Looking for new energy sources is at present one of the most important worldwide problems. The world resources of fossil fuels are finite. The growth rate of oil and natural gas production is not coping up with increasing demand and they are expected to become scarce within the next few decades with a gradual decline. The resources of coal are very large and can last for centuries. The future of nuclear power lies with the development of breeder reactors whose large scale commercial application is still some decades away. The unconventional energy sources like solar power, wind power, wave power, biomass and geothermal energy are found in abundance, but their exploitation is not so economical.

One of the possibilities of widening the fuel and energy source is the utilization of the thermal energy of coals of inferior quality. The fluidized bed combustion technology is a proven technology to burn the inferior quality coals. Presently, in many countries, the combustion of coal in fluidized bed combustor has been considered as a potential alternate to conventional industrial and utility boilers.

India has extensive reserves of coal, estimated at about 83,000 million tonnes. Of these reserves, non-coking coal constitutes 60,896 million tonnes, coking coal 20,154 million tonnes and lignite 2,025 million tonnes.
Most of the non-coking coals have more than 30% ash content. In conventional steam generating boilers, coal is burnt in either a fixed bed spread over stokers or in a pseudo-gaseous state by injecting pulverized coal particles into an air stream. The released energy is then transferred to the working fluid by convection and radiation. The inherent difficulties faced while burning high ash content, low grade coals by these methods necessitated the need for a breakthrough in the technology of coal combustion. In view of this, the proved technology of fluidized bed combustion has to be investigated and developed to utilise Indian coals.

1.1 Phenomenon of Fluidization

A bed of loose particles offer resistance to fluid flowing through it. As the velocity of flow increases, the drag force exerted on the particles increases. If the fluid flow is upwards through the bed, the drag force will tend to cause the particles to rearrange themselves within the bed to offer less resistance to the fluid flow. With further increase in the upward fluid velocity, the expansion continues and a stage will be reached where the drag forces exerted on the particles will be sufficient to support the weight of the particles. In this state, the fluid-particle system begins to behave like a fluid and it will flow under a hydrostatic head. The pressure drop through any section of the bed equals to the weight of fluid and
solid particles per unit cross section of the bed. The
bed is then said to be just fluidized and the critical
velocity of flow of the fluid at this stage is termed as
the "minimum fluidizing velocity". In the case of gas-
solid systems, any increase in the quantity of gas beyond
that required for minimum fluidization, passes through
the bed in the form of bubbles resulting in large
instabilities. At high flow rates, agitation becomes
more violent and the movement of solids become more
vigorous. In this condition, the bed will have regions
of low and high solid density. The regions of low
solid density are termed as voids or gas bubbles and the
regions of higher solid density as emulsion phase. The
bed in this state is considered to resemble a boiling
liquid and in many ways exhibits liquid like behaviour.

1.2 Salient Features of the Bed

1.2.1 Temperature Uniformity

The heat transfer capacity of a fluidized bed is
phenomenal with effective thermal conductivities upto
one hundred times that of silver [2]. It results from
the vast amount of surface area that the solid phase
possesses being exposed to the fluidizing medium and the
reduction of the film effects on this surface induced by
vigorous stirring and complete mixing effected by the
action of the rising bubbles. This high rate of heat
transfer between the solid and the fluid results in
practically isothermal conditions in the bed, both in
the lateral and vertical directions.
1.2.2 Heat transfer to surfaces

When a surface is in contact with fluidized solids, the bubble induced vigorous mixing and agitation of the solid particles results in a reduction of the thickness of the gas film adjoining the surface. In addition, due to the isothermal nature of the bed, temperature gradients are concentrated near the transfer surface. Further, due to the vigorous mixing process the residence time of the particles at the exchange surface will be much smaller. These effects contribute to higher overall heat transfer rates which are 20 to 40 times greater than that for gases alone [2]. In the case of beds at higher temperatures the heat transferred to surfaces inside the bed is further increased by the fact that the radiant heat transfer from the bed is incident over its entire cross section.

1.3 Fluidized Combustion of Coal

The chief disadvantage in the use of coal for power generation is that it is a solid. This necessitates the use of more complex equipments such as pulverizers and precipitators than those required for the equivalent oil or gas burning installation. In fluidized combustion this disadvantage is overcome by burning coal in a pseudo-liquid state.

Any combustion process for a solid fuel must essentially satisfy the three basic requirements of:
(i) exposing a large surface area per unit volume of the fuel to the oxidizing agent

(ii) providing enough time of contact between the two so as to complete combustion, and

(iii) ensuring rapid removal of the products of combustion from the reaction zone so that the rate of reaction is not slowed down.

While the combustion of coal in stokers fulfills the second and third requirements satisfactorily, it fails far short of the first one. The combustion of coal in the pseudo-gaseous state by pulverizing it provides perhaps the ultimate with respect to the first condition. But, as the particles are transported by air, their residence time in the combustion chamber is limited. Further, due to the low relative velocity between them, removal of the products of combustion encircling the burning particles is not rapid. Thus the second and third requirements are poorly satisfied.

Combustion of coal in a fluidized bed combines the advantages of both the methods. It offers a satisfactorily large surface area for the progress of the reaction front, the residence time of the particles in the bed can be controlled and the products of combustion are rapidly removed from the reaction zone due to the turbulent nature of the bed.
1.3.1 Advantages of fluidized bed combustion of coal

Apart from the temperature uniformity and higher heat transfer rates inherent in any fluidized bed process, certain distinct advantages can be realised in the fluidized combustion of coal as compared to the conventional pulverized fuel burning. Some of them are:

(a) Because of the rapid removal of the products of combustion from the reaction zone, complete combustion can be readily obtained even with a small percentage of excess air.

(b) As a major part of the bed consists of inert material, fluidized bed combustor can burn low grade contaminated coal, thus reducing the cost of processing.

(c) To prevent sintering of ash in the bed, it is operated at temperatures of 850 to 1000°C, well below the sintering temperature. At these temperatures, the corrosion and fouling of the tubes exposed to the gas stream due to the volatalized alkali salts in coal is also minimised.

(d) The higher rate of heat transfer to surfaces immersed in the bed reduces the tube requirements and thus the capital cost.
(e) By adding limestone to the bed, sulphur in the coal can be trapped in the ash, minimising the pollution caused by sulphur dioxide in the flue gas.

(f) As the coal size used is of the order of a few millimeters, the cost of crushing is much lower compared to a pulverized fuel installation.