CHAPTER - I

CHAPTER I

INTRODUCTION

1.1 Introduction

Brick is a traditional and an important building material. India is the second largest brick producer in the world after China. (www.teriin.orgs2000). Based on the limited information available on the brick industry in India, it is estimated that more than 100,000 kilns produce about 80 to 100 billion bricks per year. Out of these 50 billion are clay brick, which require more than 175 million tones of top fertile soil. Making barren more than 8000 acres of top fertile soil. The clay brick production industry is though a vital industry for housing and it also a major source of soil degradation in country.

The brick production industry is a also major source of air pollution in developing countries. The major issues in environmental improvement involve improving the combustion efficiency of existing kilns, and upgrading kilns to newer and more efficient process designs. The amount of information about brick kilns cleaner production in this industry is relatively low. Process technology upgrades are usually capital intensive in this industry. Combustion efficiency improvements can be achieved with relatively low costs in many kilns. Promoting cleaner production in this industry requires extensive understanding of and work with the brick making community because there are many social and economic factors affecting potential technology changes.

In India, as a result of rapid population growth, there is an extremely serious and fast growing housing shortage; burnt bricks are the most popular building material where current demand is estimated at 55 billion bricks per year. The attempt of technologies to improve energy efficiency

and achieve other environmental objectives has generally been lacking in the brick industry, which is still far more traditional. The Vertical Shaft Brick Kiln (VSBK) technology originally developed in China is an energy efficient, environment friendly and economically viable means to produce quality brick.

Cement based construction that results in high costs. The active participation of cement companies and the private sector is crucial in strengthening and promotion of sustainable building systems to create a win-win situation for improved affordable housing and expanding the use of cement in rural India. The research program on structural and institutional transformation processes related to Sustainable Development puts forth the proposal that increasing demand of housing and building materials must be met by augmentation of supply through technological initiatives. This needs to be achieved through sustainable production systems designed to improve the basic factor conditions in the local economy. The growth of supply of materials must be simultaneously achieved while raising the energy productivity (ton output/energy input) in the building materials industry. This can be achieved through improvements in existing products/ technologies and introduction of new alternatives that influence mass consumption.

Among the basic needs of rural and urban populations, shelter is perhaps most difficult for the poor and even the average people to afford in developing countries since most often it requires a lifetime effort, even for a very modest type of housing. It is not surprising, therefore, that the majority of people in Asian developing countries still live in dwellings that do not provide a decent living by any standards. While most governments are trying to alleviate this situation, for example by strengthening rural economic base, these efforts are far from satisfactory since rural development takes time and requires more expertise than normally available locally. Housing development both for urban and rural poor may

require a special approach and a sizable resource support for which most governments are as yet poorly equipped.

Local materials traditionally used for permanent construction as timber and stones have become scarce while modern building materials like cement and steel are more expensive and have to be imported to rural areas and are often expensive and in short supply in many Areas. Clay based material like bricks can be appropriately and effectively used as a main alternative material for low cost permanent construction both in rural and urban housing as well as public buildings. Due to its localized nature brick production provides opportunities for rural employment as clay excavators, brick workers, traders, biofuel producers and suppliers, etc. The external capital and technological inputs in brick making are still relatively low.

Despite its development advantage, there are also a number of constraints and issues in the brick industry, that have to be addressed, e.g. energy, labor, product's standard and quality, choice of appropriate technology, environment implications, market, entrepreneurial skills, etc. If the manufacturing of bricks is to be a part and parcel of rural development, the development planner should be fully aware of such issues.

1.2 Historical Background of Brick Making

Brick i.e. common burnt clay building brick a wonder building material, is perhaps the only man-made material that has defied time gracefully ever since it was invented 5000 years ago. Unlike metals and organic materials, brick weathers beautifully with time, never giving in completely to the onslaught of natural agencies working against it. Also, it is an extremely good thermal insulating material.

Manufacture of clay bricks is perhaps the oldest industry in the history of mankind. The conventional practice of firing clay bricks into rural areas is about 5000 years age-old practice from the day of early civilisation in Mohanjodaro and Hadappa (www.damleclay.struchurals.com/article1). It is also reported that hand shaped, sun dried mud bricks were made and used during the pre-pottery Neolithic period as far back as 10,000 B.C. Use of mould-box-shaped, sun dried and fired Bricks started only around 3000 B.C. Since then, the technology of clay products has made great strides with respect to both scale and efficiency of operation.

Changing traditions have jeopardised the livelihood of many craftsmen of rural India. The potter is one of them. The potter's plight is worsened by the fact that the demand for day to day earthenware has gone down drastically. Clay craft is probably the earliest of man's creations soon after man learnt to control fire and to use it in cooking and heating. He must have noticed that the ground under the fire became hardened and baked by the heat. Even though a contrast between the cultures in the Western Hemisphere and Eurasia involved was minimal or not existent, it would seem that the technology involved were reinvented over and over again in different places, seemingly unchanged over the stretches of space and time. And they remain much the same even today. (Down to Earth, 2005).

In the production of bricks Indo-Gangetic plains account for about 65% of the total brick production in the country. Punjab, Hariyana, Uttar Pradesh, Bihar and West Bengal are the major brick producing states in this region while Gujarat, Orissa, Maharashtra, Madhya Pradesh and Tamil Nadu are important brick producing states in peninsular plateau and coastal India, which contributes 35% of the brick production. (www.terrin.org, 2004)In Maharashtra there are developed brick markets in Mumbai, Pune, Nagpur, Nashik, Thane, Solapur, Aurangabad, Kolhapur,

Sangli, Bhiwandi, Malegaon and Dhule or around where abundant raw material sources are avaliable. The moving chimney kiln culture in the state is only present in Bhiwandi / Ambarnath area (District Thane), Raigad, Nandurbar, Jalgaon, Nagpur and Chandrapur districts. The total number of such kilns is estimated at about 100. Their capacities vary between 10,000 to 50,000 bricks per day, the average being 20,000 bricks per day.

Due to the rapid rate of urbanisation, particularly in the industrialised belt of Western Maharashtra, there is ever increasing demand for building material in town and cities. But the cost of land for raw material soil is one of the major investments in installing a brick-making unit, so purchasing land for top soil is not a viable option. Farmers, particularly rich, find it an easy option to sell the fertile top soil for the brick industry for temporary higher price and quick monitory gains. This is in fact can be considered as the removal of thin creamy layer on the top of the non-productive subsoil strata. However, this is at the cost of long term or permanent loss of agricultural productivity and sustained income for generations from agriculture.

In India, firing bricks and Bull's Trench Kilns (BTK) are the traditional brick making technologies. BTK technology is about 125 years old. However, during its lifetime it has witnessed little change. In the brick furnaces the two types of chimney are found i.e. the fixed chimney and moving chimney. For the firing of bricks in furnace large quantity of fuel is required. Traditionally, used fuel is coal however, now in addition increasingly agricultural biomass is used such as agricultural residue, rice husks, fire wood, dry dung etc. Apparently, no substitute to this traditional brick manufacturing has been considered as yet on commercial basis.

In 1994, due to the high polluting nature of the brick kilns. The Supreme Court of India issued directions for kiln operators to change to

cleaner production technology or face closer. The deadline for meeting new environmental performance standards was December 1997. Similarly, the CPCB brick kilns emission standards (2000) were introduced. However, as yet most of the brick kilns have not switched over to the new technologies and pollution due to brick industry continues unchecked.

1.3 Brick Industry

The convention firing bricks brick making can be described in steps as given below.

A) Process of Brick making: -

Step – I: Raw clay is obtained from various sources, which follows the step of clay preparation. Suitability of clay and other additives is solely decided by trial and error method and laboratory testing is ever employed by brick field owners. Black cotton and similar plastic soils are not considered suitable for brick making. Due to their stickiness, release of wet bricks from moulds becomes very difficult and pronounced drying shrinkage results in cracking and breakage. Clay soil must be able to show several properties to be used for brick making.

- Have enough tensile strength to keep its shape,
- Clay particles must fuse together.

Step – II: The process of clay preparation includes unsoiling, digging, cleaning, crushing, mixing, sieving. Clay soils are compounds of silica and alumina. Calcareous clays have calcium carbonate and was burns to a yellow or cream colour. Non-calcareous typically contain feldspar and iron oxides, and was burnt to a brown, pink or red, depending on the amount of iron oxide. The silica in the clay, when fired at 900-1200 °C was turn to a glassy phase. This process, called vitrification, would turn the clay to a crystalline structure. Therefore, temperature is important. If under-fired,

the bonding between the clay particles will be poor and the brick will be weak. If the temperature is too high, the bricks will melt or slump. Vitrification does not have to be complete, and does not actually occur in many of the small traditional brick making plants around the world. However, the vitrification does occur enough to give sufficient strength to the brick.

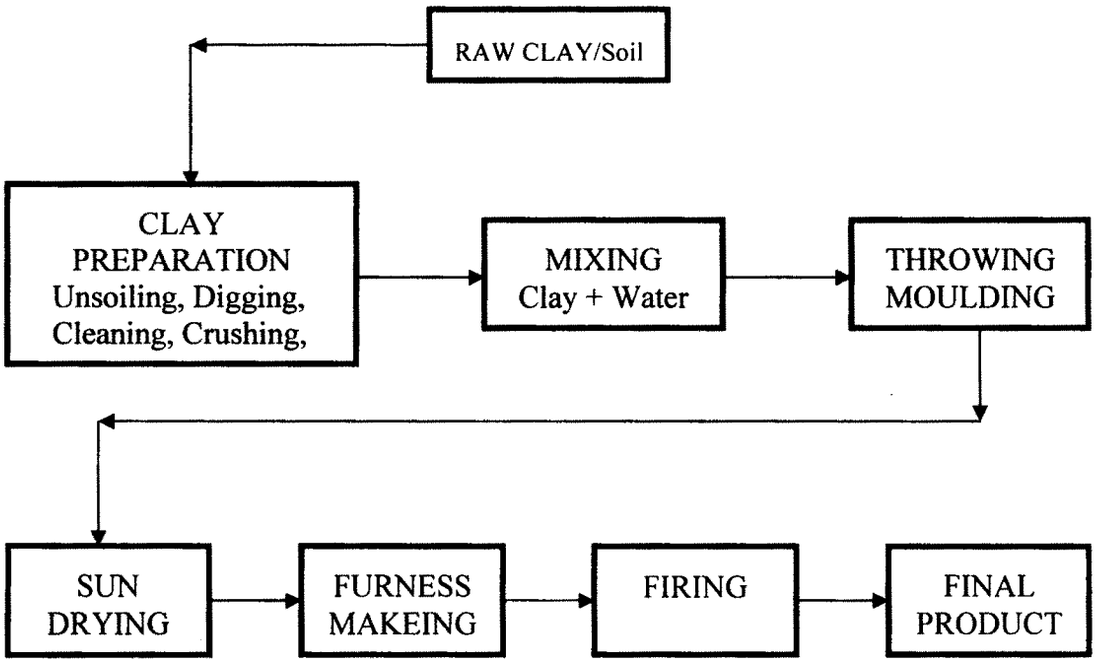
Step - III: The process of mixing includes mixing the soil and water according to the amount of bricks as per the requirement. Also coal powder, ash, chopped raw material, bagasse / husk and grog (burnt powdery material from brick kilns) is mixed with clay in the desired proportion to impart the right plasticity and burn ability to the raw mixture. This mixture is left out for one day in order to make the mixture stable. (Plate I (b))

Step – IV: Then the stable mixture is used to fill up in the mould and make the standard shape and size of bricks. Then bricks are kept in-group of 25 for drying purpose called as 'Khadki'. Because of this they can save the space. (Plate II (a))

Step – V: After drying they construct furnace by using steam coal layers in between the bricks layer. Then this furnace is ready for burning.

Step – VI: This burning of furnace lasts for 18 to 21 days. After 21 days bricks are ready for selling/use. (Plate II (b))

FLOW CHART



B) Types of Brick industry- on basis of size and brick production:

The brick kiln industries are classified according to their size and brick production capacity. They are broadly classified in these categories as

Brick Industry size	:	**Kiln daily production capacity**
Small scale	:	Less than 15,000 bricks per day
Medium scale.	:	15,000 to 30,000 bricks per day.
Large scale.	:	More than 30,000 bricks per day.

Some times brick kiln industries are classified according to their annual brick production capacity, these are as follow,

Brick kiln Industry size	:	**Kiln annual capacity**
Small scale	:	Less than 1 million bricks per year.
Medium scale.	:	1 to 2.5 million bricks per year.
Large scale.	:	over 2.5 million bricks per year.

C) Brick Standards size:

Bricks are counted and sold in multiples of thousand in two sizes. 7.5" x 3.5" x 3.5" and 7.5" x 3.5" x 1.5" as the two sizes IS: 1077-1992 recommended for modular bricks. However, almost none of the manufactures adopts either of these sizes. The 9" x 4 ¼" x 3" size bricks are called standard 'Full' size bricks, while smaller ones are known as 'cut' size. The 9" x 6" x 4" size bricks which are of recent origin are called 'double' bricks. Double bricks are very popular in Mumbai, Pune, Nashik, and Aurangabad cities in Maharashtra. The 10" x 5" x 3" size is common in the North-East India. (www.teri.org.in,2000).

The average weight of a full size brick is normally 3 kg. A 10 tonne truck accommodates up to 4000 cut size, 3,000 full size and 2,000 double size bricks. The average destination delivery price is around Rs. 1,500/- per 1,000 bricks. Bricks attract 8% sales tax and is economically sold within a radius of about 50 Km. Bricks process keep fluctuating through out the year reaching their maximum during the rainy season, when conventional brick manufacturing activity comes to halt and minimum in December/ January when fresh production floods the market.

D) Brick Industry requirements :

In the traditional brick making Industry the following type of material is used as a raw material for making the bricks. (Plate I(a))

(1) Soil:

Soil is the basic raw material in the brick industry. The term clay is used both as a rock term and particle-size term. As a rock term, clay implies a natural, earthy, fine-grained material, which acquires varying degrees of distinct plasticity when mixed with a limited amount of water and becomes hard and stone like when heated to a suitable temperature. As a particle-size term, the clay is used to designated the smallest particles in

sedimentary rocks and soils. The maximum size of particles in the clay size grade is commonly considered to be 24 (0.002 mm in diameter).

The clay is a product of decomposition of rocks, rich in alumino-silicate minerals. The decomposition may be due to superficial weathering by atmospheric factor or the hydrothermal action. The clay is composed essentially of silica, alumina and water and appreciable quantities of iron and alkaline earths are frequently present. Clay is a traditional raw material for potting and brick making as it is a very common substance abundant in nature in a great many types and varieties with differing physical and chemical properties which made it suitable for an amazing variety after burning to make a wide range of products. It is one of the commercial clays- when one or more of the clay minerals, viz. kaolinite, montmorillonite, chlorite, illite etc. occur in fine-grained aggregates, the material becomes commercial clay. These minerals rarely occur in pure form.

Compounds of iron, such as oxides, limonite and hematite, the carbonate side rite and the sulphide pyrite act as colouring agents and as Fluxes. The colour of red brick is due to iron compounds. Compounds of alkaline (Na_20 and K_20) nearly always present, are the most powerful fluxes and responsible for the vitrification of clays during burning. Lime, present as carbonate as silicate (lime-feldspar) or the sulphate (gypsum), is usually considered a very injurious impurity for most uses. Ordinarily, it is permissible only in low-grade clay product water, which is present in two forms, viz. as mechanically held moisture and as chemically combined water. Lime nodules are another position to brick making. Lime (i.e. Limestone) dissociates into quicklime (CaO) and carbon dioxide (CO_2) gas on firing. During cooling, fired bricks absorbs moisture from atmosphere which react with quicklime to form hydrated lime ($Ca(OH)_2$). The lime particles expand suddenly giving rise to disintegration or explosion of fired bricks (Deer et al, 1982)

(2) Coal:

Coal is an important ingredient in brick making. Indian experience with small capacity plants (3000 to 10,000 bricks/ day/ shift) is much better with coal as compared to large capacity plants. Generally coal is used as the main fuel material in these industries. With the present share, coal happens to be the world's most extensively used fossil fuel for generating power. At the 1994 production level, economically accessible global coal reserves are expected to last at least another 230 years. This clearly shows the eminent position coal is expected to enjoy during the foreseeable future as a power-generation fuel. However, the availability and the increasing costs of this fuel in the local market influence the price of bricks.

India is the 3rd largest producer of coal in the world after China and U.S.A. However, Indian coals have high ash content (35 to 48% as compared to 8 to 10% in developed countries like U.S.A., Japan, Germany, France etc.) and low calorific value 3,500 to 4,000 Kcal/ kg. as compared to 6,000 to 7,000 kcal/ kg in the developed countries. (www.damleclay structurals.com/article 3.)

(3) Rice husks/ stalks:

It is the cheapest locally available source of the raw material in process of brick making from the agriculture. Rice husks/ stalks are the residual matters left after the removal of the rice from the rice crops when mixed with raw soil and coal powder in the desired proportion. It imparts the right plasticity and burn ability to the raw mixture. It can be easily obtained from local farmers at low cost.

E) Fuel Consumption

In rural industries such as agro-processing industries, bricks and tile industries, the fuel costs alone account for almost 30-40% of the production cost. The places, which are far away from coal mines, like Uttar Pradesh,

in that cases a truck load of coal costs no less than Rs. 3,200/-. This implies that the incidence of cost on transportation is almost twice the cost of the material being transported, which is quite an absurd situation.

Although costs of raw material and fuel are going up day by day, consumers are reluctant to pay higher prices in the same proportion. It is estimated that the Indian brick industry consumes more than 24 million tones of coal annually in addition to several million tones of biomass fuels, with a specific energy consumption of 1.2 to 1.75 mj/kg of fired bricks for BTks and 1.5-3.0 mj/kg of fired bricks for clamp kilns. In India there was no significant improvement in brick firing practices until the mid 1990's. In 1996 the Government of India set emissions standards for the brick kilns. In addition to reduction in emissions the regulation have supposed to be resulted in some fuel savings.

1.4 Significance of Environmental Impact Assessment

Brick kilns are known to have serious impact on the air quality of the region, besides degradation of agriculture lands, which is often ignored. This impact therefore needs to be studied scientifically. Environmental Impact Assessment is, in it's simplest form, a planning tool that is now generally regarded as an integral component of sound decision making. As a planning tool it has both information gathering and decision making with an objective basis for granting or denying approval for a proposed development. It may be defined as a formal process used to predict the environmental consequences of any development project. EIA thus ensures that the potential problems are foreseen and addressed at an early stage in the projects planning and design stage. It has emphasis on man's health and well being, legislative proposals, policies, programs, projects and operational procedures and to interpret and communicate information about the environmental impacts

The purpose of the environmental assessment process is,

a) To support the goals of environmental prediction and sustainable development.

b) To integrate environmental protection and economic decisions at the earliest stages of planning an activity.

c) To predict environmental social, economic and cultural consequences of a proposed activity and to assess plans to mitigate any adverse impacts resulting from the proposed activity, and

d) To provide for the involvement of the public, department of the Government and Government agencies in the review of the proposed activities.

1.5 Air pollution problem in brick Kilns

Industries contribute to a great extent to air pollution, which severely degrades the air quality. Brick Kiln industry in rural as well as urban areas plays a significant role in influencing the spread of air pollution. Air pollution due to the brick kilns, has been found to cause serious occupational health hazards and adverse effects on the agriculture crops. In brick industries, the fossil fuels like coal and also bagasse, saw dust as well as some time wood is used as the firing material, but most of the industries prefer the coal as a firing material. In the brick industries, the clay bricks are fired for about 21 days in the furnace. The firing is generally open type of firing; there is no provision of chimney. Therefore, this leads to the air pollution due to the release of pollutants like suspended particulate matter, poisonous gases such as SO_X, NOx etc. The gases released from the brick industry have adverse effects on the human health as well as the native flora and fauna. The obnoxious and poisonous gases like carbon monoxide released from the fire result in the respiratory diseases like bronchitis etc. amongst the workers in the industries as well as the residents in the vicinity areas. The incomplete combustion of coal in the industry may also lead to

increase in the amount of dust particles in air, ultimately resulting in the air pollution. This gets deposited over the near by vegetation and cause reduction in the total chlorophyll content ultimately affect the acreage of the agriculture and its productivity in the vicinity. (Plate-IV (b))

1.6 Soil degradation due to the brick industries :

Soil is the vital basic resources as well as the fundamental component of almost all terrestrial ecosystems. It contains the major component such as air 25%, water 25%, minerals 45% and organic matter 5%. It provides a substrate for plants, a medium within which their roots can take anchorage and a source of water and nutrients for the vegetation. Different soils also act as a habitat for many of the organisms involved in the cycling of nutrients through the ecosystem. In addition outputs from soil often from inputs to aquatic ecosystems. It requires geological times for it's formation form parent rock material through physical, chemical and biological processes.

Some of the important nutrients i.e. Fe, N, P, K, Mo, Cd are present in the top soils which are used for making bricks. Regions around Kolhapur city, as most other parts of semi urban Maharashtra, are mostly agrarian and the prosperity of the region is based on the productivity of agriculture due to rich soils, particularly clay from the river basins. Brick industries in the region, particularly around the Kolhapur city are rapidly growing to meat the needs of a speedily expanding urban growth. Thus it is converting the precious and dynamic productive soil resource as a raw material into non-productive building material. Therefore, the growing brick industries are considered as one of the main cause for soil degradation in this region. (Plate III (a))

Mostly the medium scale of brick industries are found and rarely by large-scale in and around Kolhapur. The increasing demand for the soil in

the brick industries has led to degradation of the fertile top soil from the nearby agricultural land in the vicinity of the industries. The loss of top soil can be calculated as follows. A standard burnt clay brick is 10 inches x 5 inches x 3 inches. Thus, one brick roughly requires 150 cubic inch or 0.0024 cubic meters of top soil. Manufacturing unit produces on average nearly 20 thousand bricks per day (mean of 10,000 and 30,000). If such a unit functions for six months in a year, it will produce 3.6 million bricks. For this, the unit will consume 3.6 million x 0.0024 cubic meters i.e. 8,640 cubic meters of top soil everyday or 0.5684 hectares of topsoil, 5 feet (1.52 meter) deep) (Volume/ depth = area or 8.640/ 1.52 = 5,68489 m. or 0. 5684 hectares).

Now, if there are 60,000 such units in India they would be producing 60,000 x 3.6 million i.e. 200 billion bricks per year. This consumes upto 0.5684 hectares per unit x 60,000 units i.e. 34,104 hectares of prime agricultural land. Total agricultural land in India: 187 million hectares in 2000-2001 (Down to earth July 15, 2005). The suspended particulate matter, kilns spew out rich in carbon particles and high concentrations of CO and oxides of sulphur (SOx) and nitrogen (NOx), carbon particles are deposited in lung tissues. People develop asthma, chrome bronchitis and may also become more susceptible to tuberculoses. This is especially true to kiln workers, mostly poor and malnourished. Carbon monoxide has several deleterious effects on human health. It binds with haemoglobin and reduces oxygen carrying capacity to tissues chronic exposure to the carbon monoxide thus affects brain, kidneys and other soft tissues and also the developing foetus. Direct exposure to SOx and NOx irritate the eye and throat. SO_2 in the air leads to wheezing and shortness of breath. These oxides are absorbed into the blood, disrupting physiological functions. The gases make children susceptible to respiratory diseases in winters.

1.7 Labour in the Brick Industry

In brick industry, depending upon the work, three types of labourer's work the kiln who takes out burnt bricks, who makes bricks and fire. They co-ordinate to complete a circle around the chimney.

The work stopped for 24 hours. In peak season such stoppage means loss of the workers, the worker who burn bricks are usually migrant. It's the most dangerous work in a bhatta. While working they have to stand on burning bricks, black smoke constantly comes out. (Plate IV (a)). They work 14 hours a day people get burns, sometimes they even burn to death. Most migrant labours come along with their families. Here there is work for more than six to seven months. There are no any residential facilities for the migrant workers, hence due to the poverty they live in industry-slum areas in unhygienic condition. Illiteracy is the other main problem seen among the workers, who are carried on to their next generations, sometimes, their children work in the industry. (Plate-V (a)).

1.7 Brief Review of Literature

Maithel and Uma (2000) discussed the impact of environmental regulation on the brick in India, and highlights the existing barriers to large-scale dissemination of and improvement brick firing technology. Bodhale (2000) has worked on the alternatives for the conventional brick made from the thermal coal fly. Fly-G brick made from the thermal coal fly ash. Tata Energy Research Institute (TERI, 2002) worked on the solutions to increase efficiency and reduces waste in clay brick production project. In this project the efforts are taken for the fuel/energy efficiency and the innovation of the new highly energy efficient method for firing bricks i. e. Vertical Shaft Brick Kilns (VSBK). And it's another project is the resources utilisation Improvements in brick industry in these project the efforts are

taken for the specific energy consumption in traditional and new chimneys and the releasing of Suspended Particulate matter in fuel gas in chimney.

Pangtey (2004) worked on the environmental profile of the brick kilns in Lucknow. The study variables comprised SPM and RSPM levels, metal concentrations and total silica content in soil, temperature, humidity and noise levels in the work environment. According to the study 1.89 ± 0.87acre of fertile agricultural land was used for manufacturing of clay brick per kiln. The SPM level (933 mg/m^3) was found to be much higher than the prescribed limit. The workers in these kilns were at the risk from the dust and heat related diseases.

Kamalakar (1991) studied Air Pollution in the Union Territory of Delhi. According to the survey, estimated 670.93 tons of pollutants are released into the atmosphere each day. The automobile traffic gives major share of Co-discharge. About 90.6% of total carbon of total carbon monoxide discharge in the city is caused by transportation. There are many brick kilns in and around Delhi which produce pollution that forms of silica dust. Sharma (1997) reported fly ash application in the soil at 10 times of sowing of maize and transplanting of rice showed improvement in the maize yield, where as no adverse effect on rice yield were noticed at Muthiani and Gulawathi villages.

Laird (2001) studied the chemical and engineering properties of fired bricks containing 50-weight percentage of class F fly ash. The chemical characteristics and engineering properties of the test bricks produced with or without 50-weight percentage of fly ash substitution were analysed and compared. The properties of test bricks containing fly ash were at least comparable to, if not better than, those of standard test brick made without fly ash and met the commercial specifications for fired brick. The positive

result of this study on the test bricks with fly ash of greater than 50-weight percentage was warranted.

Chatterjee (2001) commented on different aspects of rural industrialisation based on the secondary data source with objective to capture the various aspects of environmental pollution associated with rural industrialisation.

Brick manufactured by mixed pond ash of integrated steel plant have been found to be cheap, superior in structural and of aesthetic qualities. The use of mixed pond ash in the range of 40-50 % remaining being the clay, provided a very viable option of the use of huge quantities of fly ash now being dumped by steel industry (Pandey, 2002).

Banne and Patil (2002) worked on the air pollution and land degradation levels due to the brick kilns around Kolhapur City. Watharkar (1997) worked on the brick furnace and land degradation, highlighting the land degradation problem in Karad, and the economical cost benefit ratio.
