USE OF BIOMASS IN BRICK KILNS

Bricks have been used as construction material for many millennia and have been found in many historic sites all over the world such as in valleys of Indus and Ganga rivers where ancient civilisations flourished from at least 3300 B.C.

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Bricks have been used as construction material for many millennia. They have been found at the historical sites all over the world, including valleys of the Indus and Ganga rivers where ancient civilizations flourished as early as 3300 B.C. For example at Mohenjodaro there is evidence to show that perfectly formed uniform bricks were fired in brick kilns and used extensively for making buildings. The structures there include houses, the ‘Great Bath’, granary, roads and toilets. The main raw material for making bricks is clay which can vary considerably in physical properties, colour, hardness, and mineralogical content. However, the raw material must essentially have the ability to be crushed and mixed with water to form a plastic material which can be moulded into various shapes required. In addition, upon heating to a high temperature these bricks should become hard, have high compressive strength and be weather resistant.

It is estimated that world-wide there are 300,000 brick kilns with a total production of 1350 billion bricks per year. Brick production is concentrated in four countries which account for about 75 per cent global production—China with 54 per cent; India with 11 per cent; Pakistan with 8 per cent; and Bangladesh with 4 per cent. This article is based on the interaction with various central and state brick manufacturers’ federations or associations. It should be noted that the data available about the brick industry in India is sketchy and not well documented.

AVAILABILITY OF DATA
The apex national federation of Brick and Tile Manufacturers has 9117 life members, even though the total number of bricks kilns in India is estimated to be as high as 100,000. This industry is un-organised and mostly based on small scale sector units. Difficulty in getting data is compounded by the fact that a large part of the production may not be accounted for in the official books of manufacturers. For instance, a field survey of biomass used in Rajasthan, covered biomass consumption based on about 1830 kilns whereas the state association estimates that there are about 3000 brick kilns in the State.

BACKGROUND
The output of the Indian brick industry is the second largest in the world after China. It was estimated that total production of bricks in the country is about 140 billion per year in 2000-01. The growth rate of the industry was estimated to be approximately at 9 per cent per year in 2000-01 while other growth estimates range from 5 to 10 per cent per annum. A study estimated that the building construction sector in India will grow at compound annual growth rate (CAGR) of 6.6 per cent per year in the period 2005-30.

By 2001, using the age-old manual moulding processes, the estimated requirement of top soil for brick manufacturing was about 350 million tonnes per year. Because of accelerating economic growth there has been a growing demand for building materials, particularly bricks in this country. It should be noted that the major concentration of brick kilns is in the rural areas in the proximity of rapidly expanding towns and cities. Urban demand for bricks is growing exponentially because of the requirement for infrastructure, commercial and residential buildings.

RISING DEMAND FOR COAL
In case a growth rate of 6 and 9 per cent per annum is assumed, the total annual production of bricks would be around 266 and 361 billion respectively, for the year 2011-12. Furthermore, assuming a coal consumption of 17.14 tonnes per one lakh bricks, the corresponding consumption of coal would be 46 million tonnes and 61.9 million tonnes, respectively. (Table 1— assumed that there is no increase in efficiency or switching of fuel).

The estimates in Table 1, which shows a demand of 61.9 million tonnes, or even 46 million tonnes of coal for the brick kiln industry in 2012, are significantly high—especially at a time when there is a shortage of coal in India. The good news from major north Indian states is that in the last few years there has been a rapid shift from using coal to using biomass for firing bricks in the brick kiln industry.

COMPARATIVE COST OF COAL AND BIOMASS FIRED KILNS
Based on data received, the consumption of coal in a coal based kiln in a traditional fixed chimney-Bull’s trench kiln (FCBTK) is 136.4 kgs of coal per 1000 bricks. The cost of coal in a coal based brick kiln is estimated to be Rs. 1022

<table>
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<tr>
<th>Year</th>
<th>Estimated Brick Production (Assumed growth rate 9 per cent) (in billion)</th>
<th>Estimated Coal Consumption (MT)</th>
<th>Estimated Brick Production (Assumed growth rate 6 per cent) (in billion)</th>
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per 1000 bricks with the coal rate of Rs. 7500 per tonne at Jaipur. On the other hand biomass based fuel consumption is 254 kg/1000 bricks. The cost of biomass is approximately Rs. 765 per 1000 bricks when the average price of biomass is Rs. 3000 per tonne at Faridabad. Thus fuel cost in the biomass based kiln is about 75 per cent that of coal based with a difference of Rs. 257 per thousand bricks. Therefore with a production of 75 lakh bricks per year a saving of nearly Rs. 19.3 lakhs per annum is possible. However, the coal based brick manufacturers insist that they are able to get better price for their bricks as they are able to produce more grade I bricks than those produced based on biomass kilns. Considering the firing process, the strength of coal fired bricks is relatively higher as compared to biomass fired bricks. However, since the structures of building nowadays is column based, therefore the walls are no longer load bearing but partition walls—as a result biomass based bricks are gaining acceptance from builders.

DIFFERENT TYPES OF KILNS
Major types of technologies used for manufacture of bricks in India include clamp type, FCBTK or moving chimney BTK, natural and fixed draft zig-zag kiln, vertical shaft brick kiln (VSBK), down-draught kiln and others. However, there has been very little impact of more efficient technologies on the brick industry as the industry continues to use traditional FCBTK. It has been estimated that 70 per cent of the brick production in India is from such kilns. The most popular brick kiln technology used in north India is natural draught FCBTK. The traditional straight line firing BTK is reported to be about 10 per cent less energy efficient as compared to zig-zag BTK and has a higher carbon foot-print.

FUEL CONSUMPTION OF VARIOUS BRICK KILNS
First comparison: The energy consumption VSBK, at 0.7 MJ/kg of fired bricks, has been estimated to be half of that of FCBTK, which is 1.4 MJ/kg of fired bricks.
Second comparison: For moving chimney BTK the coal consumption ranges between 20 to 24 tonnes per lakh bricks, whereas for fixed chimney it is around 16 to 20 tonnes per lakh bricks.
Third comparison: Based on data from a well-established coal based kiln in Rajasthan it was found that the coal consumption in this kiln was 13.7 tonnes of coal per one lakh bricks compared to the consumption of fuel in a well-known biomass FCBTK in Haryana where it was found that the biomass consumption was 25.4 tonnes of biomass per one lakh bricks.

NORTH INDIA: REVIEW
It has been estimated that there are about 25,000 brick kilns in Haryana, Punjab, Rajasthan and Uttar Pradesh which produce about 32.5 billion bricks annually. Uttar Pradesh has the largest number of brick kilns accounting for nearly 65 per cent of the kilns while the other three states share an almost equal number of kilns. The percentage of biomass used by the brick kiln industry are:

- Punjab – 5 per cent
- Uttar Pradesh – 30 per cent
- Haryana – 60 per cent
- Rajasthan 98 per cent

BIOMASS USED IN BRICK INDUSTRY OF HARYANA
Total number of brick kilns is reported to be 3000 in the State, with an average production per brick kiln estimated to be 4.5 million bricks per year. It is further reported that 60 per cent of the brick kilns operate on biomass while the balance use coal. Various types of biomass are used in Haryana depending on availability. The most popular biomass used is mustard crop residue; some amount of guar crop residue or stalks; soya crop residue or husk; and even wood are also used as fuel. In the beginning of the season in November biomass from soya residue is used, in December guar based biomass is used while January onwards to February old mustard husk is used. From the middle of February to June fresh mustard husk is used. One of the large biomass based brick kiln uses 50 per cent mustard husk, 35 per cent guar crop residue or stalks, 15
per cent soya crop residue or husks, and a small amount of wood. This kiln consumes about 2130 tonnes of biomass, at full capacity.

**BIOMASS USED IN BRICK INDUSTRY OF PUNJAB**

The total number of brick kilns in Punjab is reported to be around 2600. Average production per kiln in the State is estimated to be 4 to 5 million per year. The percentage of biomass used in brick kilns in Punjab is estimated to be only 5 per cent with wood accounting for 1 to 2 per cent. The region using most quantity of biomass is reported to be the Bhatinda which uses the mustard crop residue.

**BIOMASS USED IN BRICK INDUSTRY OF RAJASTHAN**

The total number of brick kilns in Rajasthan is reported to be 3000. The average production of bricks in a kiln is about 4 million bricks per year. It is reported that 98 per cent of brick kilns operate on biomass with only a few of them operating on coal. Even coal based kilns appear to be contemplating conversion to biomass, as coal prices rise rapidly. Rajasthan is one of the largest producers of mustard seed with an estimated production of 2.7 million tonnes per year (45 per cent of the nation’s production). Therefore, mustard crop residue is abundantly available to be used in the brick kiln industry and biomass power sectors. At different times different types of biomass are available to the brick kiln industry. These include mustard husk, *Juliflora Prosopis*, groundnut shell, cotton stalks and others. Mustard crop residue is the dominant biomass used in the brick kiln industry accounting for an estimated 80 per cent. Interestingly, in this State the use of straw as a biomass for industry is not permitted—as there is an acute shortage of cattle feed. One survey estimates that 1.6 million tonnes of biomass is used in Rajasthan by the brick kiln industry. As for coal use, one coal-based brick kiln surveyed used between 750 tonnes to 1050 tonnes of coal per year depending on the production.

**BIOMASS USED IN BRICK INDUSTRY OF UTTAR PRADESH**

The total number of brick kilns in Uttar Pradesh is reported to be around 16,000. The average production of bricks in a reasonable sized brick kiln is about 3 million bricks per year. About 25 to 30 per cent of the fuel used is biomass. Mustard crop residue is the most popular biomass used in the brick kiln industry. Many kilns are firing wood along with coal. Here wood is reported to be accounting for around 20 to 30 per cent of the fuel mix used.

**BIOMASS CONSUMPTION IN MAJOR STATES OF NORTH INDIA**

The estimated annual consumption of biomass in the brick industry in the four major states of North India given in Fig 1. Based on the above given data it can be seen that Uttar Pradesh and Rajasthan are the largest consumers of biomass with each consuming about 30 lakh tonnes per year while Haryana is a major consumer with a consumption of 20 lakh tonnes per year. The use of biomass in the brick kiln industry is limited to Punjab with a consumption of only 1.5 lakh tonnes per year.

**CONCLUSION**

Solid bricks are most popular in the country and the process of making these is still largely manual and highly labour intensive. With the introduction of the Mahatma Gandhi National Rural Employment Act and the rapid development of the country there is an increasing shortage of labour and the costs are rising steeply making increasing mechanisation inevitable in the coming years and decades. The rapidly rising coal prices will force the industry to either adopt more energy efficient kilns or to switch over to biomass based fuels.

Moreover, with rising cost of inputs including soil and sand, it appears that brick making technology is on the verge of revolution which will make this industry less resource intensive, more energy efficient and result in benefits to the consumer. Hopefully, this will also contribute to the energy security of India and reduce emissions of green house gases. With the landed price of coal mounting there is a definite price advantage of biomass over coal, and the use of biomass is bound to go up. The quality of bricks being made from biomass firing is said to be inferior to bricks made from coal firing—but with the switch over to reinforced concrete construction the relevance of the superior quality of coal fired bricks is declining.

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