Environmental Pollution by Cement Industry

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Abstract:

Cement is the primary material for building and civil engineering constructions. Therefore, the cement manufacturing sector plays a vital role in the nation's economic development. The objective of this research is to identify the environmental impacts of cement industry, propose solutions, and improve the sustainability of the cement industry. The main environmental issues associated with cement production are the consumption of raw materials and energy use as well as emissions to air.

Keywords

Cement Production, Environmental impacts, Waste disposal, Pollution

1. Introduction

Telecommunication, petroleum, coal, fertilizer, iron, steel, and cement, etc. are the key infrastructure sectors of the globe. Cement business is additionally playing a major role, within the rapid climb and development of a country as a result of cement may be a basic demand of all constructions activities. Cement is employed in housing, dams, bridges, industrial construction, roads, etc.. Therefore, cement is a basic material that is employed in kinds of constructions altogether.

Cement may be a fine material with water forms a paste that hardens slowly. It's created by sintering a mix of assorted raw materials. The most material composed within the mixture is metallic element carbonates as sedimentary rock and different alumina, silicates as clay or sedimentary rock. Throughout the sintering process, a chemical process takes place, produces nodules, called a clinker that consists of metallic element silicates and aluminates. Once the clinker is powdered with a little quantity of mineral the created powder is termed Portland cement [1].
As cement producers still search for various fuels, many of us surprise what kinds of fuel will be utilized in the combustion method. The common energy input needed to form one ton of cement is 4 million Btu—the equivalent of concerning 389 pounds of coal.

Finding ways that to scale back each energy desires and reliance on fossil fuels could be a prime priority for cement corporations. Though coal, crude oil coke, and different fossil fuels are historically burned in cement kilns, several cement corporations have turned to energy-rich various fuels. Today, several plants use a large form of various fuels as a part of their overall energy scheme; starting from ten to seventy percent of their energy needs. Usually, shopper wastes or byproducts from different industries are with efficiency burned as fuel. Convalescent, their energy worth in cement creating could be a safe and well-tried variety of exercise.

The coal and coke contain carbon and unleash larger quantities of warmth once they're burned. Coal and coke, however, aren't the sole fuels that contain carbon. Tires also are an excellent supply of hydrocarbons (carbon and hydrogen). Victimization tires for combustion during a cement oven produces 25 % a lot of energy than coal, and it can even lead to lower emissions. Any material with high carbon content may be used as a fuel. Paper, packaging, plastics, sawdust, and solvents all are appropriate to be used as various fuels. Because of the very high temperatures (well higher than 3,000 degrees Fahrenheit), these materials burn quickly and very efficiently. Burning different types of fuels in cement kilns offers many environmental edges. This sort of energy recovery conserves valuable fossil fuels for future generations, whereas safely destroying wastes that will well be deposited in landfills.

2. Process Description

The raw materials are subjected to such processes as crushing, drying, grinding, proportioning, and blending before they are fed to the kilns for the burning process. The crushing stage involves breaking the raw materials into tiny fragments. Machines known as Crushers are used for this purpose. The drying stage is typical of the dry method. Drying of crushed materials is crucial and is achieved by heating these materials (separately) at temperatures sufficiently high to drive out unmixed water.

The grinding of every material as obtained from the driers is completed in 2 stages — first, the preliminary grinding, during which the elements are reduced to a fineness of fifty mesh. Ball mills are usually used for initial grinding. Second, the fine grinding, during which the scale of the materials is reduced to two hundred mesh. This is often done by grinding in Tube Mills. The dry powder is called the raw meal.

Each stuff is so reduced to a needed degree of fineness and is kept individually inappropriate storage tanks known as SILOS or bins wherever from it may be drawn out handily in requisite quantities. Predetermined proportions of finely dried and ground raw materials are mixed together before they are fed into the kiln.

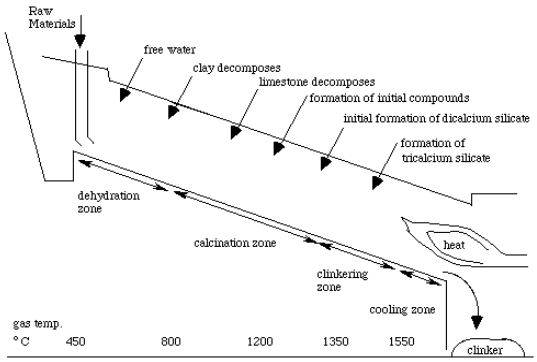

Figure (1). Burning Kiln in Cement Industry [2]

The stages of the burning kiln are given in Figure 1 [2]. The kiln is angulated by three degrees to the horizontal. By the time the raw-mix reaches the lower a part of the kiln, clinker forms and comes out of the oven in marble-sized nodules. The kiln is adjusted in an inclined position, making an angle of 15 degrees with the horizontal and rotates around its long axis. The raw mixture is burnt within the kiln until obtain the right burning which can be indicated by it taking a green-black color and vitreous (shining like glass) luster.

First, the feed is entered. In DE hydrogen zone where water is move out if there is free water at 50-200 Celsius. At 600 Celsius, the clay is decomposed. All excess gases go out from the kiln. Therefore the water vapor also go out through the kiln which the direction that the gases are moved out. The heat is supply by burning process. There is burner to supply the heat. At 600 to 1200/1300 Celsius, limestone is decomposed and CO_2 is moved out.

1. 100°C (212°F): Evaporation of free water
2. 100°C (212°F)-430°C (800°F): Dehydration and formation of oxides of silicon, aluminum, and iron. (Water is completely driven off at the very initial stages of burning at temperatures as low as 400° C.)
3. 900°C (1650°F)-982°C (1800°F): CO2 is evolved and CaO is produced through calcination. (Carbonates of calcium and magnesium are completely dissociated)

4. 1510°C (2750°F): Cement clinker is formed.

It is very hot once discharged, and is, therefore, first cooled in clinker coolers. The heated air from the coolers is returned to the kilns, a process that saves fuel and increases burning efficiency.

The entire process flow diagram of the cement manufacturing process is given by Figure 2 [3].

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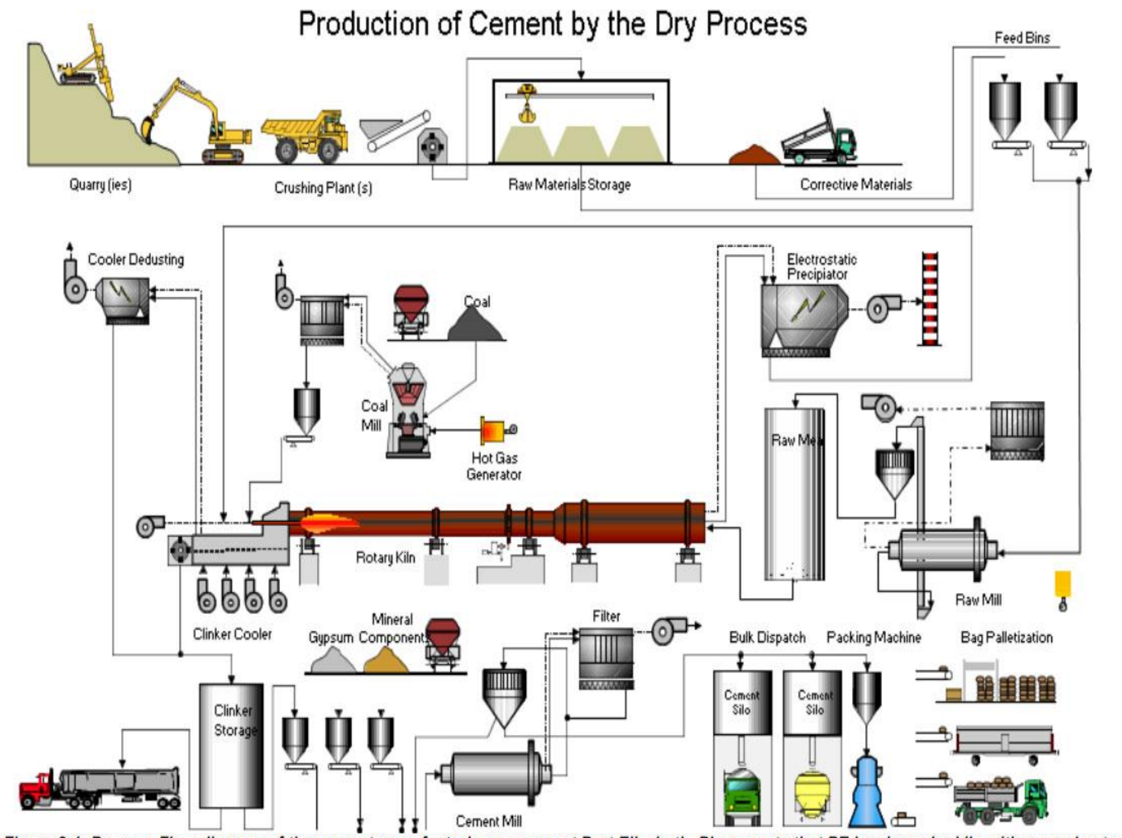

Figure 2-1: Process Flow diagram of the cement manufacturing process at Port Elizabeth. Please note that PE has long dry kiln with no preheater stage.

Figure 2. The Cement Production Flow Sheet By the dry process [3]

3. Types of wastes generated from cement industry

Solid Wastes:

In cement manufacturing mainly, solid waste includes clinker production and spoil rocks, which are removed from the raw materials during the raw metal preparation. Kiln dust and fly ash from power plant also included in solid waste. Deposit of dust in open area cause land degradation and also deposits over plant leaves. Another waste is generated from plant maintenance like used oil and metal scrap. Mostly these wastes are disposed of by landfill in the open air which causes several respiratory diseases.

In the cement industry emission of particulate matter (PM) is among the most major impacts of cement manufacturing. PM emissions are associated with intermediate and final materials usage (crushing and grinding of raw materials) and storage, usage, and storage of solid fuel, moving of materials), and packaging activities.

Waste Water:

The rainwater which is contaminated at the lime mining site and cement plant should be directed to the wastewater treatment plant and should use for industrial process. Storm-water flowing through pet– coke, coal, and waste material stockpiles exposed to the open air may become contaminated with water streams. If storm-water does contact storage yard than it may indicate the presence of high value of sulfate in soil and toxic metals like Zinc, Lead and Chromium in the dust and high TDS value in groundwater.

Air Emissions:

Typically, 40% of the CO2 comes from fossil fuel combustion in the kiln process, about 50% is due to de-carbonation of limestone (CaCO3) to calcium oxide (CaO), and the remaining 10% is related to transportation and handling Therefore there should use controlling techniques to control the emission of flue gases.

Waste Fuels:
Coal and lignite are the most commonly used fuel in the cement industry. The main problem with high sulfur contents in the fuel is that its buildup on the rings in the kiln. Cement kilns, due to their strongly alkaline atmospheres and high flame temperatures (2000°C), are capable of using high calorific value waste fuels [(e.g. used solvents, waste oil, used tires, waste plastics, and organic chemical waste including polychlorinated biphenyls [PCBs], obsolete organ chlorine pesticides, and other chlorinated materials). If they are not controlled, it can lead to emissions of volatile organic compounds (VOCs), polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs), hydrogen fluoride (HF), hydrogen chloride (HCl), and toxic metals and their compounds. Fossil fuel and waste fuel cause significant emission of heavy metal such as lead, cadmium, mercury, etc. So, waste fuels emit more greenhouse gases than other waste.

Noise Pollution:
Noise pollution is an impact in the cement industry. Mainly noises happen in stone crusher, milling, kiln, cement conveyor, compressor rooms and other machine operating places. So, noise is a safety concern in the cement industry. Long term exposure to high levels of noise can lead to hearing loss.

4. Environmental Impacts

In the cement industry, there are some major environmental impacts that we can identify, such as solid waste, wastewater, flue gas, and noise. The cement industry requires a large amount of energy to use in the whole process and to generate this, non-renewable resources are required like fossil fuel. Even though some renewable resources use in some industries still a large amount of fossil fuel use for this process. So due to this matter, major impacts on the environment are CO_2, CO, NO_X, SO_X, and VOCs.

The emission of those gases to the atmosphere is not only causing environmental problems but also affect public health. Climate change, global warming, ozone depletion, acid rain, biodiversity loss, are reduced crop productivity, etc. [4]. Water is used at some stages in the cement production process. Wastewater discharge to the environment causes to contaminate water sources (rivers, groundwater sources).

Noise pollution occurs during the whole process of the cement production process. From preparing raw materials, from the clinker burning and production process, from material storage, the heavy machines large fans used in the process [5].

Particulate matters (PM10, PM2.5) are emitting from the production process of cement from extracting process to bagging and loading process and given in Table 1 [6].

The main problem from dust emission is reduced visibility and air quality and it contains toxic metal and compounds. When dust is washed it may pollute water and also cause harmful health effect to humans.

Table 1. Particulate matter emitting sources

Type	Generation mechanism
Raw material dust	Quarrying, crushing, and handling of raw material
Feed material	Dust feeding, milling, stacking, blending, reclaiming, conveying, and transferring of feed material
Cement kiln dust	Feeding and processing of materials involving countercurrent circulation of hot gases
Clinker dust	Cooling involving air circulation
Cement dust	Feeding, milling, bagging, loading

5. Discussion and Conclusion

In the cement industry, waste can be dividing as hazardous waste and non-hazardous waste. Now some cement industries are used co-processing and pre-processing as waste disposal procedure. Co-processing in cement kilns can be considered as one of the perfect methods to dispose of hazardous and non-hazardous waste as safe manner. Co-processing is a technology used for the thermal destruction of hazardous wastes. This process can be used to land filling and incineration, as it offers a complete solution without any waste.

Co-processing in the cement industry gives a safe and sound solution for the environment and the cement industry, for non-renewable resources with waste under controlled conditions. The kiln temperature of the 1800 °C at the high residual time represent the ideal conditions for virtually completing the destruction of any organic material [1].

Dust emissions in different ways, depending on the surface condition and has the capacity and speed of transportation. Dust emission pathways can be minimized by the following measures: frequent spraying of water, oil, or other materials on soil stabilization.

Air pollution caused by particulate matter (PM) is one of the major problems of environmental pollution. Proposed strategies to control and reduce pollution, create a fully equipped indoor dust filter holder for single packing. The dust filters improve performance, according to the retrieval and reuse of materials (especially waste).

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