1.4 FLUIDIZED BED COMBUSTION BOILERS

Fluidized bed boilers produce steam from fossil and waster fuels by using a technique called fluidized bed combustion. These can be of two types:

1. Bubbling fluidized bed (BFB) boilers
2. Circulating fluidized bed (CFB) boilers

BUBBLING FLUIDIZED BED (BFB) BOILERS

In BFB boilers, crushed coal (6-20mm) is injected into the fluidized bed of limestone just above an air-distribution grid at the bottom of the bed

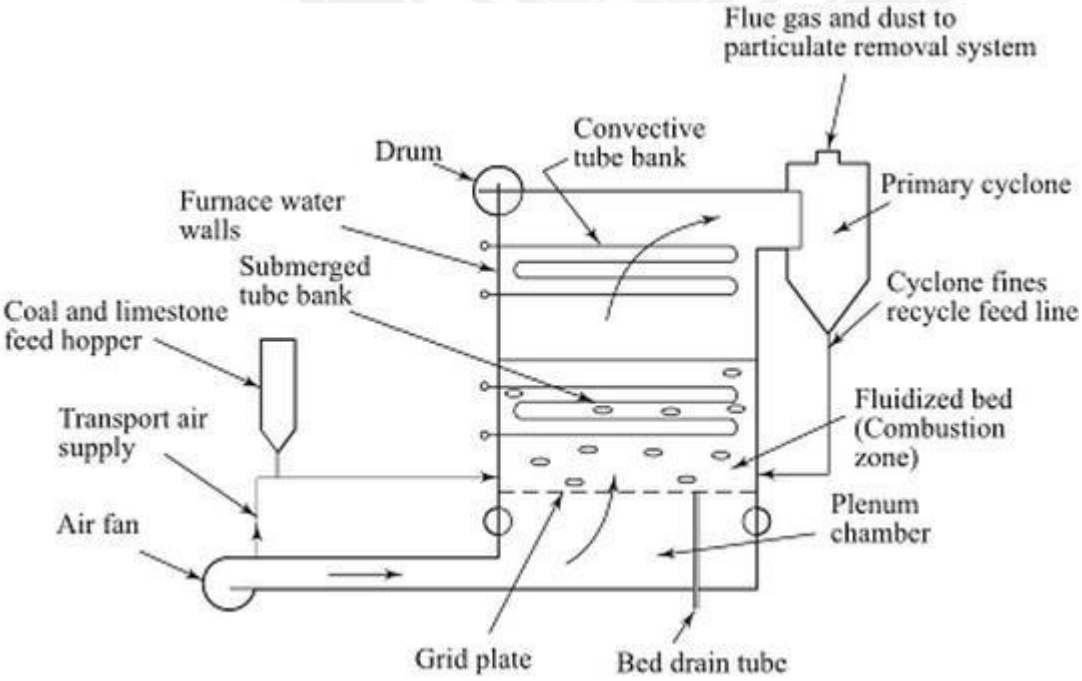

Figure 1.4.1 Bubbling FBC boiler system

[Source: "power plant Engineering" by by Anup Goel ,Laxmikant D.jathar,Siddu :3page:18]

The air flows upwards through the grid from the air plenum into the bed, where combustion of coal occurs. The products of combustion leaving the bed contain a large proportion of un burnt carbon particles which are collected in cyclone separator and fed back to the bed. The boiler water tubes are located in the furnace.

Since most of the sulphur in coal is retained in the bed by the material used (limestone), the gases can be cooled to a lower temperature before leaving the stack with less formation of acid (H_2SO_4). As a result of low combustion temperatures (800-900˚C), inferior gases of coal can be used without slagging problems and there is less formation of NO_X.

Cheaper alloy materials can be used, resulting in economy of construction. Further economies are achieved since no pulverizer is required. The volumetric heat release rates are 10 to 15 times higher and the surface heat transfer rates are 2 to 3 times higher than a conventional boiler. This makes the boiler make compact.

Figure shows a bubbling bed boiler system operating at atmospheric pressure, similar to the one of 160 MWe Tennessee Valley Authority (TVA) project at Shawnee, USA, recently installed (1993).

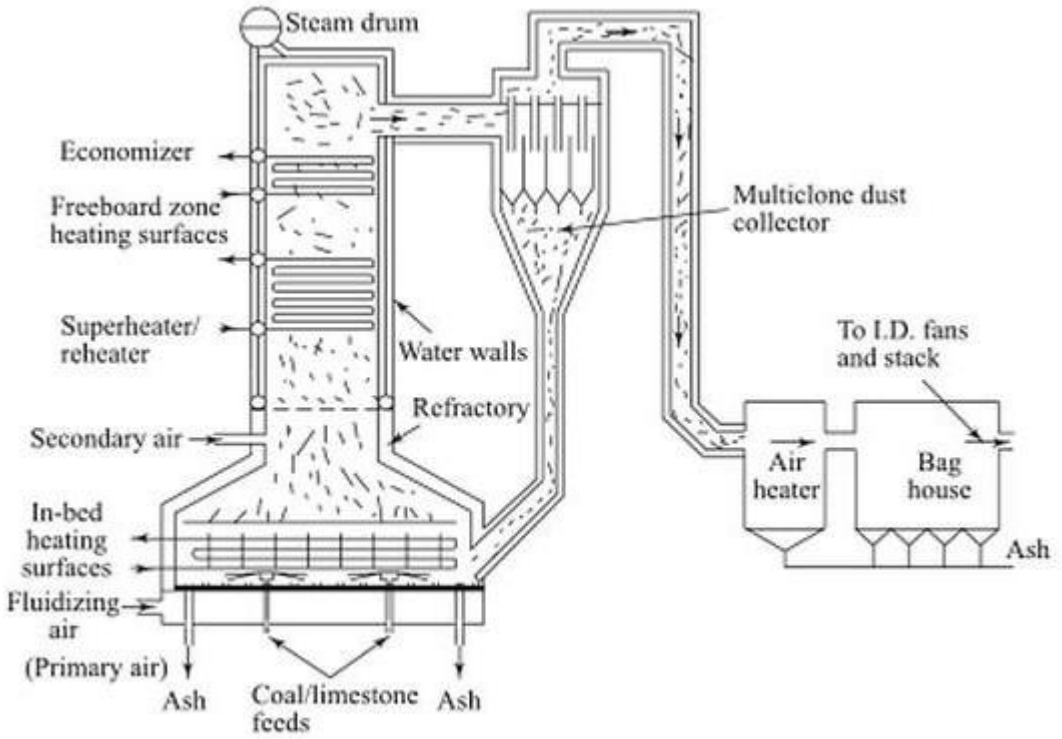

Figure 1.4.2 Atmospheric bubbling FBC boiler system

[Source: "power plant Engineering" by by Anup Goel ,Laxmikant D.jathar,Siddu :3page:19]

CIRCULATING FLUIDIZED BED (CFB) BOILERS

The CFB boiler is said to be the second generation fluidized bed boiler Figure. It is divided into two sections. The first section consists of

(a) Furnace or fast fluidized bed

(b) Gas-solid separator (cyclone)

(c) Solid recycle device (loop seal or L-value)

(d) External heat exchanger

These components from a solid circulation loop in which fuel is burned. The furnace enclosure of a CFB boiler is generally made of water tubes as in pulverized coal

fired (PC)boilers. A fraction of the generated heat is absorbed by these heat transferring tubes. The second section is

Schematic of a circulating fluidized bed boiler

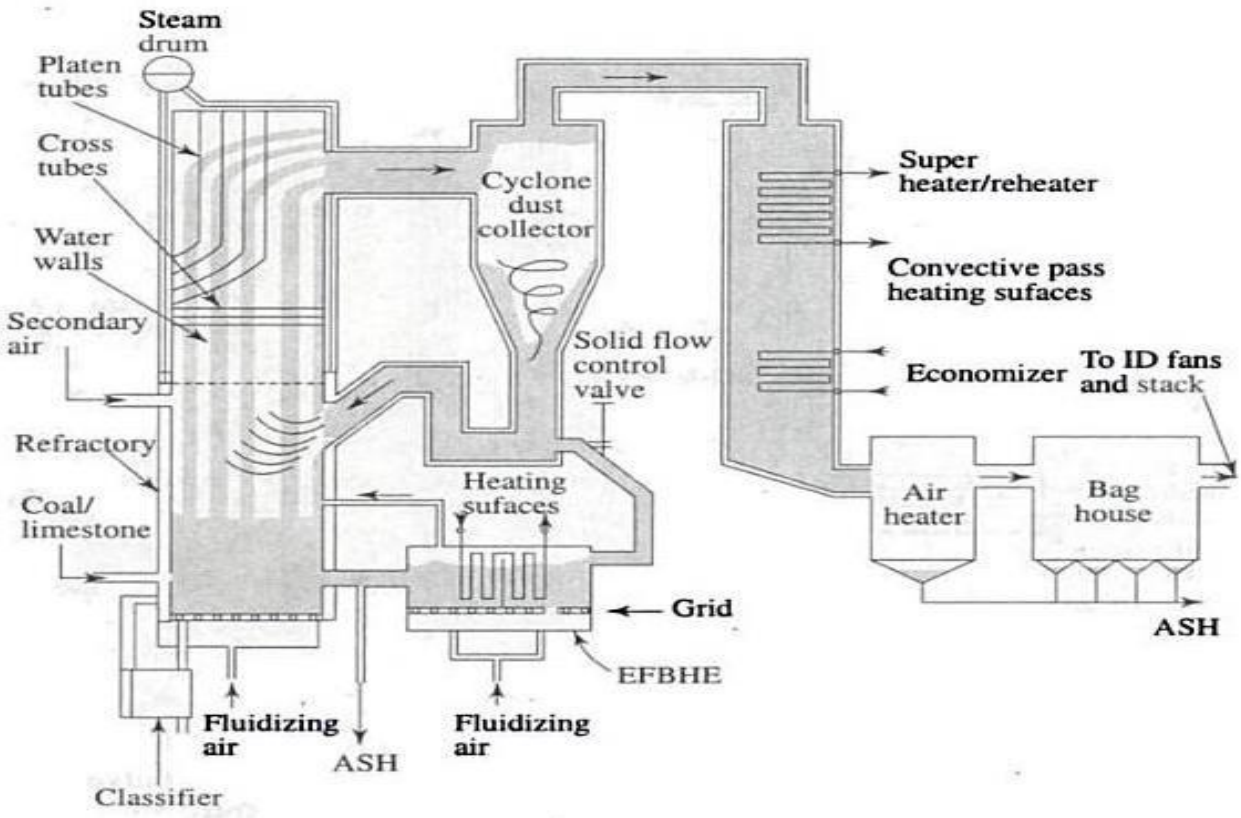

Figure 1.4.3 Circulating FBC boiler system

[Source: "power plant Engineering" by by Anup Goel ,Laxmikant D.jathar,Siddu :3page:19]

the back-pass, where the remaining heat from the glue gas is absorbed by the reheater, , economizer and air preheater surfaces (as in a conventional boiler)

The lower part o f the first section (furnace) is often tapered. Its walls are lined with refractory up to the level of secondary air entry. Beyond this the furnace walls are generally cooled by evaporative, superheater, or reheater surfaces. The gas-solid

separator and the non- mechanical valve are also lined with refractory. In some designs, a part of hot solids recycling between the cyclone and the furnace is diverted through an external heat exchanger, which is a bubbling fluidized bed with heat transfer surfaces immersed in it to remove heat from the hot solids.

Coal is generally injected into the lower section of the furnace. It is sometimes fed into the loop-seal, from which it enters the furnace along with returned solids. Limestone is fed into the bed in a similar manner. Coal burns when mixed with hot bed solids.

The primary combustion air enters the furnace through an air distributor or grate at the furnace floor. The secondary air is injected at some height above the grate to complete the combustion. Bed solids are well mixed throughout the height of the furnace. Thus, the bed temperature is nearly uniform in the range 800-900˚C, though heat is extracted along its height.

Relatively coarse particles of sorbent (limestone) and unburned char, larger than the cyclone cut-off size, are captured in the cyclone and are recycled back near the base of the furnace. Finer solid residues (ash and spent sorbents) generated during combustion and desulphurization leave the furnace, escaping through the cyclones, but they are collected by a bag-house or electrostatic precipitator located further downstream.