

KILN

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FIRING OF BULL'S TRENCH KILNS

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Introduction

THE quality of the fired brick depends largely on the temperature of firing, the rate of heating and cooling and the composition of the kiln atmosphere during burning. In the course of firing as the temperature is raised a series of physical and chemical changes take place affecting the composition of brick. At different stages of firing heat is either evolved or absorbed, steam and gases are given off and the mineralogical composition of the brick is radically changed. Firing of bricks is, therefore, a complex process and unless great care is taken in operating the kiln the out-put of well-burnt, strong and durable bricks is certain to be low.

The Bull's trench kiln which is commonly used in India for firing bricks is, however, of a crude design where control of temperature and firing is difficult, besides there is large fuel consumption, and the output of well-burnt bricks is generally below 50%. The purpose of these notes is to indicate the lines on which such kilns should be operated to obtain better results.

Selecting The Site

While constructing the kiln, it is preferable to select a site at a slight elevation and in particular avoiding the neighbourhood of tanks or ponds. Excessive fuel consumption very often is due to the suction of sub-soil water through the kiln floor. With a high sub-soil water level, it is preferable to dig the trench to only half of the desired depth, i.e. about 4 ft. and construct 8-foot high inner and outer walls. Earth dug out from the trench may be heaped outside the walls to prevent escape of heat through them.

The Kiln

Description of the Kiln :

Fig. I (top half) of the accompanying sketch is of a common Bull's trench. It is a part plan showing the method of commencing the setting and the temporary cross-wall for starting the fire. Fig. II is a part plan showing the top of the setting. The bottom halves of the above figures show a plan of a part of the kiln covered and ready for firing. Fig. III shows a cross-section through feed holes and furnaces. Figs. IV & V show longitudinal section of Figs. I & II.

In the average kiln a pair of chimneys, each about 25-30 ft. high, are sufficient to give a good draught, and should be maintained in good condition to obtain uniform burning results. The use of badly corroded chimneys with

large holes in the main shaft is a bad economy resulting in weak and irregular draught and wastage of fuel. Chimneys must be replaced whenever they become un-serviceable.

Generally in these kilns adjustable dampers are not used. However, to prevent loss of fuel and to regulate the draught, some sort of damper must be used to secure as much control as possible. A useful device is to leave a space at the bottom of the chimney for a plate of iron, 1/8 in. thick and sufficiently long and broad to completely cover the opening at the chimney base. By moving the plate in or out, the chimney opening can be varied and some measure of control over the kiln draught secured.

Setting The Bricks

Two convenient methods of setting are shown in Fig. VI. For setting the bricks a suitable template (wooden) may be used for correctly spacing the courses, and a space of 1/4" or more should be left in between the bricks. A very dense setting obstructs the passage of hot gases so that the kiln draught is reduced and only the outer faces of the bricks receive sufficient heat. To open a setting may, on the other hand, result in the escape of fuel without combustion, thus reducing the kiln capacity unnecessarily. The furnaces should be wide enough to allow at least 4-5 lbs. of coal to burn freely. As shown in the sketch the bottom of the furnace is 12"-13" wide gradually narrowing down to 9" at the 4th course from the bottom. The kiln chambers should be distinctly marked out on the walls and loading carried out in sections of 15 to 20 feet.

Commencing The Fire

As each chamber is filled, the top of the setting, as shown in Fig. III, is covered by a compact layer of dry earth and ash (about 6" thick). This layer is evenly spread over the top in level with the feed-holes, to prevent loss of heat through the top. It should be carefully sealed to prevent the lowering of kiln temperature through the escape of hot gases or inflow of cold air. The feed holes are then covered with cast iron caps and properly sealed.

When two chamber lengths and a part of the third have been set, the temporary cross-wall with the furnaces at the foot of it may be constructed at a distance of about 9" from the first row of bricks (see Fig. I). At the bottom of furnaces bricks are arranged to form grates over which coal is burnt. Initial firing may also be started with wood, coal being charged only when the bricks are sufficiently hot. The cross-damper is put at the end of the second

chamber. The space between the damper and the walls should be plastered over with mud so that no leakage of the kiln gases can take place. Initially the feed-holes in the firing zone are kept open and a very slow fire is kept up. As steam ceases to rise out of each line of feed holes, they are successively closed so that the chimneys can exert their full power.

Firing Proper

Twenty-four hours after firing has commenced, the third chamber is completely loaded and the cross-dampers are withdrawn from the second opening and put down the third. The chimneys, which are initially placed at a distance of 5 or 6 rows of feed-holes from the three rows under fire, are now shifted and placed at the end of the second chamber, the first chimney opening being closed up and properly sealed.

When there is a good bottom heat in the fourth row and the bricks in the first row are red hot, top firing is commenced from the first row of feed holes. Three or four hours later, a second may be commenced and so on. The ladle for charging coal from the top holds about 1½ to 1¼ lbs of coal. On starting the firing in a fresh line, 4 to 5 ladles are charged at once, and afterwards 3 or 4 feeds per hour are required.

The kiln is now in full working order and top and bottom firing is continued till the first furnace has been sufficiently fired. At this stage the bottom firing is slackened

down and finally stopped till about six furnaces have been fired. The furnace 'mouths' are then loosely closed with bricks. Loading, firing and moving the chimneys on is now carried on in proper order.

Terminating The Fire

When about 8 to 10 chambers have been fired, the temporary cross wall may be pulled down and unloading commenced. When it is desired to finish off the burning, a cross-wall like the one constructed at starting but without the furnaces is built at the end of any convenient chamber, about 6" from the bricks. Resting half on this and half on green bricks, two dummy chimneys about 5' long and 6' high are constructed with bricks and plastered over with mud. The top of these chimneys should be kept closed and opened only when the iron chimneys are removed from their last possible position. The bricks chimneys then finish off the burning.

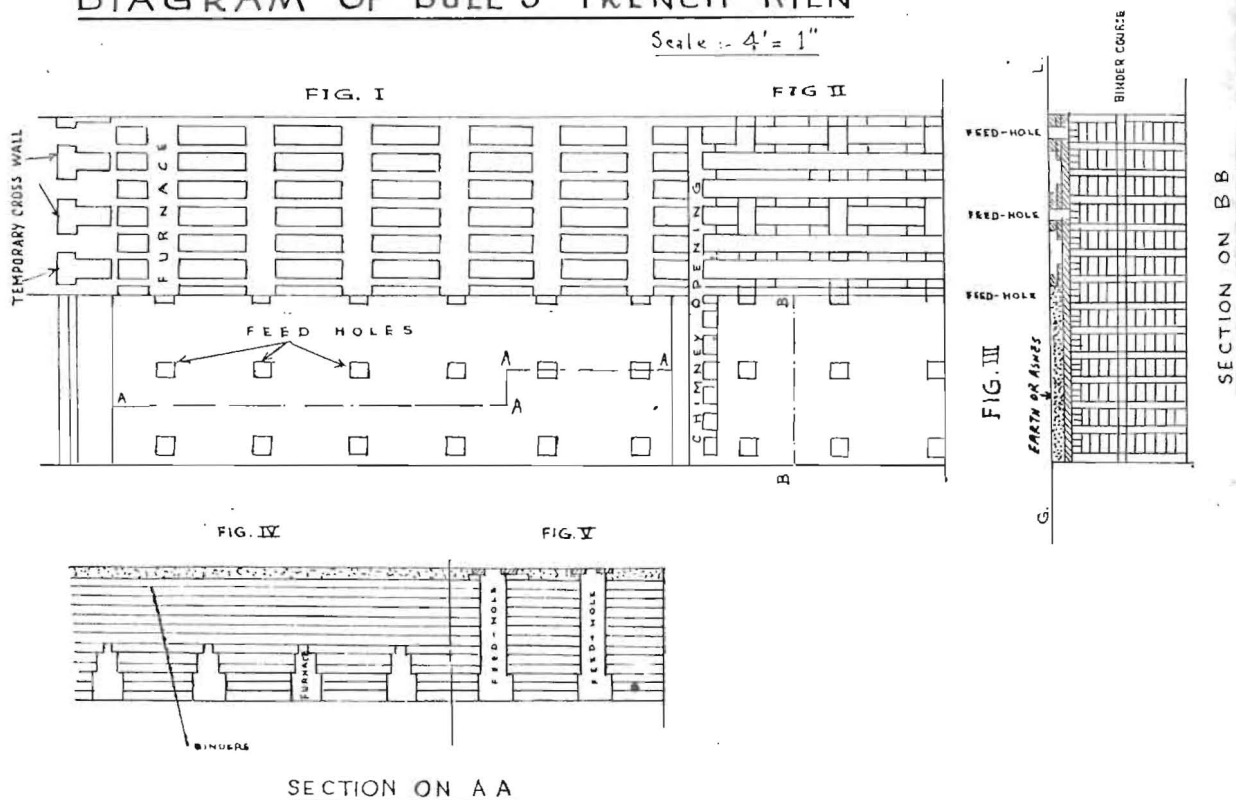
Controlling The Fire

In the above paragraphs the general process of firing a Bull's trench kiln is described. However, to operate the kiln successfully, it is necessary to observe certain precautions at every stage of firing as indicated in the following paragraphs:

Regulating the Feed: Normally in a kiln of average size it is possible to fire upto six rows in 24 hours. How-

DIAGRAM OF BULL'S TRENCH KILN

Scale :- 4' = 1"



ever, the actual schedule of firing (which may vary from kiln to kiln) should be drawn up and carefully adhered to so that the rate of heating is neither too fast nor too slow. Generally when a fresh line is opened, $\frac{3}{4}$ to 1 lb. of coal is charged every 15 minutes and the feed is gradually raised to $1\frac{1}{4}$ to $1\frac{1}{2}$ lbs. when sufficient bottom heat is secured. The common practice of using crude "Water-clocks" for indicating the time of feed is not satisfactory and such devices should be replaced by clocks.

Cleaning the Fire: Before charging fresh fuel, the fireman must make sure that the previous charge has completely burnt off. If the fuel is partially burnt, the interior of the kiln, when viewed through a feed hole, appears smoky and dark lumps of unburnt coal can be easily seen. Only when the chimney is smokeless and the interior is also clear, should a fresh charge be given. There should not be a large collection of coal on the kiln floor. Whenever this happens, it should be ascertained by introducing an iron poker of sufficient length through the feed hole and the fuel bed thoroughly stirred. The amount of coal charged at a time is reduced and normal feeding should be resumed only when the collection of fuel is completely burnt off.

Advancing the Fire: When a fresh line is opened, the one behind should be ready for closing. If, however, it is seen from the settlement that this is not the case, opening of the next line may be delayed a little, but under no circumstances should a fresh line be opened until out of the three lines under fire, the bottom heat in the front line is sufficiently high and the heat in the second line is the highest.

Cooling the Bricks: When about 15 furnaces have been closed, more air is admitted by partly opening the first line of feed holes. The object of this is to prevent smoke from eddying back along the top of the passages in the brick settings. Air entering through these holes gradually cools down the burnt bricks and is sufficiently preheated before reaching the firing zone. When firing has advanced to about the 25th row of feed holes, the second line of feed holes may also be opened to let in more air.

Positioning the Chimneys: The distance maintained between the firing zone and the chimneys is of importance. In the initial stages the distance of 5 or 6 rows of feed holes is maintained. When the kiln is in full working order and a strong draught is established, the chimneys are shifted further and a distance of 15 to 20 rows should be maintained to ensure good draught. If the distance is too short the draught becomes high and the kiln gases tend to travel along the top of the setting, the chimneys become hot and a lot of fuel in the form of smoke escapes without burning. If, on the contrary, too long a distance is maintained, the draught is weak, the rate of heating is slowed down and combustion remains incomplete.

During the period of shifting and re-erection of the chimneys no fuel is charged. Immediately after shifting the chimneys the draught is rather slack and the smoke has a tendency to go back to the feed holes left open to supply air. This must be prevented by firing slowly until the draught is re-established.

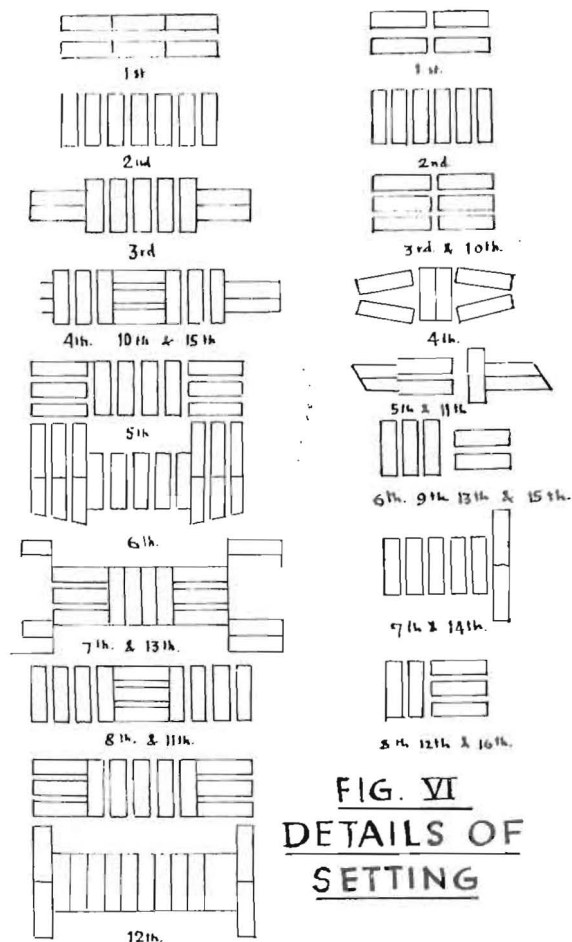


FIG. VI
DETAILS OF
SETTING

Measuring The Settlement

The settlement or sinkage of brick columns during firing should be measured from time to time. A useful method of judging the sinkage is to place three bricks in a row across the kiln between each line of feed holes, say 5 ft. apart, level with a brick on each edge of the kiln. A line stretched across them indicates the sinkage. The settlement varies with the firing shrinkage of clays but is usually 2 to 4 inches for alluvial soils. The fireman must, however, be able to judge the kiln temperature by sighting through the feed holes and give a thorough soaking heat before a line is closed.

Maintenance Of Records

For an efficient working of a kiln, it is essential to maintain a kiln book for recording the number of bricks loaded and the outturn from each chamber. The fuel consumption per chamber and the output of first class bricks from it should be carefully recorded. The date and hour of commencement and completion of each cycle should also be on record. It is also essential to maintain a continuity of operation. Except in cases of emergency firing should not be stopped at any time during the brick-burning season. Continuous operation results in a saving of fuel and operational costs are also lowered.