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Studies on the Air Pollution Around Cement and Lime Factories

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Abstract

Air pollution is a chemical or particulate matter or biological agent that changes the natural characteristics of the atmosphere. Air pollution due to lime and cement producing industries has been found to cause serious occupational health hazards, and adverse effects on crops, orchards and buildings. The people residing in the vicinity of these industries may be exposed to higher levels of pollutants. Cement production requires massive amount of energy, mostly in the form of coal, which produces a considerable amount of carbon dioxide emission as an undesirable by-product. The emission of carbon dioxide depends on the type of production processes, their efficiency, fuel used etc. One of the most important impacts of cement manufacturing is the dust generated during storage, milling, packing and transport. Atmospheric mineral dust is an important source of air pollution contains high concentrations of many metals known to have toxic effects not only on plants and animals but also on humans. On account of the gravity of the problem, this paper presents predictions of air pollutants such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon mono oxide(CO) and suspended particulate matter (SPM) during the manufacturing months with the causes, effects and the cost to the mankind, with special reference to the Madhya Pradesh region. The proposed measures should limit the ambient air pollutant concentrations to be in compliance with the standard values.

Key words: Air pollution, atmosphere, air pollutants, mineral dust

Introduction

The construction sector has bloomed during the past few years in India. Due to the availability of raw materials necessary for the manufacturing of cement in the country, many of the cement plants are planned. One of the most critical impacts of cement manufacturing is the dust generated during transport, storage, milling, packing etc. Atmospheric dust is an important source of air pollution particularly in dry climates. Mineral dust contains high concentrations of many metals known to have toxic effects not only on plants and animals but also on humans (Branquinho, C. et al., 2008; Shukla et al., 1990; Hirano et al., 1995). The impact of such anthropogenic emission into the atmosphere and their movement into the biosphere by transformation, reaction and modification is responsible for variety of chronic and acute diseases at the local, regional and global scale (Rawat and Banerjee, 1996). Impact on the plant community has also been studied worldwide in terms of plant – environment interactions, since the plants are much more sensitive in comparison to other organisms (Abbasi et al. 2004). The symptoms or effects in plant anatomy, physiology or biochemistry indicates the state of the environment. India ranks as the second largest cement producing country in the world. There are about 158 large cement plants in India. The cement sector has been rapidly growing at a rate of 8% and is expected to grow further. The cement industry in its various processes emits suspended particulate matter (SPM) and oxides of nitrogen besides carbondioxide, which is produced during calcinations process . The emission of carbondioxide depends on the type of production processes, their efficiency, fuel used etc. Particulate matter is the main pollutant emitted from cement industries. Cement manufacturing is an energy intensive process. The energy used by cement industry is estimated at about 2% of the global energy consumption; 5% of global manmade carbon dioxide emissions originate from cement production (Hendriks et al., 1998). Consuming energy from fossil fuels such as oil and coal creates carbon dioxide, the most important Greenhouse Gas causing climate change. In industrial sector, cement industry is the second largest emitter of carbondioxide and accounts for 5 per cent of global manmade carbondioxide emissions, of which 60 per cent is from the chemical process and 40 per cent from burning fuel. Wastes from other industries, fly ash (from the power sector), blast furnace slag (from the iron and steel industry) and phosphor-gypsum (from fertilizer plant) are used to manufacture cement. Today, about 12 per cent of total fly ash generated in India is used by the cement industry. Utilization of fly ash in cement sector is therefore very low. The main sources of fugitive emission in cement industry are open air handling and storage of raw materials and clinker; transfer; points; leaking joints; loading and unloading operation and vehicular movement on unpaved roads. The methods employed for fugitive dust control in cement industry include exhaust ventilation system and water spray system. In the process of calcinations, carbon dioxide emission in cement manufacturing originate from combustion of fossil fuels and from calcining the limestone in the raw mix. Calcium carbonate in limestone when calcined gets converted into lime and carbon dioxide. About 60 percent of emission caused by making cement are from this chemical process alone. As a rough estimate, total carbon dioxide emissions range from 0.85 – 1.15 tonne of cement produce, assuming clinker to cement ratio as 0.95. The approximate contributions of each of the three main sources of carbon dioxide emissions are Calcinations - 50-55 percent ; Fuel combustion - 40-50 per cent and Electricity - 0-10% (assuming that electricity is generated from fossil fuels). Various types of Air Pollution Control Devices (APCDs) in the form of dust collectors are used in cement plants to control the emission of dust to the atmosphere. The types of pollution control equipment used in cement industry to control particulate emission are cyclone and multi-cyclones, fabric filters/ bag filters, electronic precipitators and gravel bed filters. The major contributor to the cement industry of India is the state of Madhya Pradesh. The 19 cement plants in Madhya Pradesh contribute 26.23 million tonnes of cement to the total reservoir of cement in India. Andhra Pradesh has the maximum number of cement plants (20) and it contributes 17 million tonnes of cement to India. Rajasthan, Gujarat and Tamil Nadu have 16, 12 and 10 plants each and they collectively contribute 35.79 million tonnes of cement.

Gaussian dispersion model for continuous buoyant pollution plumes to predict the air pollution isopleths, with consideration given to wind velocity, stack height, emission rate and stability class (a measure of atmospheric turbulence).(Beychok, M.R.2005,Turner, D.B. 1994) This model has been extensively validated and calibrated with experimental data for all sorts of atmospheric conditions.

Environmental impacts

Environmental impacts are caused at all stages of the process of cement and lime manufacture. These include emissions of airborne pollution in the form of dust, gases, noise and vibration when operating machinery and during blasting in quarries and damage to countryside from quarrying. Equipments to reduce dust emissions during quarrying and manufacture of cement and to trap and separate exhaust gases are coming into increased use.

CO_2 emissions

The cement industry produces about 5% of global man-made CO_2 emissions, of which 50% is from the chemical process, and 40% from burning fuel.[1] The amount of CO_2 emitted by the cement industry is nearly 900 kg of CO_2 for every 1000 kg of cement produced.[2] The high proportion of carbon dioxide produced in the chemical reaction leads to large decrease in mass in the conversion from limestone to cement. So, to reduce the transport of heavier raw materials and to minimize the associated costs, it is more economical for cement plants to be closer to the limestone quarries rather than to the consumer centers.[3]

Heavy metal emissions in the air

Mainly depending on the origin and the composition of the raw materials used, the high-temperature calcination process of limestone and clay minerals can release in the atmosphere gases and dust rich in volatile heavy metals such as thallium, cadmium and mercury , which are the most toxic.[4] Environmental regulations exist in many countries to limit these emissions. As of 2011 in the United States, cement kilns are "legally allowed to pump more toxins into the air than are hazardous-waste incinerators.[5] A cement plant consumes 3 to 6 GJ of fuel per tonne of clinker produced, depending on the raw materials and the process used. Most cement kilns today use coal and petroleum coke as primary fuels, and to a lesser extent natural gas and fuel oil.[6]

Effects on human health

Exposure to air pollution is associated with numerous effects on human health, including pulmonary, cardiac, vascular, and neurological impairments. The health effects vary greatly from person to person. High-risk groups such as the elderly, infants, pregnant women, and sufferers from chronic heart and lung diseases are more susceptible to air pollution. Children are at greater risk because they are generally more active outdoors. Exposure to air pollution can cause both acute and chronic health effects.[7]

- **Acute effects** are usually immediate and often reversible when exposure to the pollutant ends. Some acute health effects include eye irritation, headaches, and nausea.
- **Chronic effects** are usually not immediate and tend not to be reversible when exposure to the pollutant ends. Some chronic health effects include decreased lung capacity and lung cancer.

Effects on human respiratory system

- Both gaseous and particulate air pollutants can have negative effects on the lungs.
- Solid particles can settle on the walls of the trachea, bronchi, and bronchioles.
- Continuous breathing of polluted air can slow the normal cleansing action of the lungs and result in more particles reaching the lower portions of the lung.
- Damage to the lungs from air pollution can inhibit this process and contribute to the occurrence of respiratory diseases such as bronchitis, emphysema, and cancer.[8]

Air pollution control:

- Air quality management sets the tools to control air pollutant emissions.
- Control measurements describes the equipment, processes or actions used to reduce air pollution.
- The extent of pollution reduction varies among technologies and measures.
- The selection of control technologies depends on environmental, engineering, economic factors and pollutant type.

The atmospheric emission from the proposed cement plant constitute flue gases from raw mill, coal mill, cement mill, packing section, kiln and crusher. The major emission is particulate matter. SO2 and NOx emissions are generated from the kiln. In order to regulate the particulate matter emission in the exhaust, pollution control devices and interlocking systems will be provided in all the critical areas so that the manufacturing operations cease whenever the
pollution control equipment trips, thus eliminating the cause of increased emissions due to failure of control equipment.

Air pollution control equipment

Various pollution control equipment proposed:

- Installation of bag house system for cleaning of raw mill/kiln flue gas.
- Installation of 3 major bag filter systems and one ESP for control of dust generated from various process units.
- Installation of about 20 bag filter systems along with ventilation systems to control the fugitive dust generated from the material handling areas.
- Installation of X - ray analyzer to monitor the raw material quality and smooth processing to have better control on the process and thereby on the bag house of the Kiln.

Control of fugitive emissions

Transportation

The roads in the cement plant will be paved to prevent dust emissions. To prevent fugitive dust, from clinker transport, water sprinkling will be used during transport activities.

Conveyor Belts and Bucket Conveyors

To control the dust emissions bag filters will be provided at various locations of
the transfer points.

Storage Piles

All the raw material stock piles will be covered with aprons to absorb
fugitive dust emissions.

Apart from above, implementation of the following additional measures for control of fugitive dust are proposed-

- A closed clinker stock pile system and bag filter for clinker hoppers
- Automatic dust cleaning system will be employed for removing the dust on the floors.
- Cement roads will be constructed inside the plant to avoid dispersion of dust.
- Water sprinkling arrangements in the raw material stockyards and cement bags loading areas.
- Development of greenbelt all around the plant boundary.

Industrial operations in the country are subject to regulation through a plethora of legislations enacted from time to time. Important among the Acts which concern cement industry from the environmental viewpoint are:

- Air (Prevention & Control of Pollution) Act, 1986
- The Environmental (Protection) Act 1986
- Forest (Conservation) Act, 1980
- Water (Prevention & Control of Pollution) Cess Act, 1974
- Water (Prevention & Control of Pollution) Cess Act, 1977
- The Public Liability Insurance Act, 1991

Conclusion

The cement industry in India is growing at a tremendous rate. Because of the liberalization measures taken by the Government of India in the 90's, India has come a long way in the production of cement. From being an importer of cement, India export large quantities of cement to the countries like Bangladesh, Nepal, Sri Lanka, Maldives, Mauritius, Africa, Scychelles, Burma, UAE, Singapore because of its numerous cement plants. The most important use of cement is the production of mortar and concrete- the bonding of natural or artificial aggregates to form a strong building material that is durable in the face of normal environmental effects. Green cement is a cement material that meets or exceeds the functional performance capabilities of ordinary Portland cement by incorporating and optimizing recycled materials, thereby reducing consumption of natural raw materials, water, and energy, resulting in a more sustainable construction material. The manufacturing process for green cement succeeds in reducing, and even eliminating, the production and release of damaging pollutants and greenhouse gasses, particularly CO_2.

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