Review Article

Physical Characterization of Battery Slag Leachate

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Abstract

Heavy metals in the environment can be hazardous for the health and most living species. Before discharge into environment these pollutants should be removed from industrial wastes. In the present study, we had measured the physical pollutants in battery slag leachate. The solid waste was converted into leachate. The physical parameters namely Appearance, Colour, Turbidity, TDS, TSS, EC, BOD and COD, were also measured. It was concluded that the solid slag had more organic and inorganic pollutants. It may be hazardous for human health. Lead is one of the most common pollutants in the world and considerable amounts of lead have accumulated in soils due to anthropogenic activities in the past few decades. This metal is potentially toxic; therefore the characterization of its behavior in industrial waste is essential.

Keywords: Pollutants, Battery, Slag, Leachate.

INTRODUCTION

Rapid industrialization in developed and developing countries has led to a substantial increase in the generation of industrial solid wastes. These wastes are a great concern to health scientists all over the world. The presence of these wastes in the environment may affect not only particular species of flora and fauna, but also the structure and function of entire ecosystems [Fent, 2003]. During the last few decades, the amount of industrial waste has quadrupled in India, and the total includes considerable quantities of hazardous waste [TERI, 2003]. The most common method for the disposal of solid waste is by deposition in landfills, and the leachates generated from the landfills can escape and contaminate the surrounding area, posing a risk to the biota. Solid wastes generated by some industries are hazardous because they contain heavy metals [Seco *et al*., 2003].

The release of heavy metal ions into environment by industrial activities is a serious problem because they are non-biodegradable and tend to circulating and accumulating throughout the food chain. The term 'heavy metal' can be defined in different ways; one is that the metal has a higher density and can have a potential toxicity even if it has a lower concentration (Podkoscielny *et al.,* 2004). Rapid industrialization and urbanization have resulted in elevated levels of heavy metals in the biosphere (Lu *et al.*, 2004). Toxic levels of some heavy metals appear as a result of environmental pollution due to removal from mining, automobile traffic, smelting, manufacturing and agricultural wastes (Oncel *et al*., 2000).

Battery industries discharge mostly inorganic pollutants containing heavy metals like lead. It is, therefore, essential to remove or reduce the presence of these inorganic contaminants in order to diminish the possibility of uptake by animals, plants, and humans and eventual accumulation in the food chain and also to prevent them from contaminating surface and groundwater by dissolution or dispersion (Kabata-Pendias 2001; McLaughlin *et al*., 2000).

Batteries may be hazardous wastes because they contain heavy metals and corrosive electrolyte solutions that are the source of their energy. Each battery contains lead and corrosive sulfuric acid solution. Smaller sealed lead-acid batteries have been used in cellular telephones and computers. Lead, is a soft malleable poor metal, has a bluish white colour; however, it loses its brightness when it is exposed to air. The primary industrial sources of lead (Pb) contamination include metal smelting, secondary metals production, lead battery manufacturing, chemical manufacturing, and lead-contaminated wastes. Lead released to surface water, groundwater and land is usually in the form of lead oxides, elemental lead and hydroxides, and lead metal oxyanion complexes (Smith *et al*., 1995).

Open dumps are the oldest and the most common way of disposing of solid waste and although in recent years thousands have been closed, many still are being used. In many cases, they are located wherever land is available, without regard to safety, aesthetic degradation and health hazard. The waste is often piled as high as equipment allows. In some instances, the refuse is ignited and allowed to burn. In others, the refuse is periodically leveled and compacted. O pen dumps tend to create a nuisance by being breeding pests, unsightly, creating a health hazard, polluting the air and polluting groundwater and surface water (Keller, 1982).

Therefore, this study presents data on the level of physical parameters of leachate from solid slag. These aspects have not previously been studied and will have significant importance in evaluating the factory's impacts on the environment and efficiency of the treatment plant of the factory. It may also initiate other scholars to conduct further studies.

MATERIALS AND METHODS

Collection of battery slag

The Battery slag was collected from Industrial area near kuruchi, Coimbatore, Tami Nadu. Leachates were prepared by following the European Committee for Standardization (1998).

Characterization of the Battery slag Leachate

Physical parameters such as Appearance, Colour, Turbidity, TDS, TSS, EC, BOD and COD, concentration of the leachate were studied using Standard method (APHA,2005).

Sample preparation for heavy metal analysis

An approximate amount of 1 g of solid slag was digested with 10 ml of 1:1 nitric acid at 95 ± 5 °C and reflux for 10-15 minutes and cooled, whereas the digestion of 1 g distilled water was performed as sample blank. 5 ml of concentrated nitric acid were added and refluxed for 30 minutes (thereafter, nitric acid is repeatedly added until no brown fume was observed). Samples were heated continually until they were about 5ml in volume and then left for cooling. Other additions were 1.0 ml of distilled water, 3 ml of 30% H_2O_2 which were carefully heated to protect the sample loss during reaction and. Addition by 1 ml of 30% H_2O_2, but not more than 10 ml of total volume, were done repeatedly. Heating was done continuously until 5 ml of samples was received and digested by 10 ml of HCl for 15 minutes. Samples' volume was finally adjusted to 100 ml.

RESULTS & DISCUSSION

Urbanization and industrial development in the developing countries during the last decade have provoked some serious concern for the environment (Reza and Singh, 2010). Human activities such as intensive agriculture, urbanization and industrialization contribute to river water deterioration (Cachada *et al*., 2012). The battery slag collected was assessed for its physical properties and its toxic metal levels were also determined.

Physical Characteristics of the battery slag leachate

As evident from Table 1, it is clear that the leachate from the battery slag leachate was brownish black in colour . The photosynthesis activity is found to be reduced due to dark coloration also affecting other parameters like temperature dissolved oxygen and biological oxygen demand etc.

Table 1: Physical Characteristics of the battery slag leachate

Parameters	Battery Slag Leachate	FEPA's standards*
Appearance	Turbid	NM
Color **(pt.co-scale)**	Brownish black	NM
Turbidity NT units	8.03±0.05	NM
Total dissolved solids mg/**L**	3,530.6±0.57	2,000
Total suspended solids mg/L	290.3±0.57	30.0
Electrical conductivity Micro mho/cm	10.4±0.17	2.25
BOD_5 at 20°C (mg/L)	280.3±0.57	50.0
COD(mg/L)	468.4±0.52	400.0

Values are mean ± SD of three samples

BOD_5. Biological oxygen demand analysed on the 5th day

*Federal Environmental Protection Agency (FEPA) (1991).

NM - Not mentioned

The total dissolved solids found in solid waste leachate is listed in table 1 and ranged as 3,530.6 mg/l. All dissolved solids are ions. TDS is anything other than the pure H_2O. TDS is sum of the cations and anions concentration. High levels of TDS will result in excessive scaling in pipes. Low levels of TDS may be unhealthy for plants and fish. The measurement of TDS in water is also extremely important for certain pharmaceutical, industrial, manufacturing, medical and agricultural applications. A large number of solids are found dissolved in natural waters, the common ones are bicarbonates, carbonates, chlorides, phosphates, sulphates and nitrates of calcium, magnesium, sodium, potassium and iron (Maiti, 2004).

Levels of total suspended solids (TSS) found in the leachate (290mg/l) were greater than that of the permissible limit (30 mg/l). Treatment of textile waste water using cyanobacterium *Spirulina platensis* **(**Sivakalai and Ramanathan 2013) resulted in the significant reduction of TSS which supports the present study.

In the present study electrical conductivity of leachate is 10.4 Micro mho/cm which is higher than the BIS limit. Electrical conductivity is caused due to the presence of electrolytes which dissociate into cations and anions (Mohabansi *et al*., 2011). The conductivity of the water is one of the important parameter used to determine the suitability of water for irrigation. Conductivity is a good and rapid method to measure the total dissolved ions and is directly related to total solids (Bhatt *et al*., 1999).

BOD is the amount of organic matter in the water and the amount of oxygen required by the micro organisms to stabilize the biologically decomposable organic matter in wastes under aerobic conditions (Bhalli and Khan, 2006). The BOD concentration of leachate in this experiment is 280.3 mg/L. High BOD value recorded in leachate is an indication of high level of pollution which could result in high biodegradation activity by microbes. The presence of high BOD and COD values indicates the organic strength of the sample taken for analysis (Zgajnar Gotvajn *et al*., 2008).

Chemical oxygen demand (COD) is the test used to measure pollution of domestic and industrial waste (Chavan and Wagh, 2005). It is the amount of oxygen required for the oxidation of inorganic matter using a strong chemical oxidant. COD is tested to determine the degree of pollution in the effluent samples (Bhalli and Khan, 2006). The COD concentration of leachate in this experiment is 468.4 mg/L.

CONCLUSION

Even though each year over 90 % of used automobile batteries are being recycled, the lead content in these used batteries has never been 100 % reclaimed. No economical technology has been developed to clean up this highly lead-contaminated solid waste (~ 22 % in lead). The current method of disposing this lead solid waste is to bury it in a designated remote area. This method of disposing such solid waste is not a positive approach to solve the environmental problem. Different sizes of the solid waste may provide valuable technical information to the battery recycling industries for reclaiming the lead from this solid waste. Overall findings indicated that the urgent discharge of battery recycling industries is polluted and remedial steps should be taken for avoiding pollution.

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