Review of Literature

In India manufacturing of bricks still follows the age old basic steps of centuries past. Technological advancements in recent past have made the modern brick plants substantially more efficient than the kilns of the past and have also improved the overall quality of the products. A more complete knowledge of raw materials and their properties, better control of firing, improved kiln designs and more advanced mechanization have resulted in the development of energy efficient modern industry.

Types of Brick Kiln

Brick kilns are classified into (i) intermittent kilns and (ii) continuous kilns. An intermittent kiln without permanent kiln structure is commonly called as clamp kiln. Clamps are generally used when the nature of production is small (Maithal *et al.,* 2003). Continuous kilns incorporate heat recovery features to utilize heat in fired brick, as well as heat available in hot flue gases. These kilns are superior to intermittent kilns in terms of energy efficiency as well as the quality of brick. Continuous kilns include Bull's trench kiln (BTK) with moving chimney and fixed chimney, Hebla or Zigzag kiln, Hoffmann kiln, and Vertical Shaft Brick kiln (VSBK).

Clamp Kiln

These kilns are still in use due to its small size and suitability to burn bricks of different shapes and sizes. Generally the production capacity of clamps ranges from 5000 to 15,000 bricks per firing. Coal, firewood, various types of agricultural residues, dung cake etc. are used as fuel for clamp kilns. The arrangement of bricks of the clamp generally depends on the type of fuel used in its firing. It is low energy efficient kiln as most of the heat in the flue gases, fired bricks and kiln structure remains unutilized (Maithal *et al.,* 2003).

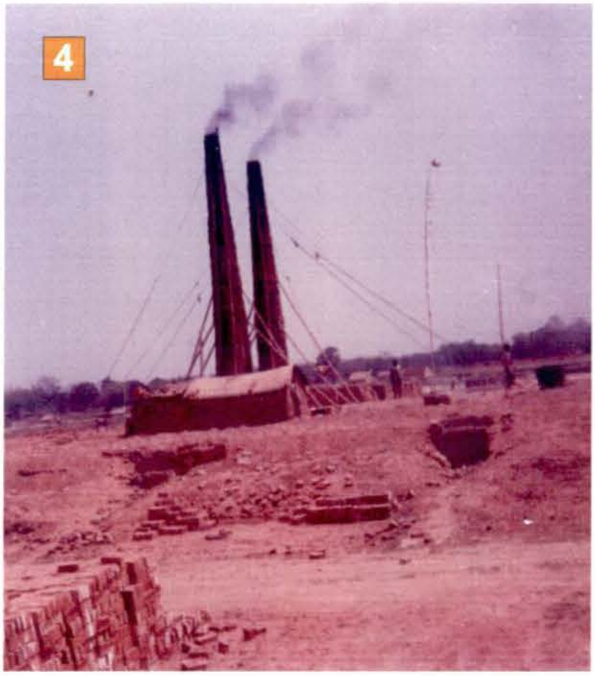
Bull's Trench Kiln (BTK) with moving chimney

The kiln is about 17 m long and 7 m wide and has two 10 m high movable chimneys. (Fig. 4) The bottom and the sidewalls of the kiln are lined with bricks, and the top is left open.. Sun dried bricks are stacked in the kiln in an orderly fashion leaving enough room for fuel stacking and air circulation. The air entrance opening (air hole) and the chimney are located at the two ends in such a way that combustion air is pre-heated by taking heat from the fired bricks. The green bricks to be fired are preheated by the flue gas in its way out of the chimney. The bricks are fired all around the kiln, which means that the chimney and the air hole must be progressively moved forward until all bricks in the trench are fired (Jain and Singh, 2000; Gomes and Hossain, 2003).

Bull's trench kiln is about 125 years old and during its long lifetime is used with little change. The production of bricks varies from 15,000 to 50,000 bricks / firing day. The emission levels of BTK with movable chimney are high. Government of India in 1996 banned their use and stipulated that it may be replaced with fixed chimney kiln. But still it is used in different regions of the country (Maithal *et al.*, 1999).

Fixed Chimney Kiln (FCK)

The position of chimney in a fixed chimney kiln is fixed and located on the central part of the kiln and in approximately 40 m high (Fig. 5 and 6). This tall chimney creates a stronger draft, thereby improving the combustion process, and releases the flue gas at a height of 40 m above the ground, thus providing faster and better dispersion of flue gas. The kiln has underground piping to direct the flue gas from anywhere in the kiln to fixed chimney. The length of the kiln is the same as that of the BTK but its width is greater to accommodate the underground piping. FCK also has better insulation in the sidewalls, reducing heat loss to the surroundings (Jain and Singh, 2000; Gomes and Hossain, 2003).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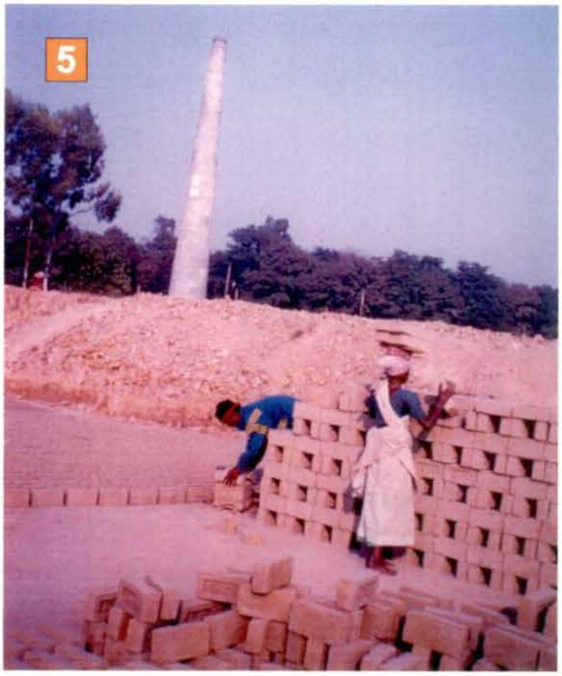
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Hebla or Zigzag Kiln

It is a rectangular shaped kiln measuring 75 m x 24 m. It has 16.5 m high fixed chimney located on one side of the kiln. The blower is located at the bottom of the chimney which draws the flue gas from the kiln and discharges to the atmosphere from 44 to 52 chambers which are separated from one another in such a way that the hot gasses move in zigzag path through the kiln. (Gomes and Hossain, 2003).

Hofman Kiln

It is rectangular in shape measuring 120-160 m by 18 m. Construction and operation is allied to FCK. The brick making procedure continue throughout the year as because the kilns are totally covered. The thick walls of the kiln and good insulation minimize heat loss to the surrounding. The chimney is 23 m high with a blower at the bottom. Green brick are fired from the top by introducing the fuel , natural gas into the combustion zone through pipe type burners. The burners are shifted forward from section to section as the fire progress. The fired bricks are unloaded at the back while green bricks are stacked in front of the firing zone (Gomes and Hossain, 2003).

Vertical Shaft Brick Kiln (VSBK)

VSBK is very fuel-efficient and saves 30 to 40% fuel in comparison to BTK. This kiln is simple to construct and operate, making it ideal for rural areas. This technology requirs only 0.4 ha of land.

Initial development of VSBK technology took place in rural China. This technology first appeared during 1960's and in 70's the VSBK became popular in several provinces in China. In 1985 Chinese Government commissioned the Energy Research Institute of the Henan Academy of Sciences at Zhengzhon to improve the energy efficiency of this kiln. Now several thousand kiln are operating in China. First VSBK technology was introduced in India in the year 1996. It is situated at Datia in Madhya

Pradesh. It has been reported that at present altogether 27 VSBK's are operating in different states of India (Maithal, 1999).

This technology shows a vertical Kiln where fire is stationary but bricks arrangement is moving. In a cross section the kiln shaft is either square or rectangular. Counter current heat exchange occurs in the kiln. The heat transfer occurs between the hot air and the green bricks that is moving upward and downward. Structure of the kiln can be divided into upper preheating zone, middle firing zone and lower cooling zone (Norsker, 1992;1994).

VSBK technology is an energy efficient technology for firing clay bricks. It is particularly suited to the needs of brick production in developing countries – which is small scale and decentralized type.

Fuel

Coal is the chief fuel used for burning bricks. In India about twentyfour million tones of coal is consumed per year, which is about 8% of the total coal consumption of the country. In addition it also consumes several million tones of biomass fuels (Development Alternatives, 2005). In Bull's trench kilns, besides coal, other fuels like firewood saw dust and rice husks are used. Firewood is used for initiating the fire. Only in Hofman Kiln natural gas is used as fuel (Bhanarkar *et al.,* 2002).

About 15-25 tons of coal is necessary to burn 1 lakh of brick (TERI, 2000). It can be noted that only 35-50% of the fuel energy can be used to burn the brick and rest of the fuel energy is lost. (Maithal *et al.,* 2003). Various causes are noticed for the energy loss such as hot air coming out from the chimney, hot rubbish on the top of the kiln, for heating the base or pavement and wall of the kiln and incomplete burning of coal. Out lay of the kiln also causes heat loss at the time of ejecting of burned bricks.

Phases of brick Manufacturing

Basic principles of manufacturing of brick are fairly uniform. Essentially bricks are produced by mixing clay with water, then sizing the clay into the bricks and followed by firing. Most of the brick kilns in India and other developing countries like, Bangladesh, Nepal are following the age old manual process of brick manufacturing (Maithal *et al.,* 2003; Bhanarkar *et al.,* 2002; Dhakal, 2003; Gomes and Hossain, 2003) while developed countries have already adopted mechanical processes in different stages of brick manufacturing. (Trevelyan and Haslam, 2000). In the brick manufacturing industry one and only raw material is clay.

Brick manufacturing process has the following phases:

Clay winning and storage

Clay is collected by digging top layers of the soil. Digging is usually done upto a depth of about 5 feet in the agricultural land. Sometime clay is collected from riverside also.

After winning, clay is stored at a specific area of the brickfield. Clay is stored in several storage areas collected from different sources (Figs. 7 and 8). At the time of preparation different types of clay are blended.

Clay preparation

This includes sorting, wetting and tempering of the clay. Sorting is done by picking out roots, stones and other particulate matter. Clay is wetted for a couple of days in a puddle dug near the working area, which produces homogeneous soft mass of clay ready for moulding. Blending of different types of clay is done by treading with feet (Fig. 9). The equipment driven by animal or machines such as pug mill are also used in other parts of the country.


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Moulding or forming

A lump of soft clay is moulded in a wooden dice to give the shape of a brick by using hands and excess clay is removed from the top of the dice by wire or fingers (Figs 10 and 11). At the time of the moulding sand is used, where lump of soft clay is rolled with sand to prevent the clay from sticking to the wall of the dice. No brick kiln in North and South Dinajpur is found using mechanized brick moulding and automatic cutter to make the final dimension of the brick unit. Clay preparation and moulding were done by moulders.

Drying

The freshly moulded bricks are left on the ground for natural drying under the sun for a couple of days. Finally the green bricks are stacked and sufficient space is allowed between brick for air circulation (Fig. 12). Shrinkage through drying is inevitable. After drying the green bricks are transferred to the kiln for firing.

Firing

Firing is one of the most and specialized factors in brick kiln by which it directly correlated with the production of quality brick. Fireman is responsible for the firing operation in the brick kiln with the help of labourers.

Cooling

After completion of total burning cooling process automatically starts. Near about 7-10 days are required for cooling in case of Bull's trench kiln. After cooling labourer carries the burnt brick from the kiln to the stack.

Transportation

Transportation of green and fired bricks (Figs. 13 and 14) was done by head and shoulder load. Generally eight to twelve bricks were carried at a time as head load causes health problems especially in women

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(Development Altematives, 2005). Sixteen to twenty bricks are carried as shoulder load.

Pollution

In every year about twenty four million tons of coal are used for brick buming which is 8% of the total coal combustion in India. After power and still plant, brick plant is the third consumer of coal in India (Maithal *et al.,* 2003). In addition it also consumes several million tons of biomass fuels. Air pollution levels near the kilns have assumed significant importance as they do not only pose serious occupational health hazards but also adversely affect the surrounding environment (Aslam *et al.,* 1994). Brick kiln emanates both fugative emission as well as stack emissions. Stack emission consists (NO_x) of suspended particulate matter (SPM), sulphur dioxide, nitrogen oxide and carbon monoxide. The particulate matters are mostly coming out from unburnt coal. The quantum of these particulate emission is a function of several factors such as quality of coal, feeding practices, duration of coal charging and idle feeding time. Sulphur dioxide (SO_2) is released from the coal due to the presence of sulphur and carbon monoxide arising out of its initial combustion and carries considerable energy with it (Jain and Sing, 2000).

Pollution load in terms of particulate matter varies depending on firing practices. In heavy firing emission level is high as 4200 mg /Nm^3 and in slow firing emission level is as low as 1200 mg/ Nm^3. Flue gas volume varies from 16,000 to 20,000 Nm^3/hour. Particle size distribution are: above 10.9 μ -50 to 60%, 4.6 to 10.9 μ -17 to 22% and < 4.6 μ -18 33% (TERI, 2000). The flue gas velocity ranges from 3.38 to 5.71 m Sec^{-1} and temperature ranges from 383 to 513^{0}K in the movable chimney. In the fixed chimney gas velocity ranges from 0.40 to 0.55m Sec^{-1} and temperature ranges from 323 – 398°K. (Bhanarkar *et al.,* 2002). At the time of kiln operation the suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM) levels were so high that are exceeding the National ambient air quality standards stipulated by regulatory authority (CPCB, 1996). SO_2 and

NO_x concentration rises high at the time of kiln emission. It is experienced that the toxic metals, which are oftenly associated with particulate matter even at low level, causes more serious health problems (Bhanarkar *et al.*, 2002).

The BTK, FCK kiln operated in Bangladesh use very low-grade, high-sulphur containing coals. Exhausts from these kilns contain flyash, carbon particles and high concentrations of CO_2 and SO_x (Gomes and Hossain, 2003).

Bajracharya (2004) reported that stack emissions made up of more than one third of the air pollution in the Kathmandu Valley, Nepal.

In Kathmandu Valley, Nepal the brick kilns are also responsible for considerable part of the air pollution. The share of Total suspended particle (TSP) is 31% and Particulate matter (PM) varies from 10 to 28% as per the study by the World Bank in 1997 (Dhakal, 2003).

The study conducted before and during brick kiln operating season at Tikathali Village development committee (VDC) of Lalitpur district Nepal showed that air pollutants like PM, TSP, sulphur dioxide, and nitrogen oxides, were three times higher during the brick kiln operating time than during the off season (Raut, 2002; Dhakal, 2003).

Zhang and Huang (1998) reported presence of fluorine in fumes emitted from adjacent brick kiln in Guangdong Province, China.

Dutta *et al.* (1996) reported very high floride levels in ground water in the vicinity of brick kilns in Delhi area.

The fugative emission in the brick kiln is due to the various operations such as coal crushing, loading of raw bricks, fuel charging, loading of the burnt bricks and local phenomena like wind blown dust, traffic, agricultural activities and the movement of labourer and animal in the kiln area. The ash obtained from the kiln bottom is loaded at the top of the brick columns for air sealing and thermal insulation. Laying and lifting of this ash itself generate a lot of dust. During removal of the burnt bricks from the kiln falling of ash cover as well as coal which is left after coal burning also generate dust. Crushing of coal releases a lot of fine coal powder. Charging of coal manually also releases coal dust along with hot gasses. Transportation of bricks from kilns also caused dust generation. The dust level in the vicinity of brick kilns is further aggravated when the wind velocity is high (NEERI, 1993a,b; CPCB, 1996). Fugative dust generation in the plant exceeds the stack emissions (Aslam, 1993; 1999; 2001).

Choudhury (1982) has calculated gaseous emissions due to coal burning. Emission factor was calculated as follows: Aldehydes -0.0025, Carbon monoxide - 0.25, Hydro Carbon - 0.10, Oxides of Nitrogen - 10.00, Oxides of Sulphur – 19.00, Particulate matter - 8, and Ash -2. (kg/ton of coal respectively). Apart from the particulate and gaseous pollutants there are hazardous trace elements, free quartz crystals with sharp edges (0.5-5μ). They are very dangerous and cause silicosis (Debnath, 1981). Particulate matter can be seen in a smoke plume, but there are also many particles, which are too small and invisible. Those particles having a diameter greater than 10μ settle out rapidly. The very small particles gather to form larger particles.

Maithel *et al.* (1999) of Tata energy research institute has worked on the resource utilization improvements in brick industry in India. The study included detailed measurements of air pollution in kiln stacks, heat loss to the ground, and heat loss from the kiln surface. Several of these studies were planned and executed in collaboration with Priya brick technology consultancy services. These studies provided a better scientific understanding of the functioning of fixed-chimney kilns and helped in identifying measures to reduce fuel consumption and emissions. Standard protocols for energy and environmental monitoring of brick kilns were also developed during the course of the study. These studies resulted in the formulation of guidelines for better operation and design of fixed-chimney

BTK. A reduction of 10 to 20% in energy consumption and 50% in emissions of SPM (suspended particulate matter) were measured in fixed-chimney BTKs. The improved performance resulted mainly from improvements in fuel feeding and kiln operating practices.

Soil destruction

Natural soil is a decomposition product. Generally its solid phase has two main constituents, -- the mineral matter derived from weathering of parent rock, and organic matter contributed by gradual colonization and death of plants and animals. Both constituents undergo physical and chemical changes and ultimately an equilibrium state is reached which characterize the mature soil. The length of time required for a soil to develop the distinct layers called horizons depends upon many interrelated factor of climate, nature of parent material the organisms and topography. Under ideal conditions, a recognizable soil profile may develop within 200 years. Under less favourable circumstances, the time may be extended to several thousand, years (Miller and Donahue, 1947).

Indian brick industry is the second largest producer of brick in the world. It is estimated that India has more than 1 lakh units having principal distribution in the Gangetic belt in northern India (about 65% of the total). This belt is the Indian alluvial plains. More than 1500 acres of prime agricultural land is being lost annually for making bricks. Most tragic matter of concern is that the top layer of soil which is the most productive layer is used for this purpose. This is found in almost all places of Northern Indian plains (Bhatta *et al.*, 1998).

Gomes and Hossain (2003) observed that with increasing demand for bricks in Bangladesh more and more paddy fields are covered to brickfields. They also pointed out that often the clay for brick was taken from adjoining fields which caused further loss of agricultural land.

Bajracharya (2004) reported about destruction of fertile topsoil of paddy fields in Kathmandu Valley, Nepal and also reported that 120 brick kilns in the valley eroded the topsoil completely and what the farmer got back at the end of the lease was a large pit devoid of any agricultural value.

The fire which is placed in the underground in the kilns reduces the surrounding soil moisture, resulting permanent damage in the ecosystem. Unplanned cutting of the soil drastically alters the drainage pattern in the surrounding areas and there by local agricultural practice is altered. It has been estimated that an astronomical figure 29,00,00,000 cubic feet top soil is used for the purpose making 350-400 crores of brick in India. If this figure is converted into a depth about 3.5 ft deep then about 1500 acres of topsoil is lost annually (Bhatta *et al.*, 1998).

Soil plays a fundamental role in the regulation of pollutants in ecosystem (Purohit *et al.*, 2004). Soil is an important sink for pollutants of various kinds through precipitation, absorption, and immobilization reactions. Life in the soil is diverse in terms of taxonomy and ecological niches. From the ecological point of view the main function of soil organisms are organic matter decomposition, mineralisation and synthesis of humic acids. Protection of such functions and stability are guaranteed if ecological structure equilibrium are maintained. Some important functional criteria are enzyme activity, nitrification, carbondioxide evolution macro and micro nutrient concentration. (Witkamp, 1966; 71; Taylor, 1976).

Loss of soil fertility is environmental cost of brick kilns. It is estimated that the brick kilns in Kathmandu Valley are using approximately 500 hectares of fertile land for brick making. After using the top fertile soils for brick making the soil nutrient concentration decrease radically (Raut, 2002).

Brick kiln lands are mining wastelands which are left unused and uncared covering a wide area and can not be put under agriculture or any other productive purpose it is also suggested that these area may be used for pisciculture (Agarwal *et al.,* 1997).

Land degradation, which ultimately affects agricultural productivity by shrinking of cultivated land (Pangtey *et al.,* 2004).

The brick kiln itself occupies considerable land which is subjected to high temperature making it unfit for agriculture in future after the site is abandoned (Development Alternatives, 2005).

Impact of fly ash

Considerable concern has been shown on the environmental impact of fly ash generated by coal-based power plants (Hui, 1984). Fly ash, a solid waste contains both macro and micronutrients, which can sustain plant growth (Negi and Meenakshi, 1991). A study conducted by Sarangi *et al.* (1999) has shown that coal-burnt ash amended soil increases the production of rice, (16% - 30%), groundnut (27%), wheat (75%), ladies finger (93%) and radish (326%). But no work has been done on small-scale generating fly ash from brick kilns. The ashes from the kilns are spread in the surrounding atmosphere and ultimately on to the soil by air current or by rain.

Fly ash generated from the coal based thermal power plant increased the soil conductivity, organic carbon and organic matter content and in organic carbon / nitrogen ratio in the paddy field (Sarangi *et al.,* 1997).

It has been reported that application of fly ash in low dose in the agriculture fields are suitable for better crop management (Sing *et al.,* 1994; Matte and Kene, 1995; Khan and Khan, 1996).

Leaches of fly ash amended with various bioactive agents, like sewage sludge, water hyacinth powder and earthworm casts help in minimizing the leaching of toxic heavy metals (Mahakur and Mishra, 1998).

Sarangi and Mishra (1998) reported on the growth, biochemical changes and yield of groundnut, ladies finger and radish in fly ash amended soil and effect of such amendment on soil metabolism.

Fly ash amendments soil showed a very favourable response on growth and yield of crops and vegetables (Sarangi *et al.,* 1999).

Fly ash amendment in soil can increase the availability of Na, K, Ca, Mg, B, sulphate and other essential nutrients except nitrogen (Elseewi *et al.,* 1981; Druzina *et al.,* 1983; Wong and Wong 1989).

There have been increasing attempts for possible agricultural utilization of fly ash as soil nutrient supplement (Sikka and Kansal, 1995).

Fly ash in agricultural field acts as a liming materials to neutralize soil activity and increase the water availability to the plants (Adriano *et al.,* 1980; Wong and Wong, 1986; Sims *et al.,* 1995; Maiti *et al.,* 1990).

Environmental hazard causes by brick kiln in Lucknow shows that the emission of brick kiln decreases herb density and nutrient disorders in plants / trees (Pangtey *et al.,* 2004).

Because of its low solubility and high absorption property in soil, phosphorus is relatively unavailable to the plant root, hence phosphorus supply is one of the major constraints to plant growth. Soil phosphate concentrations are often 1μ mole or less, and phosphorus is rapidly depleted from the rhizosphere by roots (Buchanon *et al.,* 2000).

Measurement of soil pH is a simple and reliable test to have a first hand glimpse on the nature of the soil. Any ecological change of the soil is reflected in the soil pH. Changes of the soil pH brings several plant nutrients either available or unavailable depending on the change of the pH. Absorption of pollutants by the soil is first reflected in the change of the soil pH. It may be mentioned that smoke and fumes from industrial plants, especially those containing sulphur dioxide frequently lower the pH of soils in the vicinity of the industry (Daubenmire, 1959). It is also to be noted that soil also acts as a buffer.

Potassium is an essential mineral nutrient for plants. It is known, however, that plants do not grow normally in a soil deficient of this element. Fly ash is alkaline in nature and among the other inorganic mineral elements small amount of potassium is also present (Aitken *et al.*, 1984).

The soil is an ecological habitat is very diverse in terms of taxonomy and ecology. It allows a suitable environment for the elaborate root system of the plants, hyphal system of fungi and provides mechanical support to the woody perennials. The producers absorb minerals from the soil by means of thin root. The productivity of land ecosystem is achieved and maintained by efficient nutrient recycling. In the nutrient cycle, primary produced organic matter in the form of litter fall, leachates, root exudates, and slough is broken to available mineral nutrient by a variety of soil macro and micro organisms (Bond *et al.*, 1976; Mason, 1977). To this normal process brick kiln surroundings soil receives lot of minerals and their oxides. The role of additional minerals from coal ash in the soil mineral cycle is not clear.

The soil surrounding the brick kilns or brickfields receives the fly ash and other pollutants due to burning of coal during brick ripening process. The soils surrounding the kilns receives fly ash for years together. After receiving the fly ashes it is unknown to us whether these soils are usable for normal agriculture. If, it is so, then how far it can be used. The pollution surrounding the brick kiln is well known, but no scientific work has been done on the effect of such soils on germination of plant seeds. Seed germination rate and measurement of shoot and root length after germination can be used as bioindicator of polluted environment (Ray, 1994). While sophisticated method like atomic absorption spectrophotometry require high expensive apparatus and other accessories. Bioassay methods are less expensive and far more scientific than standard methods of chemical analysis (Ray, 1994).

Health Hazards

The workers of brick industry work during the dry season. They are associated with various types of works such as clay shifting, clay melting, moulding, firing, transport of green and fired bricks, loading and unloading of fired bricks, cracking of coal etc. Agarwal (1959) in his study showed that the working conditions of brick kiln workers were far from satisfactory with insanitary surroundings, dusty environment. The dust generated during preparation, firing, loading and unloading of bricks and fly ash emitted from the chimneys pollute the environment of the brickfield area (Aslam *et al.*, 1994). The published works on health problems of the brick workers are very few.

Wozniak *et al.* (1983) reported pneumoconiosis among workers dealing with transport and preparation of raw materials for the production of thermallite bricks made up of a mixture of clay, silicious earth and saw dust.

Dust exposure caused respiratory problem among the brick workers in five brick field of Cape Town, South Africa, Investigation was carried out on the basis of questionnaires, physical examination, pulmonary function test, chest radiography and dust measurements (Myers, 1989; Myers and Cornell, 1989; Myers *et al.*, 1989 a and b).

Liou *et al.* (1996) reported that the prevalence of pneumoconiosis among the brick workers was increased with duration of employment in brick field. Zuskin *et al.* (1997) mentioned that the brickyard workers suffered from respiratory diseases like chronic cough, chronic phlegm and chest tightness. Another work also found the respiratory problem of the brick manufacturing industrial workers (Zuskin *et al.*, 1998).

Hai *et al.* (2001) observed that labourers of a refractory brick field at HaNoi in Vietnam were highly affected by respiratory illness. Chien *et al.* (2002) reported pneumoconiosis among the workers in a brickfield in

Vietnum. Raut (2002), reported that the school children of a public school in Lamatar, Nepal were highly affected and sick due to the respiratory problems caused by the nearby situated brick kiln. The report showed on an average students was absent 3.6 days per month at the school located near brick kilns, while the figure was only 1.9 days per month at the school located away from the brick kilns. It was reported that the main cause of children being absent in a school was a result of adverse impact on lower respiratory tract to the young children due to the pollution of brick kilns.

Raut (2002) also reported that particulate matter less than 10μ has direct relation to the human health, as these particulates are small enough to pass through the nose and go into the respiratory system causing problems such as asthma and bronchitis.

Exposure to respirable dust and silica were investigated among 36 construction sites in USA. It showed that serious illness can happen by brick concerning area by Rappapori *et al.* (2003).

It was reported that children were particularly vulnerable to the pollution generated by the kilns and developed respiratory problems in suburban areas near Dhaka city (Nurunnabi, 2003).

Buckle and Stubbs (1990) mentioned that workers associated with bricks, pottery, glass and cement industry had increased risk of inflammation of tendons of the hand, forearms, or associated tendon sheaths. Ferreira and Tracy (1991) reported musculoskeletal complaints among post-kiln brick sorting workers performed differently at two sister locations. They found one plant had a high level of back complaints while the other had an increased frequency of upper limb disorders. Work related musculoskeletal complaint among brick workers were also reported by Basra and Crawford (1995) and Cook *et al.* (1996). Heuer *et al.* (1996) found that musculo skeletal complaints of brick layers is decreased with length of employment in their study sample. The workers in the brick, pottery, glass and cement industry have been suffering from nerve and tendon injuries in the hand / wrist (Buckle,1997).

Trevelyan and Haslam (2000) investigated musculoskeletal disorder in a hand made brick factory in UK. They identified both upper limb and back problems among the moulders.

Excavation around brick kiln in Northem Delhi created pools and ponds where anophiles mosquito breeded profusely and malignant malaria broke out in the region (Ansari *et al.*, 2001).

Sengupta *et al.* (2001) reported that seventy one persons out of two hundred forty six individuals of two brick fields located in the south-western side of Calcutta municipal area and situated near the bank of river Hoogly suffered from acute watery diarrhoea and vomiting caused by contamination of drinking water.

Prameela Devi and Damayanti (2006) carried out epidemiological studies on health condition of occupational workers in tannery industries at Desaipet, Warangal district of Andhra Pradesh. They reported that workers were suffering with cold, fever, headache, body pains, joint pains, dermatitis, bronchitis, asthma, acute pharyngitis, acid burns, tuberculosis and injuries.