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PROSPECT AND ENERGY ANALYSIS OF ZIGZAG BRICKFIELDS IN BANGLADESH

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Abstract- *This study was undertaken at randomly chosen brickfield in Bangladesh. The objective of this research is to investigate the energy analysis of zigzag brick kiln, reduction of energy loss, to reduce environment pollution & lower the cost of operation. In zigzag kiln, flue gas movement is such a way which helps to deposit a significant amount of particulate matter mostly on the green surface and flue gas has much less particulate load. Thus, the zigzag kiln produces white smoke which is more ecofriendly. This paper particularly focuses on the modification of brick shape by making it hollow inside, managing coal, best practices in coal feeding, installation of induced draft fan. The annual energy saving using hollow and perforated bricks is 583.650 Terajoules and efficiency increased by 8.4%,,by coal management energy savings in a combustion chamber per day is 6.11×10^5KJ and increase in efficiency is 1.4%,by best practices in coal feeding energy savings is 275.612 Terajoules, and by annual energy savings by installed induced draft fan is 243.187 Terajoules. On an average in comparison to conventional FCBTK, zigzag kilns require 20% less energy*
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Keywords: Zigzag Brick kiln, Particulate matter, white smoke, Draft fan.

1. INTRODUCTION

Brick is one of the major building materials which is used to make walls, bridges, roads and many other constructions. There are about 6000 brick fields in Bangladesh [1]. Bricks are produced in the brickfield by using several technologies. The zigzag brick kiln is one of them which is more energy efficient and ecofriendly. The zigzag kiln is an improved version of FCBTK It is rectangular in shape with measurement 250ft×80ft.The fixed chimney is 55ft high, located at the Centre or on any side of the kiln [2]. The blower located at the bottom of the chimney draws the flue gas from the kiln and discharges it into the atmosphere. The kiln is divided into 44 to 55 chambers which are separated from each other in such a way that the hot gases move in a zigzag path through the kiln. Since the flue gas moves in zigzag path, most of the coarse particles are retained in the kiln and prevented from being discharged into the atmosphere [3]. Bangladesh uses mainly four types of kiln technologies as presented in the table below:

Table 1: Different Types Brick kilns in Bangladesh [4]

kiln type	Number	Percent of total kiln %	Brick production	Percent of total production
FCK	4500	92	15.8	91.4
Zigzag	150	3	0.6	0.0
Hoffman	20	0.4	0.2	3.5
HHK	10	0.2	0.2	1.4
Others	200	4.0	0.5	0.9
Total	4800	100	17.2	100

The number of zigzag brick kiln in Bangladesh is comparatively low. Though this kiln is expensive to construct, energy efficiency can be increased about 20-25%[5]. Hence, improving the kiln by managing coal, hollow bricks, induced draft fan and coal feeding energy savings can be increased.

Our prime objective is to study the energy loss in the zigzag brick kiln and the conversation of black smoke into ecofriendly white smoke. Further our project aim is to minimize the cost of production of brick and to maximize the rate of brick of brick production.

2. METHODOLOGY

For increasing energy efficiency, the following methods can be used.

2.1 By Coal Management

At the time of feeding coal to combustion chamber small amount of coal fall down on the ground near every stove. By reuse this fallen down, the amount of coal needed for one day will be reduced. Thus, efficiency will be increased. Funnel can be used at the time of feeding.

Fig.1: Funnel [6]

2.2 Using Hollow Brick

Brick which has hollow shape in its body is called hollow brick. Hollow brick needs less area to make from clay than other brick. They have good durability, fire resistant and cost effective.

Fig.2: Hollow brick [7]

2.3 Coal Feeding

Adoption of the best practices in coal feeding would result in better combustion of fuel in the combustion zone. This led to reduction in coal consumption. Following methodology for coal feeding should be adopted.

I. Increasing the number of fuel feeding lines.

II. Continuous feeding of coal, instead of feeding intermittently.

III. Monitoring rate of fire travel and temperature profit within the combustion zone.

2.4 Induced Draft Fan

In zigzag kiln the gas of combustion chamber has to go under a path overwater. Gas flow to this path due to a high draft. If fan can be added to create high draught, it will increase the efficiency of the brick field.

Fig.3: Draft Fan [8]

3. Data Collection and Analysis

3.1 Analysis for Coal management

Table 2: Energy saving by coal management

Stove sl no	Coal fall down near stove(kg)	Total coal fallen in a chamber (kg)	Coal needed for a chamber (kg)	Total stove in a chamber	Amount of coal/stove(kg)
1	0.85				
2	0.895				
3	0.97				
4	1.2				
5	1.13				
6	.985				
7	.93				
8	1.17				
9	0.89	18.645	1330	18	73.89
10	0.98				
11	1.05				
12	1.12				
13	1.105				
14	1.23				
15	1.15				
16	1.09				
17	0.88				
18	1.02				

From the table 2, it can be shown that there are total there are total 18 stoves in a combustion chamber and 14 no. stove has the more coal that has fallen around it during coal feeding. Total coal has fallen down in a chamber is 18.645 kg

In the above graph coal fallen around the stove is plotted against each stove in a chamber.

Coal fallen varies from stove to stove and it's range is 0.8 kg to 1.3 kg.

Total coal needed for a combustion chamber per day m1 = 1.33 tons

= (1.33 × 1000) Kg [since 1 ton = 1000 Kg]

= 1330 Kg

= 1330000 gm [since 1 kg = 1000 Kg]

Atomic mass of coal (carbon) M= 12

Coal fall down near all stoves in a combustion chamber m2= 18.645 Kg

= 18645 gm

Molecule of coal fall down $n_1=m_2/M$

= 18645 / 12 mole

= 1553.75 mole

We know that, Combustion enthalpy of carbon (coal) $Q_{H.V}$ = 393.5 KJ / mole

So, total energy can be saved in a combustion chamber,

$E = n_1 \times Q_{H.V}$

$= (1553.75 \times 393.5)$ KJ

$= 6.11 \times 10^5$ KJ

By managing coal efficiency can be increased chamber by = 18645 / 1330000

= 0.0140

= 1.4%

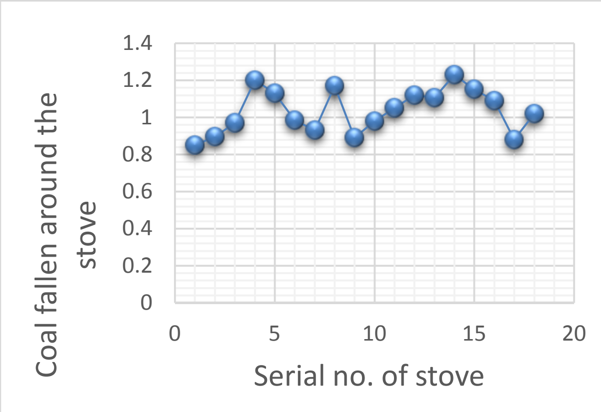

Fig.4: Graphical representation of coal fallen down vs. stove in a chamber.

3.2 Analysis for Hollow and Perforated Bricks

Hollow bricks have an important role in the modern building industry. They are cost effective and better alternative to burnt clay bricks because of their good durability and fire resistance. Table 3 and Table 4 show the energy saving calculation for hollow and perforated bricks and cost benefit analysis for them.

Table 3: Energy Saving by Hollow &perforated bricks

Description	Value	Units
Average annual brick production	31.3	Lac Bricks
Average coal consumption per lac bricks	18	Tonnes
Coal consumption per lac bricks using Hoffman Kiln	14.4	Tonnes
Kiln Average Annual Coal Consumption	563.40	Tonnes
Kiln Annual Coal Consumption after adoption of best practices	450.72	Tonnes
Kiln Annual Coal Savings	112.68	Tonnes
Annual energy saving	583.650	Terajoules

Table 4: Hollow Bricks Cost Benefit Analysis

Sl No	Description	Cost(tk)
1.	Extruction machine including Civil Works	29,50,000
2.	Preliminary &pre-operative Studies	4,50,000
3.	Others including Running cost	7,00,000
	Total Cost	41,00,000

3.3 Analysis for Best Practices in Coal Feeding

Increasing the number of fuel feeding lines is cost effective and continuous feeding of coal, instead of feeding intermittently is also good for kiln. Table 5 and Table 6 show the energy savings by using best practices in coal feeding and comparative cost for maintaining these types of coal feeding.

Table 5: Coal Feeding Energy Savings Calculations

Description	Value	Units
Average annual brick production	31.3	Lac bricks
Cluster Average coal consumption per lack brick	18	Tonnes
Coal consumption per lac bricks after adoption of coal feeding	16.3	Tonnes
Kiln Annual coal consumption	563.4	Tonnes
Kiln Annual Coal Consumption after adoption of coal feeding	510.19	Tonnes
Kiln Annual Coal Savings	53.21	Tonnes
Cluster Annual Coal Savings	12025.46	Tonnes
Cluster Annual Energy Savings	275.6128	Terajoules

Table 6: Coal feeding Cost Benefit Analysis

Description	Value	Unit
Cluster Annual Total Cost Savings	12025.46	Tonnes
Average per tonne Cost of Coal	5000	TK.
Annual Cluster Total Cost Savings	60127300	TK.
Cost of Implementations per unit	100000	TK.
Recurring Costs	5000	TK.

Cost of Implementation(cluster)	23730000	TK.
Simple Payback Period	0.39	TK.

3.4 Analysis for Induced Draft Fans

Brick making process needs industrial fans and blowers for the exhaust gas treatment plants. The furnace fumes are necessary to be cleaned before it is emitted to the atmosphere by using a draft fan. Table 7 and Table 8 show the energy saving calculations and cost benefit analysis using induced draft fan.

Table 7: Induced Draft Energy Calculations

Description	Value	Units
Average annual brick production	31.3	Tonnes
Average coal consumption per lack brick	18	Lacks bricks
Coal consumption per lac bricks after installation of induced Draft	16.5	Tonnes
Kiln Annual coal consumption	563.4	Tonnes
Kiln Annual Coal Consumption after Installation of ID Fan	516.45	Tonnes
Kiln Annual Coal Savings	46.95	Terajoules

Table 7: Induced Draft Cost Benefit Analysis

Description	Value	Unit
Average per tonne Cost of Coal	5000	TK.
Annual Total Cost Savings	53053500	TK.
Cost of Implementations per unit	170000	TK.
Recurring Costs	142200	TK.
Annual Net Savings	20916300	TK.
Cost of Implementation	38420000	TK.
Simple Payback Period	1836844949	Years
Typical Lifecycle	<10	Years

4. RESULT AND DISSCUSION

4.1 Results Found from Management Coal

It has been found that, Coal has fallen down near the all stoves in a combustion chamber = 18. 645Kg.Total energy that can be saved in a combustion chamber / day is 6.11×10^5 kJ. Efficiency can be increased by 1.4 %. And about 800-900 TK can be saved coal management.

4.2 Results Found by Using Hollow Bricks Brick

It has been found that, Hollow brick requires less volume than of automate brick. Normally in brick field daily 25000-30000 brick produced per day. Since single hollow bricks saves a mass of 0.25 kg. By producing hollow brick in replace of automated type, mud can be saved by total amount of 6250 kg – 7500 kg in a day. Efficiency can be increased by 8.47%.

4.3 Results Found from Coal Feeding

It has been found that, by continuous feeding of coal annual coal saving is 12025.46 tonnes and energy saving is 275.6128 terajoules.

4.4 Results Found by Using Induced Draft Fan

It is found that, annual coal consumption after installation of draft fan is 516.45 tonnes and energy saving is 46.95 terajoules

5. CONCLUSION

In this research paper, Author has studied a lot about brick field. Author has prepared his work on the basis of brick kiln which include different method of energy saving. Brick kilns. But these methods can be used in other brick kilns. In our country the level of awareness on energy efficiency and environment safety is very low during the production of brick. Brick kiln owners have a short term of operations. These is also a lack of technical support and knowledge. This paper will much more useful for kiln owners and workers. This paper may help the brick owners to reduce cost, to understand the conversation process of black smoke into ecofriendly white smoke and to reduce the emission of CO_2. It will be very helpful for our environment. The project activities were limited only in the brick plant sites and can be considered as environment friendly. Projects in comparison to the existing technologies. It will also reduce health impacts from pollution and of other economic incentives Carbon emission was reduced by cleaner technologies. Among of all the technologies improved zigzag kiln is suitable for our country

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