New breed of boilers for paper industry

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SUMMARY

Several long-term measures towards energy conservation in paper industry have been discussed. Special emphasis is given to adopt boilers for low grade Indian Coal. Fluidised Bed Combustion Boilers and its role towards energy conservation have been dealt with. Several advantages, operation and cost comparison have been discussed. Special emphasis is given towards its suitability for paper Industry.

Pulp and paper industry has become an energy intensive industry. Under the present context of depleting energy sources and escalating prices of energy one has to be extremely judicious in efficient utilisation of energy. Therefore, attention has been given to different equipment related to energy utilisation. Boiler being the major equipment in this area should be given serious consideration. Technologists suggest several short term and long term measures for energy conservation in Boilers. Some of the long term measures as suggested by the technologists are as follows :

(a) Introduction of total energy concept, whenever feasible;

(b) Change over from oil-fired to coal fired boilers;

(c) Introduction of systems for use of cheaper waste fuels like bark, wood waste and rise husk;

(d) Installation of Boilers suitable to adopt low quality (high ash content) coal.

The primary objective of this paper is to focus on a Boiler which is sufficiently flexible to operate efficiently with waste fuels as well as low grade coals. The Boiler to be dealt with is called "FLUIDISED BED COMBUSTION BOILER." Fluidised Bed Combustion Boilers have come out after a prolonged research in the field of combustion, especially for burning low grade-high ash coal as available in India.

The quality of Indian coal is deteriorating very fast bringing down the average calorific value from 6000 kcal/kg to 4200 kcal/kg in last twenty years. The ash content has gone up from 20 to 40 percent. The ash content in Indian coal lies between 35 to 45 percent and at times it reaches upto 50 percent. The deterioration in coal quality is explained graphically in Figure-1. Conventional coal fired boilers are facing numerous problems while burning this low grade/high ash Indian coal. Fluidised Bed Combustion Boilers eliminate all such problems and can burn this low grade coal efficiently and in an environmentally acceptable manners.

PHENOMENON OF FLUIDISATION :

Fluidisation is the operation by which fine solide are transformed into a fluid like state through contact with a gas.

If high pressure air is allowed to pass through a bed of small size inert particles, at a particular flow rate the particles are all just suspended by the upward moving air. The weight of bed material per unit area equalises the pressure drop across the bed and the bed is termed as a fluidised bed. An increase in flow rate above this value will cause bubble formation. This is called a bubbling Fluidised Bed. When the bed is fluidised its behaviour is like a fiuid.

APPLICATION TO BOILER TECHNOLOGY :

If we can heat the sand in fluidised state above 750° C by oil, gas or by charcoal and allow the coal to burn in it, its temperature will gradually go on increasing. A few cooling coils (i. e., boiler water tubes) are provided in the bed to extract a substantial amount of heat from the bed, thereby keeping the bed temperature between 800° C. and 900° C. This along with other accessories is represented schematically in Figure–2.

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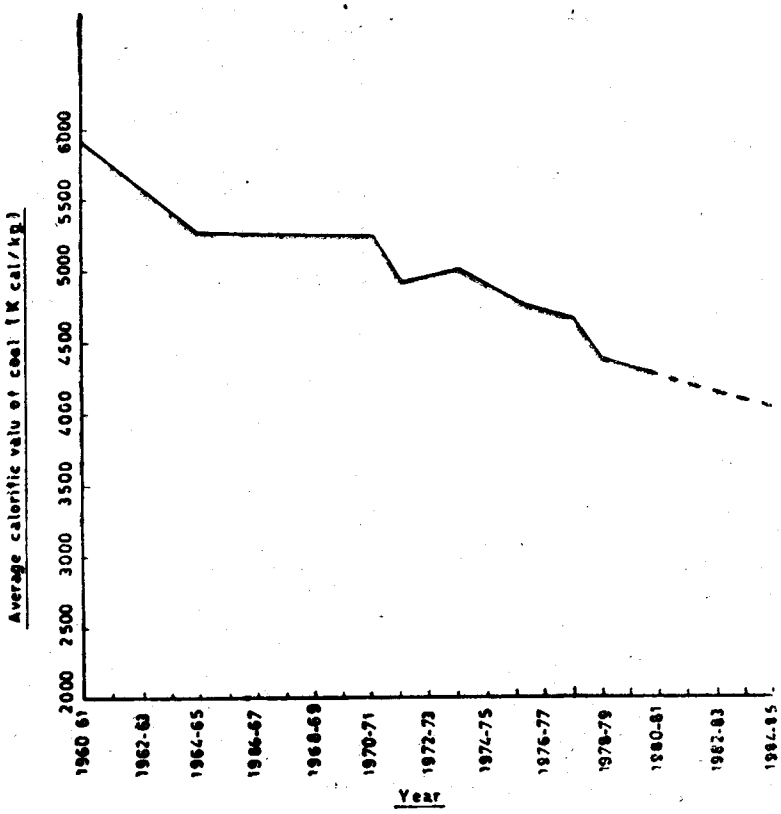


FIG-1

GRAPH INDICATING DETERIORATION OF COAL QUALITY

(SOURCE - CENTRAL ELECTRICITY AUTHORITY)

ADVANTAGES OF THESE BOILERS :

(i) Heat transfer coefficient at the fluidised bed is 5 to 8 times higher compared to boiler furnace and 10 to 15 times higher compared to convection zone. This reduces heating surface of the Boiler.

(ii) The uniform and vigorous mixing of fuel and air throughout the bed allows low grade and high ash content coal to burn in it. It has burnt successfully coal washery rejects of ash content 60 to 70% and calorific value 2000 kcal/kg to 2500 kcal/kg. Other cellulose fuels like bagasse, rice husk, bark and wood waste can also be burnt successfully. The excess air requirement for the Boiler is also less.

(iii) Coal with high sulfur content can be burnt in fluidised bed withou affecting the environment. Limestone is added with coal in the bed and by reaction it forms calcium sulphate $CaSO_4$. It controls very effectively the emission of harmful gases like Sox or Nox.

(iv) The ash from fluidised bed combustion does not fuse as the bed temperature is always kept below the initial deformation temperature of ash. This soft ash causes less erosion and fouling in boiler convection tubes, I.D. Fan and related auxiliaries.

SPECIAL ADVANTAGE TO PAPER INDUSTRY :

Watertube boilers are superior in the sense that they have faster response towards wider load fluctuation. Watertube boilers in general take less time for start up purposes.

While considering all these, fluidised bed boilers are found to be most suited because of its fastest response towards flutuating type of load prevalent in process industries in general and paper mill in particular. This is because of the bed coils placed inside the bed where transfer rate is too high.

START-UP LOAD CONTROL AND NORMAL OPERATION

Different methods are available for starting up of the bed. Some of the boiler manufactuerers have adopted start-up by over-bed burners while others are using under bed hot-gas generation. Start up by these methods takes much time and requires much maintenance work. Many developed countries have adopted start-up by above two methods. Indian Engineers have more or less adopted start-up by crushed charcoal firing. This method takes very little time for start-up and requires no maintenance. Cost for each start up is also less. The temperature rise in charcoal start-up is explained in Figure-3.

A fifty percent load reduction is possible by adjusting fuel and air. With increase in air quantity the bed expands further thereby increasing the

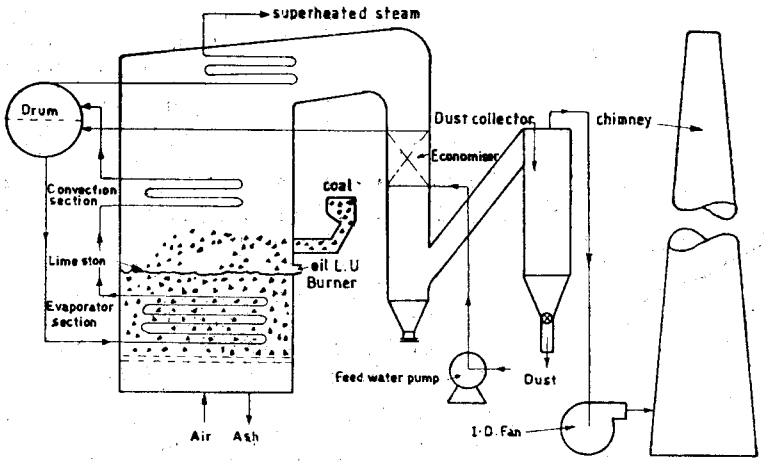
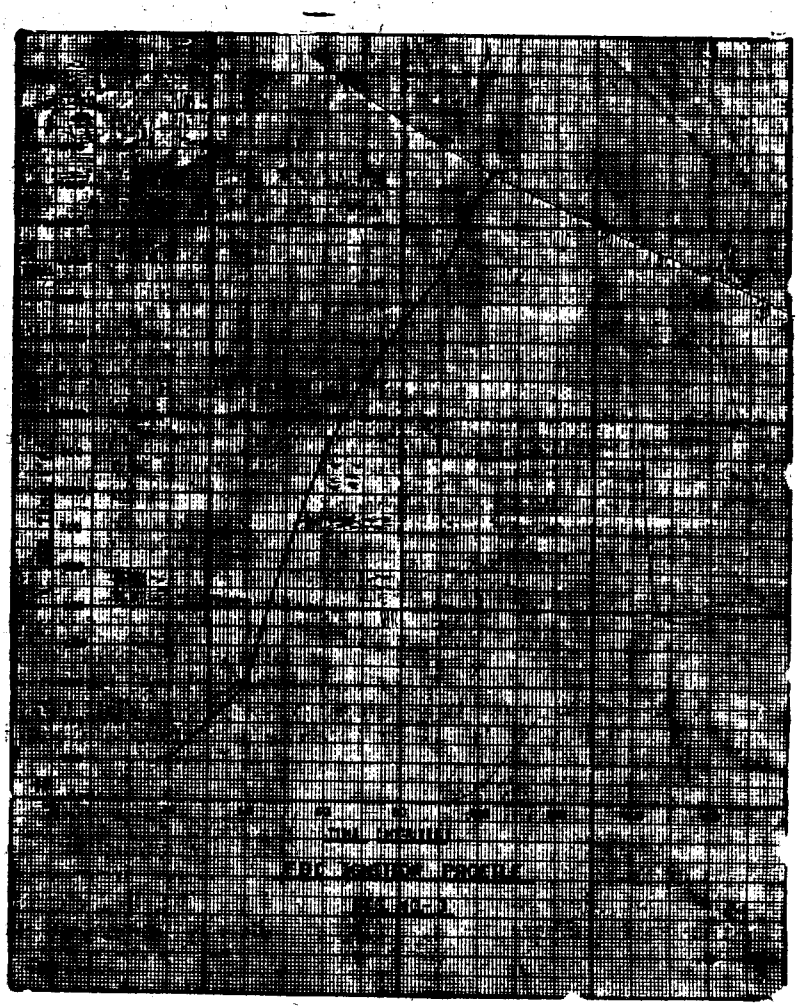


FIG. 2
SCHEMATIC DIAGRAM OF A FLUIDIZED BED BOILER WITH OVERBED COAL FEEDING



immersad heating surface. This increases the output of the boiler. An increase in coal quantity will achieve low excess air and will keep the bed temperature at a constant value. **Figure –4** shows bed expansion versus boiler output relationship. Further reduction of load can be achieved by partial bed stumping. Air box is compartmentalised for this purpose and individual dampers are provided for bed slumping purpose. A 3:1 ratio of load control is achievable after using this partial bed slumping method. As mentioned earlier, fast response is possible in F. B. C. Boilers for load fluctuation. Normal start-up time is 1½ hours from cold condition. During routing plant start-down or for cleaning, bed can be kept in slumped condition for about 8/10 hours after which warm start-up is possible. This cycle is illustrated in **Figure–5.**

ECONOMICS OF F. B. C. BOILERS :

Fluidised Bed Combustion Boilers achieve about 8 to 15 percent higher efficiency compared to conventional type of present day Boilers. It consumes higher fan power but a comparative study indicates a substantial overall saving per annum.

Table–1 is a cost comparision of F. B. C. Boilers with other designs. It indicates that the steam cost per tonne is minimum in F. B. C. boilers considering fuel cost, power cost and man power cost. Besides, maintenance work for the bed and furnace is drastically reduced.

The considerable annual saving coupled with its superiority to burn low grade/high ash content coal and other cellulose fuels like rice husk, bagasse, bark, wood waste etc. makes it attractive to Indian content.

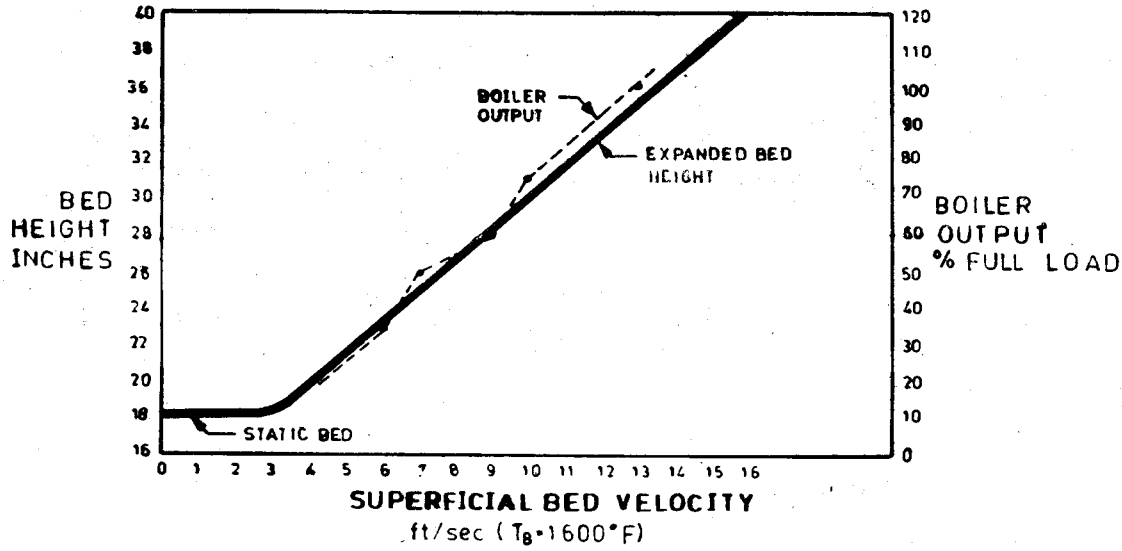


Figure No 4 BED EXPANSION AND BOILER OUTPUT vs SUPEREICIAL BED VELOCITY

SOURCE - NORTHERN STATES POWER COMPANY U.S.A.

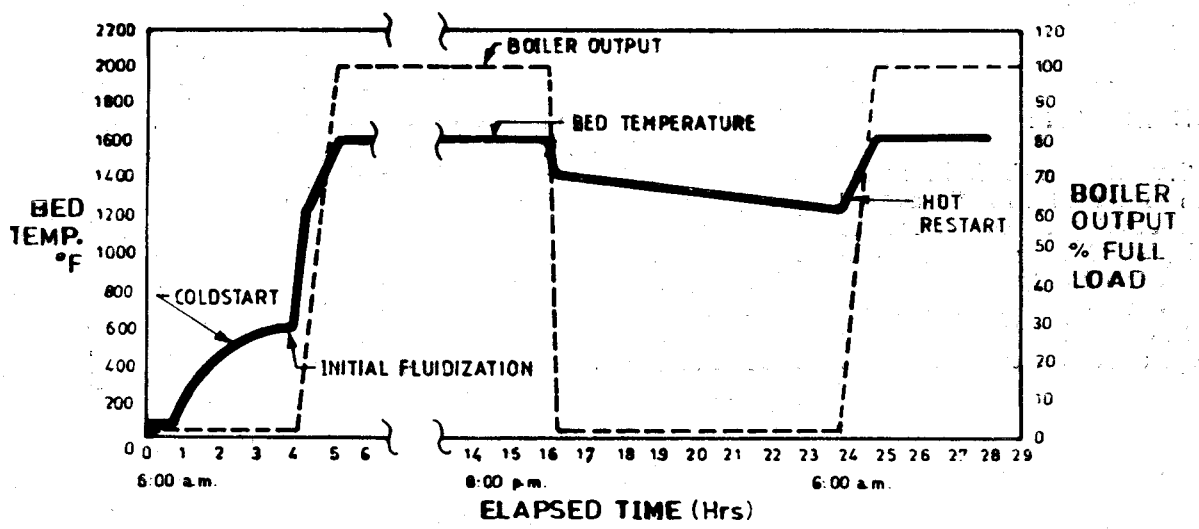


Figure NO. 5 OPERATING CYCLE BED TEMPERATURE AND BOILER OUTPUT vs TIME

SOURCE - NORTHERN STATES POWER CO. U.S.A.

TABLE - I

COST COMPARISON

BOILER SIZE - 5 TE/HR FROM & AT 100°C
OPERATING PRESURE - 150 P S I
COAL - 40% ASH, 4200 K CAL/ KG (GCV)

	ITEM	F.B.C	SPREADER STOKER DUMPING GRATE TYPE	HAND FIRING
1.	COAL PER HOUR	782 KG.	844 KG.	974 KG.
2.	POWER (F.D, I D, Feed Pump & Coal feeder)	54 H.P	50 H P	30 H P
3.	FUEL COST (PER YEAR)	RS. 28,15,000/-	RS 30,38,000/-	RS 35,00,000/-
4	POWER COST (") (F D, I D, Feed Pump & Coal feeder)	RS. 2,60,000/-	RS 2,40,000/-	RS. 1,44,000/-
5	CAPITAL COST	RS. 12,50,000/-	RS 12,50,000/-	RS 8,25,000/-
6	OPERATION COST (") (MAN POWER)	RS. 1,80,000/-	RS. 1,80,000/-	RS. 2,55,000/-
7	STEAM COST (PER TE)	RS. 90·41	RS. 96·05	RS. 108·00

CONCLUSION :

Several F.B.C. Boilers have been installed in India as well as in developed countries like U.K., U.S.A., Canada, Czechoslovakia and Rumania. China claims that more than 2,000 Boilers of F.B.C. design are in operation there. The results of commissioned units are encouraging. Most of the world's F.B.C. boilers are installed in process plants either for the conservation of energy or for air pollution control. A couple of boilers have been installed by different manufacturers in India as well. A few other organisations in India have either obtained foreign collaboration or developed F.B.C. Boilers from indigenous resources. Technologists believe that these boilers will have a large market share in near future in India because of the substantial fuel saving, ability to burn low grade/high ash coal and other specialities suitable to Indian context.