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# The Dispersion of Heavy Metals in the Air, Soil and Wastewater of Sistan Cement Factory, South East of Iran

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**ABSTRACT ─** Cement industry is economic flourishing to the rapid population growth, the change in living style, and the availability of raw material in the Iran. But in line with these economic benefits, environmental damages resulted from this industry is inevitable; because the production of this material is such that many pollution are dispersed in the environment during different stages, which are mainly consisted of air, soil, and water pollutions. These practices can result in the release of toxic metals and organics. The present study aimed to investigate environmental effects of Sistan cement factory activities that is located in the South East of Iran. Our findings indicate that after the implementation of the proposed project, concentrations of heavy metals in waste water, soil and dust emitted from the electro filters system are found Less than the allowed range for environment quality. Therefore, the proposed activity is not likely to have any significant adverse impact on the environment in the vicinity of the proposed project.
**KEY WORDS:** Cement Industry, Environment, Pollution, Heavy Metals

## Introduction

One of the concerns about the growing progress of industries and factories in the present societies is environmental pollution. Human is the most effective and the most important factor in environmental changes. Factors such as increasing population, industrial development, the availability of natural resources and many other factors are proposed in environmental degradation (Isikli et al., 2003).The industries which are created for providing welfare of the society are considered as one of the factors threatening human life because of inattention and lack of observance of environmental issues (Bilen, 2010 and Shahrabi, 1995).
Air pollution due to industrial activities has been proved in the whole world. Heavy metals may also be present in the raw materials and fuel used and are released in kiln gases. Cement kilns, with their high flame temperatures, are sometimes used to burn waste oils, solvents, and other organic wastes (Al-Khashman, and Shawabkeh, 2006). The most important adverse effect of cement factories is dust dispersion and pollutant emissions. In fact, the cement factories pollute the air at first, then the Contaminations transferred from the air to the soil. Heavy metals has significant importance among other pollutants due to the serious adverse effect on the organisms of alive (Kragickova and Majestrik, 1984). The wastewater from industrial activities also plays the most important role in environmental pollution. Thus, implementation of environmental legislations and standards seem essential for improvement of regional situations (Cachier etal., 2005).

## Materials and Methods

To investigate environmental pollutions in this study, the efforts have been made during sampling from the soil to design a regular systematic sampling network as radial which is centered by Cement Factory; so that the samples will represent the entire of sampling area. In April, 2012, 5 soil samples were collected in the designated sampling points. Soil specimens were taken with a small plastic shovel from the upper5- 10 cm of the soil and stored into labeled plastic bag. Any large stones or foreign objects were removed. In the laboratory, the soils were dried for three continues days. All samples were sieved and after sieving, particles below 63 micron (mud fraction) were being dried, crushed and homogenized by agate mortar and stored until analytical procedures were carried out. ICP-OES analysis was used to determine the amount of heavy metals. To determine the quality of wastewater output, measure PH, DO, BOD, COD, TDS wastewater output of Sistan cement factory was done.

## Description of the study area

This research was conducted in South East of Iran. The study area is Sistan cement Factory, located at 65km of Zahedan- Zabol road and 13 km to the West. Sistan Cement Factory was founded in April 2009, in a land with area of 73.5 acres aimed to produce 1 million ton of gray cement. Given the above discussions and the importance of environmental studies, in the study tried to be assessed impact of environmental pollution this factory.

Table 1. The position of sampling areas

| Samples stations | Geographical Position | |
|---|---|---|
| Station 1: | 30°09'45.25"N | 60°05'22.15"E |
| Station 2: | 30°12'02.55"N | 60°04'17.33"E |
| Station 3: | 30°15'55.57"N | 60°07'40.45"E |
| Station 4: | 30°20'33.62"N | 60°05'12.15"E |
| Station 5: | 30°25'47.44"N | 60°08'25"48E |

**Results and Discussion**

**Air Emissions**

The impact of the atmospheric pollution on the ecosystems was demonstrated at several times. Zerrouqi et al, reported that the main impacts of the cement activity on the environment are the broadcasts of dusts and gases. These particles or dusts are very numerous and varied. There are basically two types of particles thus: primary particles that are cleared directly in the atmosphere and secondary particles that are formed in the atmosphere following chemical transformation. The particles can enter into soil as dry and humid deposits and can undermine its physiochemical properties (Hosker and Lindberg, 1982). Similar studies have revealed that atmospheric particles can lead to the reduction of biodiversity and the quality of goods and services offered by the ecosystems. Indeed, the dusts can be emitted at every stage of the manufacturing process of the cement production. A maximum emissions level of 50 milligrams per normal cubic meter (mg / Nm3), equivalent to a maximum of 0.2 kg /t of clinker, for particulates in stack gases under full-load conditions is to be achieved (Dolgner et al., 1983). This emissions level is based on values that are routinely achieved in well-run plants (Lin and Lee, 2004). Maximum emissions levels for sulfur oxides are 400 mg/ Nm3; for nitrogen oxides, 600 mg/ Nm3. Management's capacity to maintain the necessary operational and maintenance standards should be carefully evaluated. If necessary, training for plant personnel should be provided under the project (TRF, 2008). The EA and the prefeasibility or feasibility study should examine the effects of fugitive and stack emissions (including dust, sulfur oxides, and nitrogen oxides) on ambient air quality and implement measures to maintain acceptable ambient air quality levels (Molina et al., 2004 and Domingo, 1994).

**Liquid effluents**

Normally, effluents requiring treatment originate from cooling operations or as storm water. Treated effluent discharges should have a pH in the range of 6-9. Cooling water should preferably be recycled (Nejat Jahromi, 2009). If this is not economical, the effluent should not increase the temperature of the receiving waters at the edge of the mixing zone (or 100 meters, where the mixing zone is not defined) by more than 3o Celsius. If quantities of suspended solids in the effluent are high in relation to receiving waters, treatment may be required to reduce levels in the effluent to a maximum of 50 milligrams per liter (mg /1) (APHA, AWWA, WEF.2004). Note that the effluent requirements are for direct discharge to surface waters (Wang et al., 2002).
Tables 1and 2 summarize the concentrations of 5 heavy metals, in 5 soil samples and dust emitted from the stack collected in the Sistan Cement plant ,respectively. All the 5 elements display their presence in all the soil samples and dust emitted from the stack used for the study. Table 4 shows the qualitative factors of waste water Sistan sistan cement plant. The results show that despite 6 years of activity cement factory in the area, Fortunately, The study area non-polluted than heavy metals investigated.

**Soil pollution**

Studies revealed that changes in soil properties have been associated with environmental alteration resulting from human activity (Ibanga, 2008). Cement contacts the soil surface and its constituents usually alters the physical and chemical constituents of the soil. Cement has high carbonate content, the dust tends to be highly alkaline. Therefore, it is revealed that soil contaminated by cement will have high pH. The biological, physical and chemical properties of soil, such as water content, electrical conductivity, and pH, were all found to be affected when treated by raw materials of cement (Khan, 1996). The determination of soil physical and chemical properties are very important parameters in monitoring environmental pollution (Adefila et al., 2004). Further emissions of the cement dust will bring about soil degradation. The highest level corresponded to Zn and Fe followed by Mn. The lowest level of metal was recorded for Cd and Mo (Bergman, 1992 and Chen et al., 2005) has shown that the toxic levels of Cr in soil is around 2-50 ppm. Meanwhile, the elemental concentrations in soil samples from five stations are in the decreasing order for station Zn>Fe>Mn>Ni>Cu>, station 2 Zn>Mn>Fe>Ni>Cu>, station 3 Zn>Fe>Mn> Cu> Ni, station 4 Zn>Fe>Mn> Cu> Ni, station 5 Zn> Fe>Ni>Cu> Mn, and the metals concentrations in dust emitted from the stack decreased in the sequence of Zn > Mn >Fe > Ni > Cu. So can say that the distribution of heavy metals in the soil around the cement plant dust emitted from the stack is the uniformity of the process. To determine the quality of waste water output, measure the PH, EC, TDS, DO, BOD, COD of the wastewater plant was performed and it was determined that with the exception of DO, other measured parameters, are less than standard discharge into surface waters. This subject indicates that the cement factory's output wastewater treatment system is fully capable of decreasing the contamination levels of output wastewater system to the standard levels in this factory.

Table 2. Heavy metal concentration in soil samples from Sistan Cement plant

| Heavy Metals | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 |
|---|---|---|---|---|---|
| Ni | 51.2 | 10.6 | 19.8 | 6.3 | 11.8 |
| Zn | 78.1 | 68.6 | 80.2 | 44 | 38 |
| Mn | 63.5 | 34.2 | 54 | 26 | 7.1 |
| Cu | 44.6 | 2.1 | 33.1 | 10.1 | 7.4 |
| Fe | 73.1 | 18.5 | 78.7 | 32.1 | 21.1 |

Table 3. Heavy metal concentration in dust samples emitted from the stack Sistan Cement plant

| Heavy metals | Ni | Zn | Mn | Cu | Fe |
|---|---|---|---|---|---|
| Amounts | 103.1 | 168 | 141.2 | 36 | 113 |

Table 4. The results of measuring qualitative factors of waste water Sistan Cement plant

| BOD | COD | DO | TDS | EC | PH |
|---|---|---|---|---|---|
| 30.5 | 60 | 10.57 | 5.4 | 8.1 | 8.3 |
| Standard limit: 30 | Standard limit: 60 | Standard limit: 2 | Standard limit: - | Standard limit: - | Standard limit: 6.5-8.5 |

## Conclusion

Due to infrastructure developmental activities cement industry is flourishing and resulting in the environmental deterioration and in turn degradation of the human health worldwide. The gaseous and particulate emissions from cement plants are degrading air quality and thus creating considerable environmental pollution. Recent studies and researches have listed the cement industry as one of the major contributor in global warming and climate change. Literature reviewed in this study shows the clear picture of dire consequences of emissions from cement manufacturing for rapid infrastructure growth and economic development. From this review it can be concluded that cement industry causes a tremendous harm to ecology and human health. The main environment and health concerns have identified are significant amount of fine dust and gaseous emissions. Gaseous emissions can have major impact on surroundings and ecology resulting in deteriorated environment. For then sustainable development it is recommended to focus on effective emission control technology, energy efficiency, adoption of state of art technology and global synergy in environment friendly technologies. The key production and control practices that will lead to compliance with emissions guidelines can be summarized as follows:

Give preference to the dry process with preheaters and proclaimers.

Adopt the following pollution prevention measures to minimize air emissions;

1. Install equipment covers and filters for crushing, grinding, and milling operations.
2. Use enclosed adjustable conveyors to minimize drop distances.
3. Wet down intermediate and finished product storage piles.
4. Use low-NOx burner with the optimum level of excess air.
5. Use low sulfur fuels in the kiln.
6. Operate control system to achieve the required emissions levels.

Develop a strong unit or division to undertake environmental management responsibilities.

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