High Draught Kiln—Its Operation, Control and Economics

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Introduction

Estimated figures for the manufacture of building bricks in the country is around 3,000 crores per annum. It is still far below the market demand and the shortfall is likely to increase manifold in future. Although a large number of bricks are burnt in clamps, the bulk of the production is burnt in Bull's trench kiln. The Bull's kiln was introduced in this country by the British Engineer. W. Bull about a century ago. This kiln is generally known to be wasteful in fuel and its poor thermal efficiency is reflected in the higher fuel consumption (varying from 180 Kg to 200 Kg/thousand bricks in different regions of the country), and the poor quality of the products. No efforts have been made over the years to improve either its design or its method of operation. It has suffered and continues to suffer this neglect primarily because the construction, operation and maintenance of the kiln had all along been entrusted to illiterate or semi-illiterate workmen who had no technical background and were guided exclusively by the rule of the thumb methods. Another contributing factor had been the easy and plentiful availability of coal and firewood at extremely cheap prices.

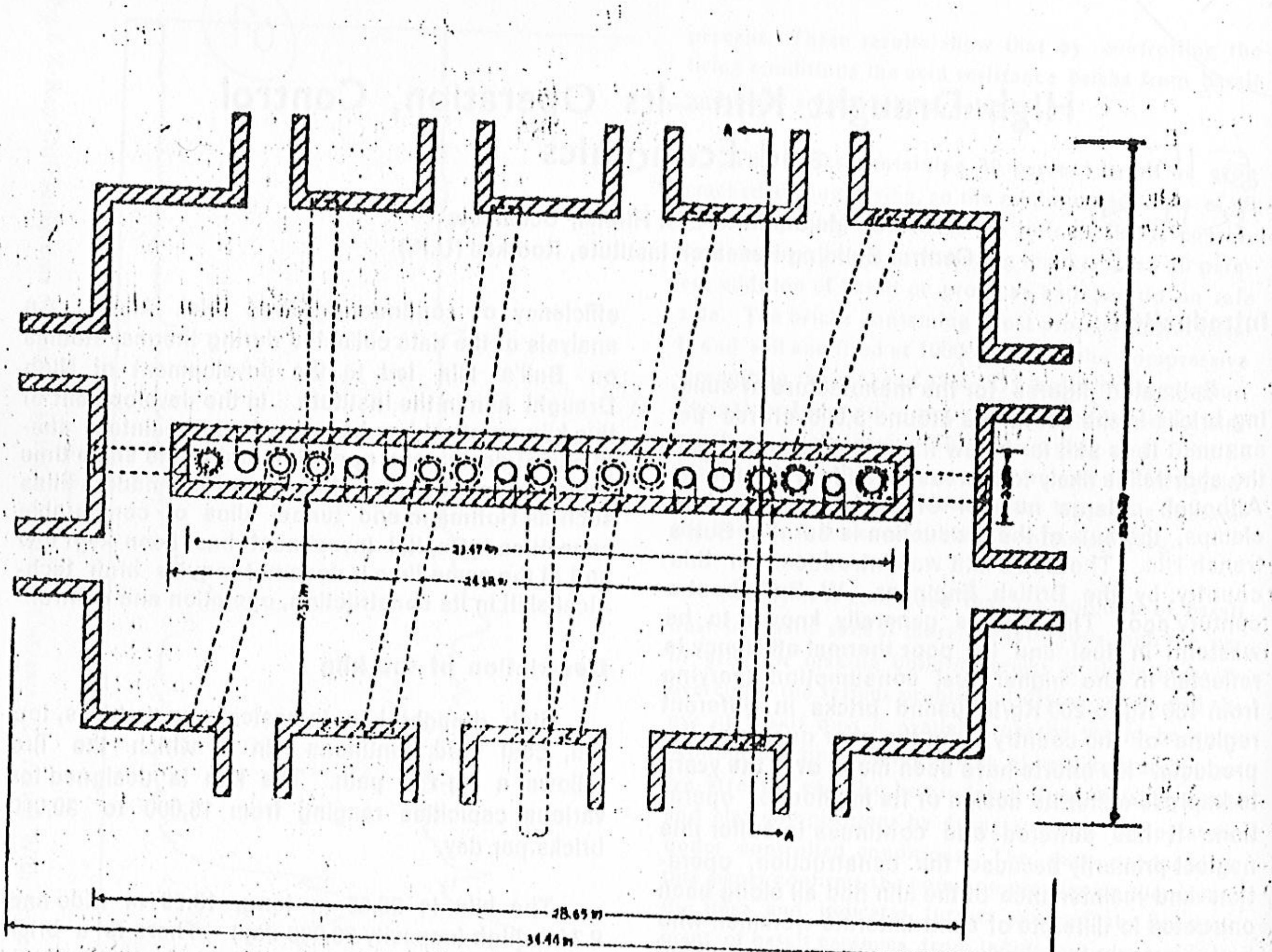
The situation that faces the brick industry today is entirely different. Coal and firewood have become scarce materials and their prices have shot up nearly ten fold in the past two decades. Whereas kiln owners previously showed little concern if a few extra tonnes of fuel were wastefully burnt or a considerable proportion of bricks were either under or over-burnt, they are now anxious to save as much coal as possible and at the same time reduce the incidence of sub-standard production.

In recent years research investigations were undertaken in Central Building Research Institute to study the basic factors that led to low thermal efficiency of continuously fired brick kilns. An analysis of the data collected during thermal studies on Bull's kiln led to the development of High Draught kiln in the Institute. In the development of this kiln an effort has been made to maintain simplicity of design and operation and at the same time achieve high thermal efficiency of the modern kilns such as Hoffmann and tunnel kilns of comparable capacities. Capital investment has been kept low and at the same time it does not require high technical skill in its construction, operation and control.

Description of the kiln

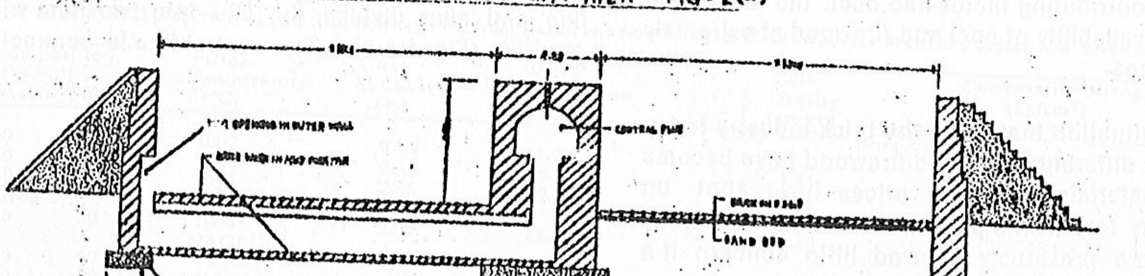
High draught kiln is basically an archless, top fed, coal fired continous kiln in which the fire follows a zig-zag path. The kiln is designed for various capicities ranging from 15,000 to 30,000 bricks per day.

The kiln is 28.65 m long, 18.29 m wide and 2.74 m high (capacity 30,000 day) There is a brick structure 24.78m long, 2.43m wide and 2.74m high in the centre of the kiln which encloses the central flue and also divides the kiln into two 7.3m wide galleries (Fig. 1 & 2). The central flue is connected



PLAN

C.B.R.I. HIGH DRAUGHT KILN - FIG - 2(a)



SECTION AT A-A FIG A(b)

to the galleries through eighteen chamber flues of these ten flues open into the outer walls and eight in the inner walls. A cost iron plug damper is placed at each junction of the chamber and central flues. The damper can be lowered from the top of the kiln through a nut and coller arrangement. From the centre of the central flue a down take leads the waste gases to a powerful induced draught fan.

An additional plate damper is provided in the last flue, fixed just before the fan to secure further control on the draught. The fan is connected to a short masonry chimney (about 6m) to exhaust the flue gases at a convenient height. The exhausting capacity of the fan is 425 cu.m/minute and it produces a draught o 75 mm water gauge at ambient temperature and 50 mm at the working temperature.

For the loading and unloading bricks 12 wickets 1.02m wide are provided in the outer walls of the kiln. All the civil work is done with red bricks laid in mud mortar. The kiln is covered by a shed.

Setting of Bricks

The setting space is divided into 24 chambers by constructing temporary partition walls with unfired bricks. Each partition wall runs along the whole cross-section of the gallery except at one end where 60 cm space is left for communication between adjacent chambers as shown in Fig. 3. Bricks in these walls are throughly burnt and are removed at the time of unloading the bricks.

A chamber comprises the rectangular space enclosed between any two partition walls. Dry bricks are set in this chamber. The pattern of setting adopted in the kiln is more or less similar to Hoffmann kiln but the firing platforms for burning coal at different levels of the kiln are taken from the Bull's kiln. Spaces are left within the setting to permit coal being fed from the top. Each chamber holds 15,000 bricks. The top of the setting is sealed with a compact layer of ash, leaving out feed holds for charging coal. The feed holds are fitted with portable cast iron feed pots which are closed with airtight cast iron lids.

Firing of Bricks

When some 14 chambers have been loaded, the fire is started in the first chamber. A temporary cross wall is constructed in front of the setting. Three grates are provided in the cross wall on which lump coal is burnt on bars of 2.5 cm square section and 60 cm long. Firing can also be initiated with firewood. Damper nearest to the fire is opened. A draught of about 5 mm is maintained by partially lowering the plate damper in the main flue. When the bricks in the first blade are red hot, the top feeding of coal is started. Both top and bottom firing is continued till fire reaches the end of the record chamber. As the fire advances next damper is opened and the previous one closed. At this stage bottom firing is stopped. Initially the firing is kept slow at the rate of one chamber a day (24 hours) till the fire reaches the fifth chamber. The rate of firing is increased gradually till it reaches two chambers a day. To achieve the optimum efficiency of the kiln, a firing rate of two chambers a day should be maintained. When the kiln has been brought to full firing order, the following schedule is maintained:

Operation	No. of Chambers
Cooling	8
Soaking	2
Full fire	2
Preheat	4
Drying	2
Setting	2
Drawing	2
Empty	2
Total	24

In the chambers under full fire, coal is fed every 10 minutes and those under soaking a 15 minutes feed interval is maintained. Two chamber dampers are kept open, one nearer the fire-zone fully open and the other half open. Draught as measured near the fan is maintained at 25.50 mm (Water gauge).

Fuel Used in Firing

Bituminous slack coal, generally available in the market, is used in the firing of bricks. The run of the mine slack coal delivered to brick kilns contains a considerable quantity (30-40 percent) of large lumps (upto 50 mm or more). In the kiln the coal must necessarily burn on the solid floor. Large size coal takes longer to burn due to slow rate of diffusion of oxygen into the coal, particularly on the floor or the kiln where it forms a heap. Ideally, coal fed to the kiln should be of such a grain size that particles burnt out completely during their passage from top to the floor. High combustion efficiency is achieved if coal is crushed thus exposing larger surface area for rapid oxidation. Consequently coal used for burning bricks in high draught kiln is crushed in a jaw crusher below 12 mm size. The average coal consumption in the kiln is 120 kg per 1000 bricks.

The kiln has also been fired with firewood after slightly modifying the pattern of setting. Rice husk has also been successfully used as supplementary fuel thereby saving coal consumption to the extent of 25-30 percent. Other local waste materials such as cashew-nut-shell or ground-nut-shell etc. can also be used wherever available.

Control of Firing and Instrumentation

At the time of setting the bricks in the kiln, care must be taken in the proper alignment of the brick blades and the trace holdes for the easy movement of fire through the setting. Wet bricks should not be loaded in the kiln which result in their cracking.

Any gap in the top course of bricks should be sealed so that ash does not fall down into the kiln. If even a small gap is left, this will widen up because of the very powerful draught inside the kiln and cold air is sucked in resulting into underburnt bricks at the cost of increased fuel consumption.

Draught is measured by draught gauge attached to the main flue leading to the fan near the plate damper. Suitable draught is maintained according to the firing conditions in the kiln. Dampers are checked occasionally for possible leakage.

The firing temperature in the kiln is maintained between 950° to 1000°C. This is checked regularly with the help of thermocouple and pyrometer.

A thermocouple is fixed into a feed hole just ahead of the firing zone and when it shows a temperature of 700°C, it is ready for accepting coal feed and the thermocouple is then shifted to the next row.

The quantity of coal fed into a particular zone is judged from the condition of fire in that area. In the full fire zone where the fire is likely to be vigorous care is taken not to feed excess amount of coal which result into overburning of bricks. Accumulation of unburnt coal in the furnaces and at the floor is also not desirable.

Working Results

In actual commercial firing campaigns, the kiln has proved to be highly efficient. The thermal efficiency achieved is thus comparable to that of modern and vastly more sophisticated kilns of comparable capacities.

The principal factors which contribute to the attainment of high thermal efficiency of this kiln are as below :

- —Use of a powerful induced draught fan; the strong draught produced by it ensures complete combustion of fuel.
- —Fast removal of moisture from bricks in the drying and preheating chambers.
- —Channelising the waste gases through a system of flues suitably controlled by dampers.
- —Prevention of in-leakage of cold air through feed hole pots of improved design.
- —Maintaining of exhaust flue gas temperature at as low as 100°C.

—Specially designed pattern of setting ensuring uniform heat distribution.

—Use of coal crushed to below 12 mm size.

Apart from high thermal efficiency, the kiln has an added advantage of being almost smokeless even when high volatile coal is used, and unlike Bull's kiln does not add to the pollution of environment.

The quality of the bricks fired in the kiln is very good, 80% of bricks are first class, 15% second class and the rest are overburnt, underburnt and rejects.

As the kiln is conveted by a shed it can work throughout the year. It also provides more congenial working conditions for the firemen, brick setters and unloaders in all seasons compared to conventional kilns when working conditions are very harsh.

Cost

Estimated cost of construction of the kiln is Rs. 3,50,000 including the cost of shed. Cost of firing comes round to about Rs. 70 per thousand bricks. In calculating the cost of firing it has been assumed that coal will be available at the rate of Rs. 300/- per tonne (controlled rate). Power consumption for round the clock running of fan is 12 K W for 24 hours.

Acknowledgement

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