MJS, Vol. 5, No. 1, January - June 2006, pp. 38-46
ISSN 0975-3311
https://doi.org/10.12725/mjs.8.5

# IMPACT OF HAZARDOUS INDUSTRIAL WASTE ON HEALTH AND ENVIRONMENT

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## ABSTRACT

*From the days of primitive society, human and animals have used the resource of the earth to support life and to dispose waste. Rapid population growth and uncontrolled industrial development are seriously degrading the urban and semi-urban environment in many of the developing countries placing enormous strain on natural resources and undermining efficient and sustainable development. Industrial operations leads to considerable generation of hazardous waste and in rapidly industrializing countries such as India the contribution to hazardous waste from industries are largest. Hazardous waste generations from industries is also critical due to their large geophysical spread in the country, leading to regionwide impacts. Due to liberalisation policy the pace of industrialization has been accelerated, which has resulted in increasing amount of hazardous waste every year. This along with a growing amount of municipal solid waste due to rapid urbanization and inadequate policy and technological measures*

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*continues to remain a daunting issue of environmental concern to India. In this scenario the present paper discusses various aspects of hazardous industrial waste like its origin, distribution and environmental and Health hazards. Hazardous waste from industrial sector contains heavy metals, pesticides, radioactive materials and other chemicals, which are toxic, flammable, reactive, corrosive or have explosive properties. Normally Arsenic, Cadmium, Chromium, Copper, Lead, Zinc, Boron etc are found in pulverized fly ash. Cement industries emit huge quantity of fluoride into the environment. Large quantity of mercury emitted from caustic soda industries using mercury electrodes, from chemical industries, paper and pulp industries etc. Tin mines emit tin in the vicinity of the mines. The metals such as Cadmium, Lead, Chromium, Arsenic etc, if present in the body, are hazardous to the health. Presence of fluoride within the range of 0.5 to 1.5 ppm is very essential in water for the health, if present in excess leads to Florosis. Fluoride may cause harm not only through water but also through air by way of respiration and soil. In river estuaries, the concentration of metal traces will reach to a high degree of contamination because of stagnant water, when industrial effluents are fed into rivers and streams. This paper throws light upon many more such factors and also suggests measures to control and manage hazardous waste.*

## What is Hazardous Waste?

The term hazardous substance or hazardous waste is difficult to define. But to formulate and apply the appropriate disposal standards to such materials a clear definition is necessary. Environmental Protection Agency (EPA) defines "any waste or combination of wastes of a solid, liquid, contained gaseous, or semisolid form which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or (b) pose a substantial present or potential hazards to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed".

The EPA also defined hazardous materials in two ways; (1) the chemical listed as hazardous materials, or (2) the material fails in one of six tests that then define it as a hazardous material. The listing includes specific chemicals such as chlorinated pesticides, organic solvents and 50,000 others. The six tests used to define a hazardous material are:

1. Radioactivity - should not exceed maximum permissible concentration level as per Nuclear Regulatory Commission.

2. Bioconcentration - This criterion captures many chemicals such as chlorinated hydrocarbon pesticides.

3. Flammability - This standard is based on the National Fire Protection Association test for how easily a certain substance will catch fire and sustain combustion.

4. Reactivity - This test is based on how fast a substance will react with other. For example chemicals such as sodium are extremely reactive with water.

5. Toxicity - This criteria based on $LD_{50}$ (lethal dose 50), or that dose at which 50% of the test species (e.g., rats) die when exposed to the chemical through a route other than respiration. Inhalation and dermal toxicity, where $LC_{50}$ is the lethal concentration resulting in 50% mortality during an exposure time of 4 hours.

6. Genetic, carcinogenic, mutagenic and teratogenic potential - These are measured by the standard developed by the National Cancer Institute.

Hazardous waste can be classified into :

- Industrial waste
- Hospital (Bio-medical) waste
- Agricultural waste
- E-waste
- Radioactive waste.

In the present paper we would like to concentrate mainly on the impact of Hazardous Industrial Waste on health and environment.

## Introduction to Industrial waste

Detection of traces of toxic chemicals in drinking water supplies, in polar ice caps, groundwater sources and episodes such as those in Minamata Bay, Japan and Love Canal, USA have focused the attention of the public worldwide on the risks posed by inappropriate disposal of hazardous waste and accidental release of toxic chemicals into the environment. Though hazardous waste rules were introduced in 1989, the response towards their implementation has not been very effective. Due to liberalisation policy the pace of industrialization has been accelerated, which has resulted in increasing amount of hazardous waste every year. This along with a growing amount of municipal solid waste due to rapid urbanization and hospital waste (Bio-medical waste) due to inadequate policy and technological measures continues to remain a daunting issue of environmental concern in India. Industrial operations lead to considerable generation of hazardous waste and in a rapidly industrialising country such as India the contribution to hazardous waste from industries is largest. Hazardous waste generation from industries is also critical due to their large geographical spread in the country, leading to regionwide impacts. The annual growth in hazardous waste generation can be directly linked to industrial growth in the country. States such as Gujarat, Maharashtra, Tamil Nadu and Andhra Pradesh, which are relatively more industrialised, face problems of toxic and hazardous waste disposal far more seriously than less developed states. The major hazardous waste-generating industries in India include petrochemicals, pharmaceuticals, pesticides, paint and dye, petroleum, fertilisers, asbestos, caustic soda, inorganic chemicals and general engineering industries such as cement, steel, glass etc. Hazardous wastes from the industrial sectors mentioned above contain heavy metals, cyanides, pesticides, complex aromatic compounds (such as PCBs), and other chemicals which are toxic, flammable, reactive, corrosive or have explosive properties. The first few attempts to quantify hazardous waste generation established by the Organization for Economic Cooperation and Development (OECD), reported the generation of hazardous waste about 0.3 million tonnes per annum in 1984. World Bank estimates place this at approximately 4 million tonnes per annum for the year 1995.

## Sources

A report reveals the fact that in total, around 7.2 million tonnes of hazardous waste is generated in the country of which 1.4 million tonnes is recyclable, 0.1 million tonnes are incinerable and 5.2 million tonnes is destined for disposal on land (MoEF 2000). Studies conducted by MoEF through respective SPCBs says till 24th March 2000 in Maharashtra had maximum number of about 3953 industrial units generates 200784 TPA of hazardous waste in which 847436 TPA recyclable, 5012 TPA incinerable and 1155398 TPA disposable. Karnataka had about 454 industrial units which produce 47333 TPA recyclable, 3328 TPA incincerable, and 52585 TPA disposable type waste. These units produce hazardous waste about 103243 TPA. (Total of recyclable, incinerable and disposable will not add up due to waste sold or otherwise disposed)

**Sources and quantum of waste generated from major industries**

| S.No. | Waste | Quantities (MTPA) | | Source/Origin |
|---|---|---|---|---|
| | | 1990 | 1999 | |
| 1. | Fly Ash | 30.00 | 58.00 | Conversion of pig iron to steel and manufacture of iron |
| 2. | Lime Sludge | 3.00 | 4.8 | Sugar, Paper, Fertilizer, Calcium Carbonate industries |
| 3. | Phosphogypsum | 4.5 | 11.00 | Phosphoric Acid Plant, Ammonium Sulphate |
| 4. | Red Mud/Bauxite | 3.0 | 4.0-4.5 | Mining and Extraction of Aluminum from Bauxite. |

**Source:** National Waste Management Council - Ministry of Environment and Forest.

As per the information provided by the MoEF, there are 323 hazardous waste recycling units in India, and of these 303 recycling units use indigenous raw material while 20 depend on imported recyclable wastes. The status of hazardous waste imported for recycling and recovery of mostly metallic constituents in country is presented in Box. The major types of hazardous waste imported by the country include battery scrap, lead and zinc dross, ash, skimming and residues and galvanised zinc.

Apart from the waste generated from our own industries, developed countries illegally shipping the hazardous waste to India in thousands of tonnes every year (Anjello and Ranawana, 1996) (Agarwal 1998). In 1995 Australia exported more than 1450 tonnes of hazardous waste like scrape lead batteries, zinc and copper ash to India. Huge quantity of PVC waste is still exported to Asian countries despite an international agreement (Greenpeace 1998). A Greenpeace analysis of Indian foreign trade date says at least 1127 tonnes of Zinc ash were imported from USA since May 1996. Some 569 tonnes of lead battery waste were brought in through main sea port of Bombay between October 1996 and January 1997. About 40000 tonnes of broken Lead batteries were imported during 1996.

In Maharashtra, Thane-Belapur industrial area there were about 1200 industrial units, produce 100 tonnes of solid waste every day. About 85% of which is either acidic or alkaline. This area produce wastes contains halogen, which is difficult to treat. The sediment of Ulhas river is polluted due to disposal of waste from this industrial area. (Shankar, Martin, Bhatt and Erkman 1994).

In Ahmedabad-Vadodara-Surat industrial belt has over 2000 large scale industrial units and more than 63000 small scale units manufacturing chemicals like soda ash, dyes, yarns and fertilisers. Vapi in Valsad district has around 40 polluting industries. Industries in all these area usually dump their waste in low-lying areas within 2 km radius which is in the banks of river Ganga. Indian Petrochemical Corporation limited (IPCL) at Vadodara dumps about 1800 tonnes of hazardous waste every month at site near Nandesari. This dump site is on the hill and during rainy season the hazardous constituents if these waste are washed down into the river (Shankar, Martin, Bhatt and Erkman 1994).

In Wazirpur industrial estate and Shahadhra-Maujpur industrial estate as well as along the Grand Trunk Road at Delhi, small and tiny scale industries processing non-ferrous metals such as copper, brass, aluminium as well as steel rolling mills were dumping their heavy metal rich effluent and acids into open cess polls and drains. This had led to percolation of effluent deep into the ground water table and makes water unfit for potable purpose.

During 1988-89, M/s Silver Chemicals and Jyothi Chemicals at Bichhri in Rajastan were producing around 375 tonnes and 20 tonnes of H-acid (a naphthalene sulphonic acid) respectively. This results in some 8250 cu mts of wastewater and some 2400 to 2500 tonnes of processed sludge. The wastewater flowed through Udaisagar canal across the entire region while the rainwater washed the sludge across the soil and into the ground water. An official survey indicated that the ground water upto 70 feet below the ground level had been contaminated over an area of 7 sq Km affecting 8000 people in seven villages. The NEERI report to the extent of contamination in this area says that an amount of Rs. 4 crore will be needed to reverse the process of soil and ground water contamination.

Improper storage, handling, transportation, treatment and disposal of hazardous waste results in adverse impact on ecosystems including the human environment. When discharged on land, heavy metals and certain organic compounds are phytotoxic and at relatively low levels can adverserly affect soil productivity for extended period of times. For example, uncontrolled release of chromium contaminated wastewater and sludge resulted in contamination of aquifers in the North Arcot area of Tamil Nadu. These aquifers can no longer be used as sources of freshwater. Discharge of acidic and alkaline waste affects the natural buffering capacity of surface waters and soils and may result in the reduction of a number of species.

Pulverized coal fly ash is one of the major byproduct of thermal power plants, which is produced, in a huge quantity. The chemical composition depends upon the geological features of its origin. Normally Arsenic, Cadmium, Chromium, Copper, Lead, Zinc, Boron etc. are found in pulverized fly ash. Rayachure power plant in

Karnataka utilize about 21,000 MT of Coal per day and 40% of that i.e. about 8200 MT of pulverized fly ash it produce every day. (Vijaya Karnataka 20th September 2004).

In metal extraction industries, it is not possible to remove 100% metal from its ore. The waste produced; after the metal is removed from its ore contains high concentration of metal compared to the natural soil. In our country there are 400 lead smelting industries. It is reported that in the vicinity of these industries average lead concentration is about 40.80 ppm. Cement industries emit huge quantity of fluoride into the environment. Large quantity of mercury is emitted from caustic soda industries using mercury electrodes, from chemical industries, paper and pulp industries etc. Tin mines emit tin in the vicinity of the mines. It is reported that in Malaysia 0.0022 to 0.025 ppm of tin is found in 22 pools around tin mines (Romero et al. 1993).

## Distribution of Toxic Waste and Its Effects

When the toxic gases and metal vapour are discharged into atmosphere, it is carried by wind for a long distance. Then it is deposited on the plants and water bodies. Once these toxic metals are deposited on the ground, they react with oxygen and water, leached out and accumulated on topsoil. Due to this the entire soil chemistry and subsequent change in the nature of soil will take place. Plants and animals require only some of the trace metals such as Iron, Calcium, Magnesium etc, to their metabolic activities. The metals such as Cadmium, Lead, Chromium, Arsenic etc, if present in the body, are hazardous to the health. Plants and some aquatic animals such as fish show the capacity to adapt to the changed environment for the certain extent. For example plants can extract only the harmless, required nutrients for their metabolic activities from soil and water. This can only be up to some threshold level of concentration of contamination. But mammals including man have no resistance towards the changed environmental conditions. Once the concentration grow above the upper limit, then these toxic elements starts accumulating in body of the habitat. Many mammals including man depend on plants and aquatic animals for their food. The toxic elements will enter the body of the mammals through the contaminated food and go on accumulating in the body causing metabolic imbalances and health hazards. Transportation of toxic elements from soil to plants to animals and man is a continuous process. Beyond certain limit these accumulated toxic metal traces cannot be eliminated from the body, which causes certain serious changes in body functions.

Studies show the fact that body contamination of lead and cadmium is much higher in case of city dwellers compared to others who are not exposed to (Hecker et al. 1974). Presence of sodium in excess quantity increases the salinity of soil and makes the soil less fertile/unfertile. Presence of fluoride within the range of 0.5 to 1.5 ppm is very essential in water for the health, if present in excess leads to Florosis. Fluoride may cause harm not only through water but also through air by way respiration and soil. Though, the plants show the capacity to resist the metal intake, when the concentration level increases about two to three times of threshold level, the visible damage will occur in the form of discolourization, colored spots etc on the leaves. Dosskey and Adriano (1993) reported that high concentration of Boron, Manganese, Lead, Cadmium etc would reduce the root growth up to 20 percent, smaller leaves with margin cuts and Necrosis. It is found that even metals like Aluminium around 87 mg/L reduces gill enzyme activity and accumulates even in fresh water invertebrates (Rosselend et al, 1990). Rai et al (1990) reported reduced biomass and intragenous activity due to increase in mercury and zinc concentration in river Ganga. Goh (1995) reported that 19 mg/l nickel cause 50 percent larva mortality.

In river estuaries, the concentration of metal traces will reach to a high degree of contamination because of stagnant water, when industrial effluents are fed into rivers and streams. During 1988-90 about 10000 birds and more than 7 million fishes died in still water lake at Navada, which was attributed to Arsenic and Boron induced diseases. In a study conducted by Andre and co-workers (1991) revealed high mercury concentration (about 80 mg/kg) in Dolphins from French Mediterranean. The lever tissues and muscles contained high concentration of mercury compared to other parts of the body.

Birds normally depend on fish for their food and their physiology is drastically affected if they consume heavy metal contaminated fish. These heavy metals consumed by the birds through fish start accumulating in various parts of their body. High level of lead in the body parts of the birds reduced their population by 44% (Harper and Hind Marsh, 1990). Benson et al. (1993) reported that selenium poisoning resulted in deformed embryos and unhatched eggs of hundreds of shore birds in Kesterton reservoir, California.

Plants and insects, physiology is closely interrelated with metal contamination, which cause change in mutation rate, growth rates and mortality. Deway (1973) collected a wide variety of insects in a kilometre area around aluminium plant and analysed for fluoride content. He reported 0.58 to 0.585 ppm in pollinator, 0.1 to 170 ppm for predators, and 21.3 to 255 ppm for foliar feeders. For such insects based on statistical calculation, he suggested a threshold concentration of 30 ppm of fluoride.

Excessive exposure to toxic metals will definitely result in severe toxic symptoms often leading to death. Morbidity such as Minamata disease, Itai-Itai disease, florosis, selenosis etc are associated with mercury, cadmium, fluorine, molybdenum and selenium respectively. The physiological impacts on man, when he is exposed to low-level toxic metals have not evaluated. There is no clear threshold concentration level for healthy exposure and establishment of this is a very difficult task. The health factors such as nature of chemical compound, exposure period, adsorption and retention time in the body, physical condition and age of the affected person.

## Conclusion

Indiscriminate disposal of hazardous industrial waste pollutes the air, water as well as soil. If once the concentration of pollutant reach above the threshold level it causes the serious health problems. Every industry gives out byproducts. It may or may not recyclable. Recyclable waste should be recycled which reduce the pollutant concentration. If the waste is not recyclable should be properly treated and then disposed off. Despite the New Delhi court order banning import of toxic material, thousands of tonnes of toxic waste is being imported to India for recycle and dumping. In our country only seven companies are licensed to do this business, but more than one fifty companies are involved in this. Therefore proper implementation of the law is very much essential to improve the situation of waste disposal. No doubt industrialization helps in total development of the nation, provided proper control and management of waste produced from industries is taken care of.

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