CHAPTER: 2
AIR POLLUTANTS EMISSION FROM THE BRICK KILN INDUSTRY, ITS IMPACT, AND REMEDIAL MEASURES

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Abstract

Brick industries are small-scale and unorganized industrial sectors. Bricks are the prime building material for construction purposes. The need for bricks in construction projects is growing every day. Coal, sawdust, wood, and other raw materials needed to make bricks are degrading the air quality by releasing gaseous and particulate pollutants. Brick kilns generate a lot of pollutants, including greenhouse gases like Carbon dioxide, Carbon monoxide, and Sulphur dioxide, due to outdated traditional techniques and the burning of inefficient wood and coal. Brick kilns pose a serious environmental threat because of their significant toxic gas emissions. The present chapter deals with the study of air pollutants arising from brick kilns and the harmful effects that plants and humans are facing due to these kilns.

Keywords: Brick kiln, industries, bricks, plants, humans, air pollutants.

Introduction

Industries are a collection of dynamic businesses that produce or provide goods, services, or revenue sources. These industries can be divided into organized and unorganized sectors. The informal or unorganized sector is a major portion of the Indian economy. Small-scale businesses like brick kilns, lime kilns, stone crushers, etc. make up the unorganized sector. Millions of new buildings and homes must be built every year to accommodate the rapidly growing population, industrialization, and urbanization, making the construction sector one of India's most dynamic businesses. The construction industry alone is responsible for 22% of all Carbon monoxide emissions in India. Bricks are a crucial component of construction in India and other developing nations. The brick industry is extensively dispersed throughout India and is primarily concentrated in rural and semi-urban areas. The brick kiln units use a lot of biomass and roughly 24 million tonnes of coal each year to produce about 140 billion bricks. The Central Pollution Control Board has identified the brick-making business as one of the most significant small-sector land and air polluters.

Due to their low cost and long history of use in the building industry, bricks are an essential building material today. The brick kiln sector is expanding quickly and employs individuals who live in rural locations where other forms of employment are insufficient to provide for their needs. India's traditional, unorganized small-scale businesses produce fired clay bricks [1]. There are both legal and illicit brick kilns functioning in the nation to serve a sizable portion of the population. More than 1,40,000 brick businesses operate in India.

The ambient air quality in India has also steadily declined due to human activities, including fast urbanization, industrialization, an increase in vehicle density, poor roads, building waste, garbage burning, domestic cooking, and a lack of public awareness. Fuels like coal, sawdust, wood, and other raw materials needed to make bricks are degrading the air quality by releasing gaseous and particle pollutants. By generating greenhouse gases, traditional brick-making techniques significantly harm the environment by affecting the air quality and, ultimately, the climate. Due to outdated machinery and inefficient wood and coal burning, it produces a lot of pollutants, including greenhouse gases like carbon dioxide (CO_2), carbon monoxide (CO), oxides of nitrogen (NO_x), and sulfur dioxide (SO_2). Fine dust particles, hydrocarbons, SO_2, NO_x, CO, fluorine compounds, and a small number of hazardous dioxins are among the pollutants released by brick kilns when rubber tyres are used as fuel. Fly ash, which contains a wide range of hazardous metals like potassium, sodium, zinc, magnesium, iron, etc., in higher proportions, is a crucial and primary by-product of the brick-making unit. Due to their large poisonous gas emissions, brick kilns pose major environmental risks.

Air pollutants emitted from the Brick kiln industry

Brick manufacturing is the main cause of environmental damage, such as decreased soil productivity, reduced groundwater levels, and rising air pollution [2]. The current brick kiln technologies and their excessive emissions are hazardous to the environment [3]. Fine dust particles, carbon monoxide, hydrocarbons (HC), SO_2, NO_x, fluoride compounds, and cancer-causing dioxins are among the pollutants released by brick kilns [4]. The brick production, along with other factors, not only degrades air quality but also poses health risks to those who live close to brick kilns [5]. The main air pollutant released during brick production is SO_2, which also contributes to acid deposition and urban pollution [6]. The brick factory typically produces eight lakh bricks per day using eight tonnes of low-quality of coal and eight tonnes of rubber to start the combustion process, which releases various harmful pollutants like carbon monoxide, NO_x, and dioxins [7]. Globally, increasing brick production and the clustering of brick kilns have increased major environmental risks. In addition to other biomass fuels, burning coal in brick kilns leads to the discharge of particulate matter, carbon monoxide, sulphur dioxide, and nitrogen oxides [8]. During industrial and domestic uses of coal and petroleum, SO_2 is released into the atmosphere as a major pollutant [9,10]. Numerous brick manufacturers use low-grade coal and other solid waste, which produces carbon monoxide, particulate matter, oxides of sulfur and nitrogen, as well as several other organic pollutants. Emissions from these sources are suddenly increasing and harming the environment [11,12]. It has been determined that biomass from conventional brick kilns is responsible for releasing CO_2, methane (CH_4), SO_x, NO_x, greater concentrations of carbon monoxide, and a significant amount of harmful exhausts made up of suspended particulate matter rich in carbon.

As nitrogen is oxidized during the combustion process while producing bricks, NO_x emissions are produced [13,14]. Vehicle emissions and coal-fired power plants are the main sources of NO_x pollution [15,10]. Although NO_x emissions come from a variety of natural and man-made sources, traditional brick kiln industries account for a significant portion of their concentration in rural areas. Inadequately built brick kilns release gases like CO, SO_2, and NO_2 as well as serve as a point source of ozone. Massive amounts of the highly significant nitrogen-containing species NO are released into the environment due to human activities like driving and fuel burning in power plants, as well as in residential and commercial locations [16-18].

Suspended particulate matter refers to finely divided solid and liquid particles dispersed in the air due to combustion, home activities, industrial processes, and natural sources, including dust, forest fires, and volcanoes [10]. In the environment, suspended particulate matter is generally of two sizes, PM_{10} and $PM_{2.5}$. Two types of suspended particulate matter are distinguished: primary particles, which enter the atmosphere directly, and secondary particles, which arise from convergence with other substances, such as the photooxidation of NO_x to create nitrates [19]. Brick manufacturing causes the discharge of particulate matter made up of dust and other mineral matter that has been trapped in the exhaust [20].

Air pollution from the brick kiln industry and stress on the plants

Plants are the essential components of ecosystems, and their response to air pollution is more significant [21]. Air pollution has become a primary concern for crop plants due to increased urbanization and industrialization over the past few decades [22]. Plants that are nearby the brick kilns show immediate effects [23]. The harmful effect of SO_2 is seen as foliar injury and physiological and biochemical changes in the vegetation [24]. Among all the plant parts, leaves are considered the most sensitive to air pollutants [25]. The physiology of the plants is extensively damaged due to the particulate and gaseous pollutants [26-28]. SO_2 enters the leaves from the stomata causing direct injury to the plants and leading to detrimental effects on their growth [29]. The vulnerability of photosynthetic pigments to air contaminants may determine how those pollutants react with plants [30]. While prolonged exposure to lower NO_x concentrations may not usually cause visible harm, it does stunt plant development by delaying photosynthesis. Depending on the weather, NO_x combined with other pollutants, particularly SO_2, can affect flora more than just NO_x alone. Ozone (O_3) is a highly reactive pollutant that may damage the guard cell receptors next to the stomata before it reaches the stomata, impairing their ability to respond to environmental stimuli [31]. The main ozone-related damages include bronzing, browning, and death of conifer needle tips, as well as bleaching of the upper leaf surface. O_3, SO_2, and NO_2 alone and together diminish the yields of many crop plants [32-34], which frequently results in a decline in photosynthetic activity and nutrient supplies required to promote reproductive development and seed germination [35-37].

Impact of air pollutants from brick kiln industry on human health

The health impacts of pollutants from the brick kiln industry, road and building construction, diesel buses and trucks, forest fires, etc., are linked to mortality and respiratory diseases like bronchitis, asthma, and emphysema. Particulate matter is made up of a complex variety of particles with different shapes, sizes, and compositions that settle in the human respiratory system and affect one's health in different ways. Industries and power plants generate a variety of pollutants that are harmful to human health, including fine dust particles, hydrocarbons, CO, SO_x, NO_x, fluoride compounds, and a small number of toxic dioxins. Long-term exposure to air pollution leads to altered lung function, an increased occurrence of respiratory symptoms and disorders, irritation of the eyes, nose, and throat, and early mortality in people [38,39]. Children, adults, and anybody with respiratory conditions like asthma are at risk. The effects of NO_x, SO_x, and CO exposure include dizziness, headache, fatigue, sluggishness, impaired judgment, lung irritation, bronchitis, pneumonia, asthma, respiratory infections, pulmonary edema, and emphysema [40]. The upper respiratory tract is affected by SO_2, a gas that is irritating and water-soluble. Acute SO_2 exposure results in bronchial constriction, airway contraction, greater airway reactivity, higher pulmonary resistance, and metabolic changes, but sustained SO_2 exposure results in mucosal tissue inflammation and increased secretions [43].

The airborne particles' surfaces also bind SO_2, and the smaller particulates have a greater area and greater capability for lung penetration [38]. After inhalation, SO_2 breaks down into sulfite and bisulfite on the aqueous surfaces of the human body, where it is subsequently absorbed by the cells of the gastrointestinal tract and distributed throughout the body [42,43]. Breathing problems, cancer, heart disease, and organ damage are just a few of the acute and long-term health effects of airborne particles and trace metals [44-46]. Pollutants like SO_2 can aggravate bronchitis by irritating the respiratory system. In reaction with water, oxygen, and other elements in the air, SO_2 creates acids that include sulfur. If inhaled, these acids react with airborne particles and can have extremely damaging effects on the lungs.

Additionally, it damages the respiratory system and lung tissue, leading to long-term respiratory conditions and possibly cancer. The function of the lungs is altered when there is an excessive concentration of NO_x due to water buildup in the air passages. It can exacerbate respiratory conditions like the common cold and influenza as well as chronic bronchitis and asthma. Cancer, reproductive issues, and mutations are all brought on by volatile organic chemicals like formaldehyde and benzene. Exposure to carbon monoxide can result in a coma, sluggish reflexes, blurred vision, headaches, nausea, tiredness, and impaired thinking and awareness. The weariness of the body hampered psychomotor abilities, and detrimental effects on the cardiovascular system are other impacts of carbon monoxide. Additionally, carbon monoxide tends to build up and is bound to hemoglobin for an extended period, reducing the blood's ability to carry oxygen. It has been noted that exposure to air with 0.001% carbon monoxide can result in collapse, unconsciousness, and even death.

Remedial measures

The following remedial measures will help us get started with the transition to improving the quality of air by addressing the problem of air pollution from the brick kiln industries and learning about ways of minimizing it.

- Natural materials like clay, shale, and sand shouldn't be used to make bricks. Examine the possibility of making clay bricks from the garbage. Industrial waste of all kinds needs to receive more consideration. The three main components that can be utilized to make bricks are quarry dust, fly ash, and bottom ash.
- Bricks shouldn't be fired while they are being made, and the bricks sector should function in a sustainable way moving forward. It is necessary to conduct more research on environmentally friendly brick making.
- The government should develop a long-term plan to reduce pollution in these locations since conventional brick kilns are responsible for the majority of carbon emissions. Encouraging owners of kilns to upgrade them to environmentally friendly models that don't use coal or dirt to operate, creating a thorough training course on building an environmentally efficient kiln. The owner is provided with funding and incentives to make green bricks. If current rules are amended, it will be simpler to get approval or a license to build a kiln.
- Reduced emissions of gaseous and particle pollutants will result from using high-quality fuel and efficient technology. Establishing a sufficient three-tier plantation in and around the brick industry's periphery is also suggested as a preventative measure to reduce particulate matter emissions in the area.
- Reducing illegal kilns, using cleaner technologies like vertical shaft kilns and fixed chimney kilns, and replacing old-fashioned kilns with modern machinery

all contribute to reducing air pollution. Regulations require that brick kilns be constructed distant from habitations.

- Briquettes of bio-coal can be used as a substitute for coal as a fuel. Solid fuels called "bio-coal briquettes" are produced from crushed biomass. Bio-coal is a long-term energy source that is an environmentally beneficial coal substitute that aids in lowering coal-related pollution. Bricks cook more quickly because the bio-coal generates more heat in less time. Compared to coal, bio-coal produces fewer pollutants.

Conclusion

Brick kilns emit a significant amount of particulate and gaseous pollutants, which degrade the quality of the environment. The brick industry's increased emissions of gaseous air pollutants, particulate matter, and dust are the main cause of the decline in air quality. Additionally, the air quality deteriorates due to brickmakers being unintentionally located in busy areas. Massive amounts of gaseous pollutants are produced during the brick-making process, and improper brick kiln waste disposal results in soil or land pollution. It was found that the brick industry had a negative impact on the morphological traits of local plant species. When coal and other fuels are burned, dust and other small particles are released into the air. These particles land on neighboring plants and enter their leaves, resulting in chlorosis, necrosis, and other damage. The amount of air pollutants released into the atmosphere is higher during the operational phase of brick kilns, thus altering the morphology and biochemistry of plants. The studies clearly show that the emission of brick kilns, urbanization, and transportation play a crucial role in hampering the environment [47]. Brick kiln emissions have a substantial negative impact on the environment, including air pollution, human health problems, and plant growth. Therefore, the deterioration of ambient air quality caused by brick kilns in rural regions poses a severe threat to human health and the environment.

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