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Technology Development in Brick Kilns in India – Future Prospects

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Abstract

Brick is single of the important resources for production which is used by human beings from the original time in the culture of men for construction. The overcooked bricks were used in the partition of Babylon city during 15th century BC. In India, a long and rich history of mud fired bricks manufacture exist since Indus valley civilization (2500-1500 BC). The Indian brick business is one of the industries where no transformation has taken up, the majority of the industries still following the long-established techniques of brick making. Furnace is one of the most important part of brick process. It is the position where bricks are burnt with a very little modify in the figure and size the green bricks are overcooked to make solid. Green bricks surrounded by Kiln heated form 600° to 1100° to attain the finished product. Brick industry is single of the major sources of discharge of green house gas CO_2 which is for the most part being responsible for worldwide warming. The brick industry at the moment need environmentally responsive technology for firing bricks which is energy proficient and diminish green house gases discharge. The first emanation standard for brick Kiln set up in 1996. The revising progression was initiated in 2009 but these principles yet to be revised. The practice of revising standards seems to be tremendously slow. National Capital Region (NCR) since 2015 initiates proceeding to trim down air pollution which includes substitution of the technology.

Keywords: Brick Kiln, FCBTK, MCBTK, VSBK, Bio-Gas, Unfired Brick, Papercrete, Solar Furnace.

Introduction

Brick is one of the important materials for construction which is used by human beings from the earliest time in the civilization of men. The world famous archaeological excavation reveals information about the use of brick in different parts of the world. In past years brick were made at warm places and use sunlight for drying and hardening. During Neolithic time brick use were first found in southern Turkey. The Sumeria palace in Kish, in Mesopotamia was another biggest example of the brick use in ancient time. The burnt bricks were used in the wall of Babylon city during 15th century BC. In the world famous historical monuments of ancient Egyptians sun dried clay bricks were used during Roman Empire period the use of bricks spreads throughout the whole Europe and in Italy and thereafter Byzantine. In construction work the use of bricks spreads to Trance during 11th century[1].

In 12th century bricks were introduced from Italy to Germany. This introduction of bricks develops the brick Gothic period however which reduced the style of Gothic architecture which was very commonly prevalent in most of the areas of northern Europe. Most of this time buildings were build mainly of fired red coloured clay bricks. The Gothic style buildings were found mainly in "Finland, Estonia, Sweden, Lithuania, Germany, Latvia, Russia Poland and Denmark". The art of making brick was very advanced in England during the time of Henry –VIII (1491-1547)[2]. London city was rebuilt after the great fire of 1666 with mainly by brick structures. The sun dried brick used in Central America particular in Mexico from centuries. In Virginia (America) brick i.e. English Brick[3] were used since from 1611 in Baroque and renaissance period the exposed brick walls become unpopular because brickwork was covered generally by plaster. However during 18th half the visible brick wall again regains its popularity[4].

In India, a long and rich history of clay fired bricks production exist since Indus valley civilization (2500-1500 BC). Qutab Minar (12th – 13th century AD), Sarnath (3rd century BC -11th century AD) Nalanda (4th -12th

century AD are some of prominent illustrations which reveals the use of fired clay bricks. In Mughal period the brick making was much influenced by the arrival of Europeans, during 18th century German missionaries introduced clay roofing tile art manufacturing at Malabar cost. The beautiful examples of bricks however been found in 20th century in India until about 1885 brick production continues by hands. In 19th century brick manufacturers begin to develop through mechanical process. This is mechanized clay preparation and machinery extrusion for shaping. In such the Hoffmann Kiln use for firing the tiles and bricks[5].

The brick size during British was large (10 inches x 5 inches x 3 inches). They introduced large clay brick production which was established near big cities, one of the largest unit was set up in 1881 at Kolkata near Akra which produce 20-30 million of brick every year. The continuous brick firing technology introduced by Britishers in 1873 called as Bull's trench Kiln which is of oval shaped Hoffmann Kiln[6]. The production of bricks during 19th and 20th century is of stagnation regards to technology and of enterprise management. The present condition of Indian brick industry likened to that exist in England and Europe during 1850 to 1900 certain improved technology have been attempted to use after independence however the role of change has been slow.

Objective of the Study

The aim of article is to find out the different types of technology prevalent in brick Kiln industry and enforceability of the use of best for future, which control environment pollution and protect rich natural resources.

Review of Literature

Zigzag Kiln Performance Assessment – 2012 & 2013, A Report prepared by Greentech Knowledge Solutions, New Delhi (India), September 2013, pp 47.

The report analyses and concluded that the performance of the zigzag firing technology is superior to the current baseline technology, the fixed chimney bulls trench Kiln (FCBTK) on all important technical and financial parameters. The study suggested that the large-scale promotion of zigzag firing and the replacement of all FCBTKs with zigzag fired Kilns will be an important step in the transition towards cleaner brick production.

Pallab Kanti Ghoshal, Prospects and Problems of Brick Industry, Delhi: Mittal Publications, 2008, pp 167.

This book is the outcome of an in-depth study of the organizational and administrative setup, capital involved, marketing and manufacturing techniques followed in the industry. This book provides a detailed financial analysis including ratio analysis, break even analysis production trend and cost analysis, observable fact on demand and supply, etc. A detailed study on the work force engaged in the industry is also incorporated in the book. This book focuses on the fact that the brick is one of the most important building materials and continues to be the mainstay of construction activities. No alternatives of brick have, in fact, yet been able to threaten the existence of burnt clay bricks seriously on technical as well as commercial ground. Book focuses on the necessity of technology advancement in the brick Kiln so they can produce minimum pollution and develop green brick industry.

The Complete Technology Book on Bricks, Cement and Asbestos, NPCS Board of Consultants & Engineers, New Delhi: Niir Project Consultancy Services, 2007, pp 720.

Construction industry is the largest consumer of material resources. The book describes that technology advancement can transform the brick industry. Bricks are easily moulded from plastic clays, also known as brick clays or brick earth. Bricks can be moulded by any of the three methods; soft mud process, stiff mud process and semi dry process. There are various kinds of bricks; silica bricks, carbon bricks, magnesite bricks, dolomite bricks, alumino silicate bricks, refractory bricks, etc. Some of the major contents of the book are moulded and ornamental bricks and blocks, including copings and lintels, cutters and rubbers, fireplace bricks, fire bricks and other refractory bricks mixing, bricks made of calcined clay or grog, silica bricks, transition temperatures of silica on cooling, magnesium silicate bricks, high alumina bricks, spinel bricks, developments in refractory brick etc.

Dinesh Chahal vs. Union of India Original Application No. 1088/2018 (National Green Tribunal, Principal Bench)

The Central Pollution Control Board (CPCB) directed the NCR State Governments for adoption of Zig Zag Technology on 30.12.2015 for NCR as the cases of air pollution is causing deaths and diseases and to adoption of latest technology is remedy to the situation. Reference was made to the Judgements of the Hon'ble Supreme Court in M.C. Mehta v. Union of India, (1998) 9 SCC 149, M.C. Mehta v. Union of India (2000) 7 SCC 422, M.C. Mehta v. Union of India, (2002) 4 SCC 378, K. Guruprasad Rao v. State of Karnataka, (2012) 12 SCC 736 wherein the Hon'ble Supreme Court directed closure or shifting of brick Kiln industries and M.C. Mehta v. Union of India, (2001) 9 SCC 235 laying down that brick Kilns may be allowed to operate after studying the impact on human population and vegetation.

Dheeraj Lalchandani and Sameer Maithel, Towards Cleaner Brick Kilns in India: A Win–Win Approach Based on Zigzag Firing Technology, New Delhi: Greentech Knowledge Solutions Pvt. Ltd, March 2013, pp 22.

Brick Kilns consume a large amount of coal and are an important source of air pollution in the country. Intermittent Kilns such as clamp Kilns, which produce bricks in batches in small quantities, are widely used in the peninsular region, contributing to about 25% of the total brick production. The book specifies that other firing technologies, such as Vertical Shaft Brick Kiln (VSBK), Hoff mann Kiln, and Zigzag Kiln, account for less than five per cent of the total brick production. Retrofitting of the FCBTKs into Zigzag- firing technology offers a win–win opportunity

not only for brick-makers (by doubling their profits) but also for the nation leading to annual savings.

M.Manoj Kumar and G.Uma Maheshwari, Papercrete, International Journal of Science, Engineering and Technology Research, Volume 6, Issue 8, August 2017, pp 1289 – 1297.

This article focuses on utilizing the waste materials like waste paper and fly ash into cost effective building bricks and recycle the wastepaper without any environmental problem to the surrounding environment and the society. The paper concluded that the Paper Crete bricks are relatively low cost, light weight and more flexible and they are most suitable for earthquakeprone areas.

Nivit Kumar Yadav and Rahul Kumar, *Zigzag Kilns: A Design Manual*, Centre for Science and Environment, New Delhi: Centre for Science and Environment, 2017, pp 31.

In South Asia, the most widely used technology for firing bricks is the Fixed Chimney Bull's Trench Kiln (FCBTK). Improper distribution of heat in different parts of the combustion zone is another major downside of an FCBTK. On the other side zigzag Kilns, green bricks are arranged in a way that forces hot air to travel in a zigzag path. In natural draft Kilns, depending upon the width of the trench, bricks can be stacked to achieve single, double or triple zigzag patterns. Thus study focuses on operational aspects of the brick Kilns.

Brick Industry in India: Brick Kiln industry is one of the demand based industry. Brick industry fulfills growing demands for rural urban expansion and of economic development. Brick Kiln industry situated in peri-urban and in rural areas to fulfill requirement of construction work, such industries categorized as small scale industries. Brick Kiln industry provides employment both for men and women during off agricultural season; it is based upon local resources therefore it forms an important part of rural and urban economy. Brick is the backbone of the construction, after China, Indian brick industry rank second among brick production in the world and solely contributes 60.45% of share in net domestic product of India. The industry annual consumption around 25 million tons coal every year[7] and industry having an annual turnover of more than 140 million. Brick Kiln the third largest coal consumer after steel and thermal power plant. Brick making is low technology based industry during season the men women and children employed in skilled and semi skilled work, these workers are mainly seasonal migrants which belongs to poor and weaker section of the society[8].

The Indian brick industry is one of the industries where no modernization has taken up, most of the industries still following the traditional techniques of brick making. The intermediate technology is commonly be used between simple and advance method of brick making. Industry use top soil which is highly fertile and rejuvenation of which takes place after very long time. The green bricks baked by coal, fire wood, agricultural waste the traditional method of hand molding and sun drying force the industry to operate only for six to eight months a year, however it depends upon the climatic conditions of the region which made it a seasonal occupation. The brick hand molding or through mechanical takes place as per recommendation prescribed by Bureau of Indian Standard (BIS) (7.5″ x 3.5″ x 1.5″) and (7.5″ x 3.5″ x 3.5″) as size recommended for modular bricks and (9″ x 4.25″ x 2.75″) for non modular bricks. The most acceptable size for western part of India is 9″ x 6″ x 4″) which is called double size bricks and in rest parts of India usually produces (10" x 5" x 3") however the first class, second class, and third class grade bricks are commonly be used in brick production in whole of India[9].

Prevalent Technology: Kiln is one of the most important part of brick manufacturing process it is the place where bricks are burnt with a very little change in the shape and size the green bricks are burnt to make solid. Green bricks inside Kiln heated form 600° to 1100° to obtain the finished product. Brick industry is one of the largest sources of emission of green house gas CO_2 which is largely being responsible for global warming. Brick Kiln have a production capacity between 50000 to 500000 bricks per rotation, approximate 66-84 million ton of CO_2 emitted by brick Kiln annually and approximate 100000 tons of black carbon emitted yearly from brick Kilns which gives warming influence on climate. Particulate matter and sulphur dioxide are the main air pollutants from brick Kiln, these pollutants have adverse impact upon vegetation and human health due to burning of fuel in brick Kiln cluster, the emission are significant source of $PM_{2.5}$ among several Indian cities due to combustion of high sulphur containing coal, sulphur dioxide is generated which adversely affect crops and vegetation, due to burning of fuel a significant amount of fugitive emission takes place during manufacturing of brunt clay which adversely affect the health of the workers.

The brick industry now need environmentally friendly technology for firing bricks which is energy efficient and reduce green house gases emission. The first emission standard for brick Kiln set up in 1996 with a maximum permissible limit for emission of suspended particulate matter (SPM), these standard are applicable upon the moving chimney bull's trench Kiln (MCBTK) which contribute around 70% of total brick production in the country, however these emission standard change over from MCBTK to fixed chimney bulls trench Kiln (FCBTK) technology. These emission standards did not cover clamp which individually contribute 25% of total brick production[10]. The Central Pollution Control Board (CPCB) and Ministry of Environment, forest and Climate Change (MoEFCC) both under process of revising the emission standard for brick industry but the process of revising standards seems to be extremely slow. The revising process was initiated in 2009 but these standards yet to be revised. The field study shows that the energy and environment performance shift from MCBTK to FCBTK[11] which result in controlled energy consumption, suspended particulate matter (SPM) and increase brick production. National Capital Region (NCR) since 2015 initiate proceeding to reduce air pollution which includes replacement of the

technology from FCBTKs with less polluting zigzag Kiln technology, this shifting of technology from FCBTKs to Zigzag Kilns which have the possibility of fuel reduction about 20% and Suspended Particulate Matter (SPM) emission from gases up to 75% after shifting from FCBTKs to Zigzag Kiln technology[12].

Adopted Prevalent Technology in Brick Kiln: Downdraught, Clamp, FCBTK, Natural Draught Zigzag, High Draught, BSBK are some of the examples of the prevalent technologies of brick making, in terms of specific energy consumption VSBK is the most efficient technology among above followed by High Draught and Natural Draught Zigzag Kiln technology. The adoption of VSBK, High Draught or Natural Draught Zigzag result in 20-60% energy saving technologies in comparison of tradition FCBTKs and Clamps.

Specific Energy Consumption (SEC) MJ / Kg of fined bricks:

Technology	(SEC) MJ / Kg
VSBK	0.75-1.0
High Draught	0.95-1.1
Natural Draught Zigzag	1.0-1.2
FCBTK	1.0-1.4
Clamp	1.5-2.0
Down Draught	2.5-3.0

Fix Chimney Bull's Trench Kiln (FCBTK): It is cross-draught, annular, continuous moving fire Kiln which is operated under natural draught and provided by a chimney. In FCBTK fire moves throughout the brick therefore it is moving fire brick Kiln and staked in the annular space which formed between the outer and inner wall of Kiln. Green bricks loaded in front of firing and cooled bricks removed from behind. This Kiln is of oval or circular shape. This type of Kiln builds over the ground and side walls erected with permanent construction unlike original of Bull's Trench Kiln (BTK) employed a moving chimney which is of metallic. However FCBTK having fix chimney which is exist at the centre of the Kiln. In the annular space green bricks are placed which is covered with temporary roof covered by partially fired or by green bricks. A layer of brick dust and ash spread over the top to seal which helps in thermal insulation. For the entry of air its unloading end kept open for air entry however the end area sealed with metal, plastic damper, paper, and cloth. Fuel feeding in FCBTK done with intervals between two successive operations ranging from 20 to 50 minutes which generally fed to two to three rows, after which a black smoke can be seen our just after fuel feeding. Sometimes High coal feeding creates temporary deficiency of oxygen which results in incomplete combustion. During fuel feeding different kinds of fuel is used some of which is authorized and some unauthorized. In authorized fuel coal, fire wood is used at a large level however in unauthorized rubber, plastic, industrial waste is used. FCBTK is the main technology used for brick production in India[13].

High Draught Kiln: High draught Kiln is a zigzag Kiln; the word zigzag is used because fire follows in zigzag path inside Kiln instead of straight as in the FCBTKs however this zigzag Kiln considered improved technology over FCBTKs. This zigzag technology was first used in Burher Kiln which was patented in 1868 however the Burher Kiln was almost similar to Hoffmann Kiln with regards to construction. In this Kiln the main innovation was the zigzag path which increases the firing length with accelerating firing by flue gas fan. These zigzag was widely be used in Germany between first and second world war. The zigzag Kiln introduced in India by Central Building Research Institute (CBRI) during 1970's with the name as High Draught Kiln (HDK). More than forty years since its introduction many modifications have been take place. In this draught was created by induced draught fan having a 15 horse power motor.

Zigzag Kiln having supremacy over FCBT Kiln technology[14].

1. The turbulence which was created by zigzag air movement result in much better mixing of fuel and air which result into complete combustion of fuel.
2. Second is the longest combustion area which increases the six fold reaction time in combustion zone which provides sufficient time to combustion.
3. Zigzag movement results in larger area cover to heat transfer.

Natural Draught Zigzag Kiln: No fan is used in natural draught zigzag Kiln and based upon the natural air transfer in Kiln however the path follows is zigzag therefore brick setting for baking is different as compared to High draught Kiln. The Natural Draught Zigzag Kiln used in 1997 by an Indian brick maker Mr. Rajendra singh who modifies his FCBTK to Zigzag which is operated by natural draught. The feeding zone in Zigzag Kiln is six times longer than FCBTK.

Comparison: FCBTK with Zigzag Kiln technology.

1. Zigzag technology is energy efficient and saves 20% fuel and controlled over CO_2 emission
2. Profit of producers almost double due to fuel saving and improvement in quality of production.
3. Zigzag technology reduces 75% Suspended Particulate Matter (SPM).

The FCBTK can be retrofitted into natural or high draught zigzag Kiln but its costs increase between 10 to 25 lack rupees which almost depends upon the condition of existing Kiln because retrofitting involves partial reconstruction of chimney and reconstruction of flue ducts and outer wall of Kiln. Shifting from FCBTK to zigzag technology is an attractive option in terms of energy consumed and emissions reduced[15].

Vertical Shaft Brick Kiln (VSBK): The development of this technology took place in rural china in 1996 since then this technology transfers to several countries including Afghanistan, Pakistan, Sudan, Vietnam, South Africa, Nepal and India. Among all these above countries this technology gain popularity only in Vietnam. This VSBK technology transferred to India by Swiss agency for development and

cooperation under a project in 1996[16]. VSBK technology have vertical shaft of square or rectangular cross section. The shaft in VSBK is located inside rectangular brick structure. The gap between outer Kiln wall and shaft wall is filled with insulating material. This kind of Kiln works as counter current heat exchanger where air continues flow and moving upwards and brick moving down "intermitted movement". In VSBK green bricks loaded from top in batches and brick moves down through preheating firing and cooling zones. The unloading of the finished goods takes place at the bottom[17]. The combustion of fuel which put along with the green bricks at the top takes place in middle section of shaft. In this technology air required for combustion enters the shaft at bottom; the green bricks get preheated by hot fired bricks in lower section of shaft before arriving in combustion area. The unloading of finished brick carried out from bottom by using trolley. The two chimneys located diagonally opposite to each other which are provided for the removal of flue gases. The VSBK technology first introduced in 1996 however after passing of so many years the rule of dissemination still remains low because the quality of fired bricks in VSBK found to be better when performed mechanically and thickness between 50 – 70 mm.

Because of availability of low fund and least development of technology there is dependency upon existing technology however a variety of options exist for conservation among fired clay brick making.

1. Adoption of reformed technology to develops efficient Kiln
2. Promote internal fuel while brick baking
3. Promote burner system and mechanized coal stoking
4. Promote hollow and perforated bricks

There exists energy saving potential between 20 to 60% by replacing inefficient technology as Clamp, Down Draught, and FCBTK with reformed efficient technology as VSBK, High Draught, and Natural Draught Zigzag Kiln technology. The internal fuel addition reduces fuel consumption and SPM emission. Cheaper fuel as coal dust, charcoal dust, coal slurry can only be used as internal fuel. The mechanized coal stoking system or solid fuel burners reduce coal consumption, the solid fuel burners includes fuel crushing and mixing and moving distribution units. Apart from this hollow and perforated bricks required less clay which leads to reduction in fuel consumption[18].

Tunnel Kiln based upon biogas or LPG as fuel: - Biogas can be the biggest alternate fuel for firing green bricks. Most of Kilns are established near villages or cities near the villages therefore it is easier to arrange cow dung cake. Running of Kiln upon biogas gives two great advantages

1. That it is environment friendly.
2. It helps in the protection of natural fuel available like coal and fire wood.

First biogas based brick Kiln in India situate in Haryana, Bhivani Tehsil, Shivani Mandi, Village Ikral. There is requirement of 2000 cubic capacity biogas plant for continuous firing and for production of biogas this plant requires about 40 tons of cow dung cake as raw material. This plant produces 2000 cubic bio gas. Biogas from this plant used in Kiln thermal plant which requires big burners through which biogas mix with oxygen and delivered towards the brick furnance. The structure and technology used in this plant is much more different from the other Kilns. This is tunnel shape Kiln which baked green bricks. The produced biogas can only be used after removing / separating Hydrogen Sulhur. In this brick Kiln both hollow and handmade bricks can be prepared, however in hollow bricks more than 20 types of bricks can be prepared. An automatic machine can be used to make green bricks from which 8000 to 35000 green bricks can be made in 8 hour's. Sun drying for 1 day required before baking these green bricks because this Kiln have a drier of which the approximate temperate is 200^0 C and in one time 4000 bricks can be loaded in the drier chamber for 1 to 2 hours and immediately transferred to the main firing zone where it takes 24 hours to bake in other kind of Kiln there is requirement of 7 to 15 days of sun dry it mainly depends upon the weather conditions of the situated Kiln. Because of use of sensors a uniform temperature can be maintained inside the Kiln which is approximate to 1000^0 C. and this temperature stability guarantees the quality and uniformity of bricks output. Therefore it can be said that only first quality of brick can be produced with this Kiln. A total of 30000 finished bricks can be prepared with this plant within 24 hours. For cooling the hot bricks blower is used at natural temperature.

One of the largest brick manufacturing companies of world enters in Indian market which set a production facility near Bangalore. Among all the plant of the company this is the most advanced plant in the world which have dryer chamber and tunnel based Kiln technology. As far as fuel is concerned plant based upon pet coke and LPG and having a production capacity of 6600 tons biogas every day[19].

Unfired Building Products new Technology: Today there is limited application about variety of bricks that is only of clay. These building material having low strength and low durability in humid climate and therefore these are better for the non structural walls. But now pressed clay blocks having unique features and enhanced durability with improved design have been produced named Interlocking Compressed Soil Blocks (ICSB). In ICSB for increasing moisture resistance and strength ground granulated blast furnance slag (GGBS) or fly ash from thermal power plant (FA from TPP) added to the clay. However these types of bricks and blocks are stabilized only after addition of 5 to 15% of cement. This product having highly improved strength characteristics and moisture resistance which is within interest of housing construction in many countries such as India, China, North Africa, Middle East and others.

Technically advanced countries developed scientific technique by adding lime and Fly Ash (FA) or GGBS to the clay in which binding phase generated by chemical reaction clay with additives and water. This process takes place at a temperature of 20^0 to 30^0 C. such production technology is simple which comprises the steps of mixing, moistening, moulding, mellowing

and curing in humid atmosphere by air drying at room temperature. Some of these methods and technology already implemented as industrial production and some others are being tested.
This production intends to develop new methods to obtain product having high performance compared to fired clay bricks, which although lowers the expenses and also save energy these product minimize the emission of harmful gases in the atmosphere and lastly to utilize the fly ash and GGBS.

Articles	Fired Bricks	Unfired Bricks
Composition	Clay / Soil	Cement, Slag, Fly Ash, Lime, Gypsum, etc.
Shape / size	Different shape and size	Uniform shape and size
Colour	Red/ brown	Cement Colour
Compressive strength	35 Kg / Cm^2	75 Kg / Cm^2
Water absorption	20 to 25%	6 to 12%
Cost / per piece	5 to 10 Rs.	4 to 6 Rs.
Waste in transit	10%	2%

In a patent granted in 2007/0000412 A1 a highly improved technology developed for production of unfired bricks and other construction material such is possible by using class C fly ash with introduction of air- entrainment agent having compaction on room temperature with 7 to 28 MPa pressure and by curing humid climate. In this process chemical activation of fly ash with lime not applied because of their own binding properties. This newly developed last for 50 cycles of throwing / freezing which even satisfy the requirement of frost-resistance which established with ASTM C 62 for bricks firing. This technology used for mass production in US.
The technology for production of unfired bricks which is obtained from fly ash (class F) gypsum, lime, calcium carbonate and sand was first developed in India which is known as (FAL-G Bricks). In this the sufficient strength of the product is obtained by combining of two processes. The reaction of fly ash with lime forms gel product and forming of ettringite to accelerate the rate of pozolanic reaction the moulded product continuously saturated with water. However with the help of clay, lime and gypsum unfired building product like bricks, blocks etc. can be obtain.Therefore economic and environment friendly technology corresponding put a benchmark upon production of fired clay bricks[20]. The analysis shows that the energy consumption in unfired bricks from clay lime and GGBS is lowers by 85% and harmful emission lowers by 80% as compared to clay fired bricks.
Papercrete Bricks: The entire construction industry, the use of the industrial waste in building technology transfer to new era. For instance, the use of glass powder, waste rubber, industrial waste fibres, limestone powder wastes and wood sawdust wastes in building material production has received industrious awareness over the past a small number of years. Papercrete is a matter in the beginning developed 80 years previously but it is only recently rediscovered. Papercrete is a fibrous cementitious amalgam comprising waste paper along with Portland cement.
These two mechanisms are blended among water to generate a paper cement pulp, which can then be poured into a pattern, allowed to dried out and be utilized as a long-lasting building substance. Papercrete has three derivatives, that is to say fibrous concrete, padobe and fidobe. The fibrous concrete is a combination of paper, Portland cement and water. There are no injurious by-products or preventable energy use in the produce of papercrete. Simply it can be said that the using waste materials like paper, flyash etc, in the process of manufacturing novel type of eco-friendly bricks, namely papercrete bricks. As the structures of tomorrow be converted into taller and more obscure, the materials of construction will be mandatory to meet more challenging standards of presentation than those in force today[21].
Clay brick firing in a High-temperature Solar Furnace: The firing process intended for clay brick production in traditional Kiln generates atmospheric greenhouse gasses when industrial and household particle is use as fuel. A substitute is the using of cosmological energy for clay brick. This system of baking bricks is mounting stage which produces a temperature between 900^0 C and 1050^0C, these temperature are sufficiently high to fire bricks or comparable ceramic products. The mechanism of solar furnace for clay-brick firing with inner chamber dimensions of 0.48x0.61x0.64m. To convey the sunbeams to the firing chamber, a heliostat with nine 1 x 1 m mirrors is used to send the emission of the sun to an off-axis parabolic concentration that focuses the light on the doorway of the firing chamber. The heliostat has a solar-tracking arrangement which makes primary and secondary adjustments to give surety that the reflected solar radiation always arrives at the concentration. The firing chamber contains a prismatic hollow space that absorbs the solar radiation to engender the heat which is needed for baking the bricks in the interior of the firing chamber.[22]

Conclusion: Although there are numerous brick making technologies existent but the majority of them are running with traditional technology. Most of the brick Kilns are of traditional coal fired fixed chimney Bull's Trench Kilns (FCBTK) type, with fixed natural draft chimneys. These common technologies for brick production are outdated and incompetent combustion resultant into environmental pollution. The emission standards set by the MoEFCC changed several times (October 2015 and August 2016) but these preventive seems to be insufficient for pollution control. Brick industry CO_2 emission cross 62 million tons/year and natural resources exploitation reached to its zenith which needs technological change. There is need to adopt a suitable technology which is energy efficient

along with fit to the present practice of manufacturing and helpful in environmental protection. Overall the environment guiding principle framework for brick industry in India consists of incoherent individual practices developed through a top down approach with limited understanding of the implementation issues. The Government of India require to focuses on use of most efficient technology in firing bricks as to control environment pollution and to protect natural resources. The use of fuel efficient Kilns or alternative fuels Kilns or no fuel technology considered necessary to improve brick quality with increase productivity and bring down cost of energy moreover to prevent environmental pollution.

End Notes

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