

iv. No flexibility it create more draught to take peak loads.

2. Artificial Draught:

In bigger power plants, the draught of the order of 25–350 mm of H_2O column is required. Far producing this much draught, the chimney height has to be increased considerably, which is neither convenient nor economical. Also, since the draught depends upon the climatic conditions, some mechanical equipments are used for producing the required draught and the draught so produced is called as the artificial draught.

i. Forced Draught:

In a Forced draught system, a Fan or Blower is provided is shown in figure which forces the air in the combustion chamber. In the combustion chamber combustion of air and fuel takes place and hot gases generated. These gases are forced to pass through the flues, economiser, air pre–heater and then they are exhausted after recovering heat of flue gases. This draught system is known positive draught system, since the pressure of gases throughout the system is above atmospheric pressure.

It is to be noted that, the function of chimney use is to discharge the gases high in the atmosphere to reduce air pollution and it is not much significant for producing draught.

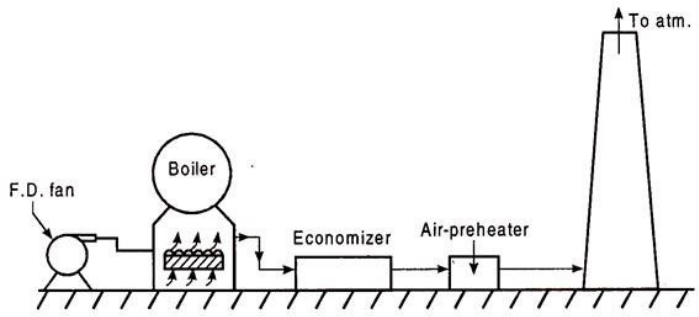

Fig. 11.24

ii. Induced Draught:

In this system, the Blower or Induced Draught fan is located near the base of chimney. The air is sucked in the system, by reducing the pressure through the system below atmosphere. The flue gases, generated after combustion are drawn through the system and after recovering heat in the economiser, air–preheater, they are exhausted through the chimney to the atmosphere.

Here it is to be noted that the draught produced is independent of the temperature of hot gases, so the gases may be discharged as cold as possible after recovering as much heat as possible.

Advantages of Forced Draught (F.D.) over Induced Draught (I.D.):

i. The size and power required by I.D. fan is more because this fan handles more gases.

ii. Since the I.D. fan handles hot gases, water cooled or air cooled bearings are to be used.

iii. F.D. fan consumes less power and normal bearing can be used.

iii. Balanced Draught:

It is always preferable to use combinations of I.D. and F.D. instead of Forced or Induced draught alone.

If Forced Draught alone is used then the furnace cannot be opened for firing or for inspection. Because the high pressure air/gases inside the furnace will try to blow out, and there is every chance of blowing out of the fire completely and the furnace may stop.

If Induced Draught fan alone is used, then also furnace cannot be opened either for firing or for inspection. Because the cold air will try to rush into the furnace, which reduces the effective draught.

To overcome both these difficulties Balanced Draught is used. In this case I.D. fan and F.D. fan are provided as shown.

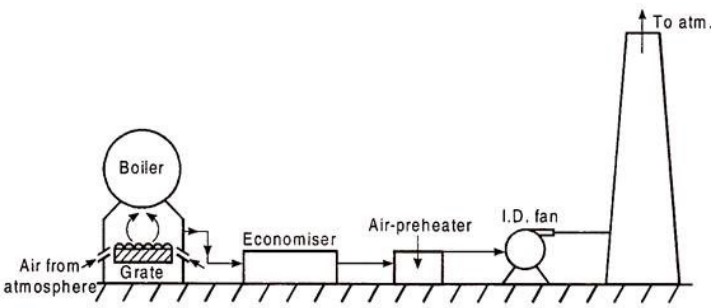

Fig. 11.25

iv. Steam Jet Draught:

It may be Forced or Induced type. If the steam jet is directed into the smoke box, near, the chimney, the air is sucked through the system, into the smoke box. If the jet is Located before grate, air is forced through the system. Induced type is favoured as forced draught increases heat losses.

Induced draught is produced by steam jet in case of Locomotive boiler. When the Locomotive in stationary, steam from the boiler may be supplied to the smoke box through the nozzle to create draught. While locomotive is running, due to motion, the air flows to the furnace.