Leaching Behavior near MSW Management Plant and E-Waste Management Plant in Coimbatore

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Abstract

India generates the MSW and e-wastes regularly due to individual usage of total populations, industrialization. Improper dismantling of MSW and e-waste causes severe effects on health of human beings as well as surrounding environment. Electronic and electric devices are most dependent one in the day-to-day life. Though the advancement of the use of devices has increased, there is a major impact in their management / recycling systems. E-waste is non-biodegradable waste which causes harmful effects on humans and livestock. E-waste consists of heavy metals like cadmium, chromium, zinc, nickel etc. leaching into soil and water, causing acidification and geochemistry changes. Dumping of e-waste affects the soil fertility and pollutes the ground water and flow of the polluted water will cause irreversible harm to health on human beings and it leads to mental disorders.

This study focuses on identification of concentration of heavy metals and chemical characteristics in leachates and ground water samples near garbage management plant, Vellalore and e-waste management plant, Thadagam, Coimbatore. Heavy metals concentrations are higher near e-wastes management plant than that of MSW plant. The dilutions and dispersions of heavy metals from MSW and e-waste plant form colloids which will transport to groundwater. Considering the threat seriously, public needs to have awareness of segregation of MSW and e-wastes. Environment engineers have to identify the ways to recycle the MSW and e-waste efficiently and professionally.

Keywords: E-waste, MSW, Leachates, Groundwater, Characteristics study, Heavy metal concentration.

Introduction

High amount of hazardous e-waste is generated globally as well as in India due to high usage of electrical, electronic appliances and devices. According to the Hazardous Waste management rules and Global market report 2020, MSW incineration (MSWI) has advantages like volume and mass minimization and power generation.[5] Nevertheless, the concentration of heavy metals like Cd, Cr, Pb, Cu, Ni, Zn, As and Hg from MSW incinerators is a matter of concern.[2,16] People responsible for the improper disposal and non-technical ways of management of e-waste and MSW are punished under the law as per Central Pollution Control Board.[11] Electronic and electrical devices play a major role in daily activities of the world population. These electrical and electronic devices reduce the physical efforts in day to day work with effective results.

The advancement of electronic devices results in huge e-waste generation.[8,12] E-waste affects human health and also reduces soil fertility. These issues happen due to the presence of heavy metals in large amount which affects environment badly.[1] In the present scenario, the electronic waste recycling is one of the peak businesses in many countries.[15] By proper management of wastes such as reducing, reusing, recycling and proper sanitary landfill method of disposing, health problems can be addressed, greenhouse gas emission can be reduce and new jobs can be created.[4,14] The recycling is carried out by sorting, dismantling and recovery of valuable materials which is achieved through refurbishing and reuse.

Refurbishing means recycling to recover the metals, valuable metals and various nonmetals from whole electronic or from one of its components.[3,7] Some of them emit hazardous characteristics as well and they must be properly managed. Dumping/storage of e-wastes polluted the soil; ground water and can affect the atmosphere while processing.[9] Heavy metals are widespread pollutants originating primarily from industrial wastes.[6] The developing countries are facing huge challenges in the management of MSW and e-waste.[13] As like developed countries, India also implements strict legislation mandating electronic manufacturers and importers to take-back used electronic products at their end-of-life. Improper recycling practices of MSW and e-wastes are highly polluting the environment if the non-engineering practices are used for only material recovery activities.[10]

The project focuses on the analysis of physical, chemical characteristics and heavy metals concentrations like cadmium, chromium, zinc and nickel dissolved in both the leachate and ground water samples which have been sampled from the Municipal solid waste management plant Vellalore, Coimbatore and near e-waste management plant, Thadagam, Coimbatore, Tamilnadu.

Material and Methods

The methodology followed for sampling and analysis of samples is shown in figure 1.

Site selection and sampling method: The leachates and ground water samples are collected from sampling locations 1 (Vellalore, Coimbatore) and 2 (Thadagam, Coimbatore).

Figure 2 and figure 3 show the map and photographic view of sampling location 1 respectively. Sampling location 1 is a municipal solid waste management plant. Similarly, the map and photographic view of sampling location 2 are shown in figures 4 and 5 respectively which is a dump yard near e-waste management plant, Coimbatore. Three leachate samples were collected as grab samples. Three ground water samples were collected from bore wells near sampling stations each 0.5km apart. Sampling is carried out every two weeks for three months duration.

Laboratory investigation: Physical and chemical analyses were performed with a known volume of each of the sample according to standard methods for the examination of water samples. The samples were analyzed for pH, turbidity, electrical conductivity, chloride content, COD, DO, BOD and heavy metals concentrations (Cadmium, Chromium, Zinc and Nickel). Atomic absorption is the recent practice for detecting the concentration of metals and metalloids in environmental samples. Using Atomic absorption spectrophotometer, the quantitative determination of heavy metals concentrations was carried out by utilizing the absorption of optical radiation.

Results and Discussion

The physical and chemical characteristics of leachate and groundwater samples near sampling location 1 (Vellalore, Coimbatore) and 2 (Thadagam, Coimbatore) are determined and listed in table 1. From table 1, it can be seen that the pH values of all the samples fall below 6.5 and do not lie in the permissible limit. The turbidity values of both leachate and ground water samples exceeded the permissible limit of 10 NTU. Similarly, all the samples exhibited high conductivity values. The other characteristics namely chlorides, COD, dissolved oxygen and BOD exceeded the permissible limits in both the leachate and ground water samples.

The ground water and leachate samples collected from the sampling locations were tested for the concentration of heavy metals namely cadmium, chromium, zinc and nickel and the results are reported in table 2.

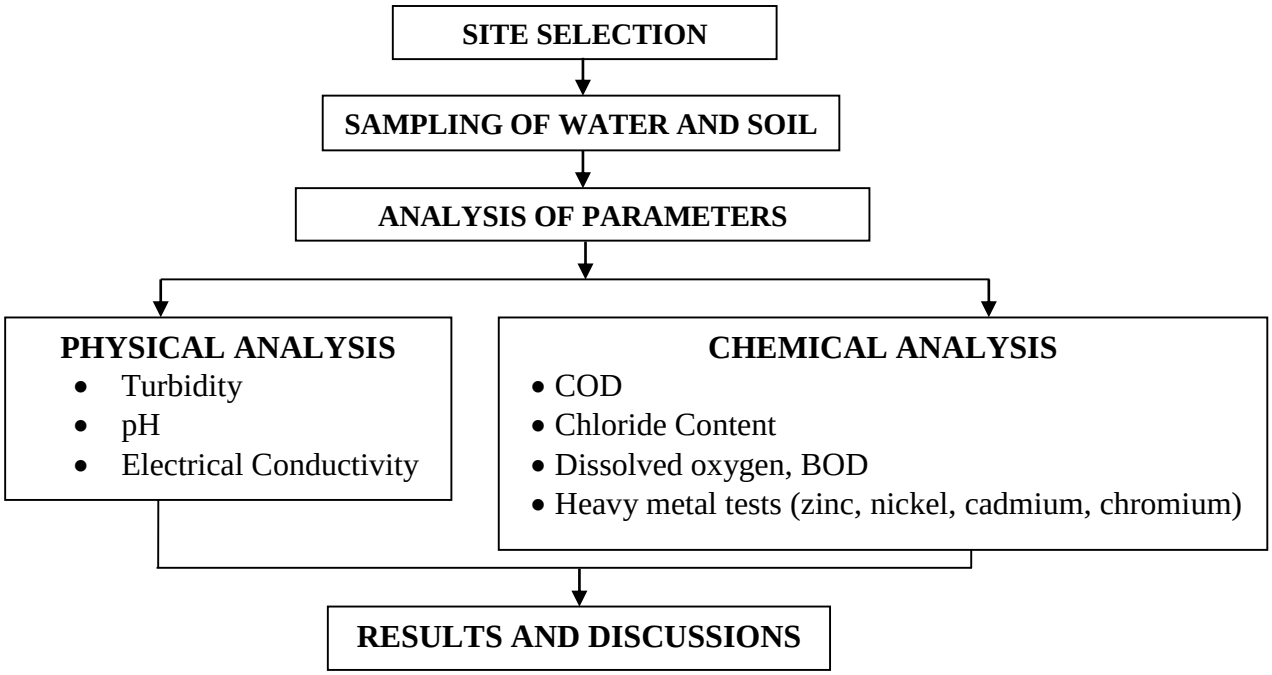

Fig. 1: Methodology

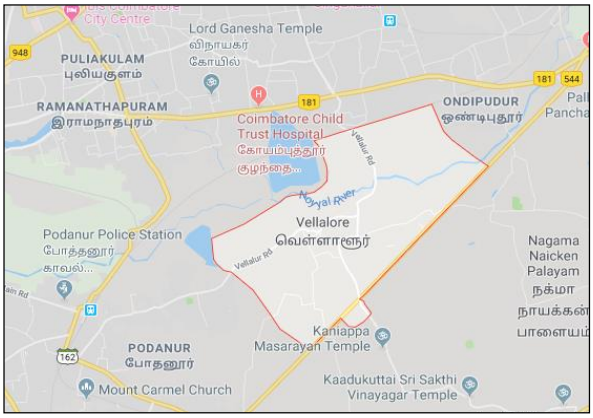

Fig. 2: Vellalore, Coimbatore

Fig. 3: Municipal solid waste management

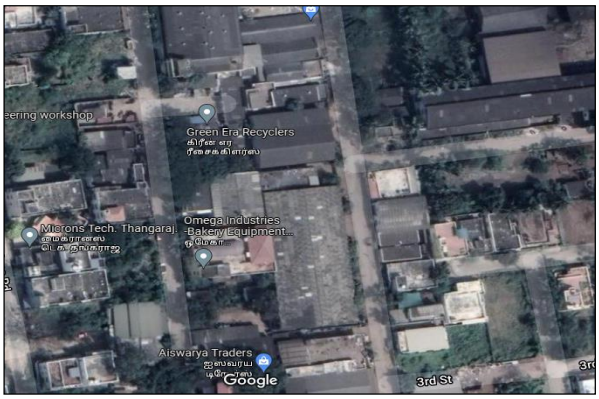

Fig. 4: Thadagam, Coimbatore

Fig. 5: E-Waste management plant

Table 1
Physical and Chemical characteristics of Leachates and Groundwater samples near both sites

Characteristics	Leachate Sample		Ground Water Sample	
	Municipal solid waste	E-waste	Municipal solid waste	E-waste
pH	6.11	5.57	6.2	5.8
Turbidity (NTU)	16.1	14.8	10.5	11.2
Electrical conductivity (Ωm)	0.079	0.049	0.019	0.234
Chlorides (g/l)	0.4	0.5	0.4	0.9
COD (mg/l)	3.6	4.8	2.3	4.09
Dissolved Oxygen (mg/l)	5.52	4.89	6.3	5.9

Table 2
Concentration of Heavy Metals in Leachate and Groundwater samples

Heavy Metal	Concentration of Heavy Metals (mg/l)				Permissible limit as per WHO (mg/l)
	Leachate		Ground Water		
	MSW Plant	E-waste plant	MSW Plant	E-waste plant	
Cadmium (Cd)	0.067	0.8	0.081	0.16	0.003
Chromium (Cr)	0.003	0.048	0.02	0.3	0.1
Zinc (Zn)	0.9	2.1	1.2	5.7	3
Nickel (Ni)	0	0.04	0.01	0.25	0.1

As far as the leachate samples are considered, samples from both the locations contained cadmium more than the permissible limit. The chromium levels in leachate samples from both the locations fell within the WHO standards whereas the chromium level in the ground water sample collected near E-waste plant exceeded the limit. The amount of zinc in the ground water sample collected near E-waste plant alone exceeded the limit whereas the amount of zinc in the other three samples fell within the limit. Similar trend was observed for nickel also. The groundwater sample collected near the E-waste plant was found to be highly contaminated with chromium, zinc and nickel.

Conclusion

Detection of high amount of hazardous metals in the waste material confirms that e-waste creates big issues to the environment compared to MSW. Based on the result, leachate and ground water near e-waste plant are slightly acidic in nature. The concentrations of heavy metals chromium, nickel and zinc are very high in E-waste as per WHO standards whereas cadmium concentration is high in the water samples from E-waste and MSW plant. Hence, it affects fauna and ground water dependent ecosystem.

Ground water near MSW Plant and E-waste management plant was to be treated with adsorption, electrocoagulation etc. The best way to process the E-waste for material recovery can be done through electrolysis, osmosis, electrolytic recovery, condensation, filtration and centrifugation. The other special techniques used are Incineration and landfilling.

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