Management of Institutional Hazardous Waste

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ABSTRACT

The existing rules on institutional hazardous waste management are very limited. Presently, hazardous wastes get mixed with the usual waste. But this could affect the treatment and other related processes. These effects are being discussed in this paper. A study was done on the institutional wastes from one of the laboratories of IIT Delhi. The work was limited to only liquid wastes. The quantification and characterization of the wastes were done which gave an idea about what are the main constituents of the laboratory wastes. The toxicity level of the waste was assessed by conducting tests like bioassay test, Biochemical Oxygen Demand (BOD) exertion test etc. Bioassay studies for liquid wastes coming from different sources give the response of test organisms to the toxicity present in wastewater. The bioassay test was done on Guppy fish and the results were obtained as LC 50 equal to 8.11% concentration of the sample diluted in water which showed the high toxicity of the waste water. The BOD exertion test gave the result that the addition of the hazardous waste from the laboratory showed distinguishable effects on the dissolved oxygen concentration in the sewage sample. This hints that mixing up of the laboratory wastes in the sewage could affect the treatment processes.

Keywords: Institutional waste, Hazardous, Toxicity, Bioassay, BOD

1. INTRODUCTION

Mostly the activities of mankind influence and even degrade the environment. The waste management which is nature friendly and sustainable always demands a well-planned system of collection, recycling and final disposal of wastes. A portion of the waste from homes, industries and institutions contains materials which can be toxic or otherwise dangerous to humans and animals. Commonly, these materials are known as hazardous waste. More care is given towards the handling of refuse and hazardous waste nowadays, and both the government and the people demand more in case of protecting the environment and improving waste management. Everyone is responsible for the environment and it mainly involves the safe and proper handling of hazardous waste, reduced use, and safe disposal. Hazardous waste above the permissible limit should not be allowed to mix with normal rubbish or be poured down the drain. There are a set of rules for the management of industrial hazardous wastes, biomedical wastes, municipal solid wastes, etc.

However, the rules existing related to institutional hazardous wastes management are very limited. There are many situations emerging in the present day such as new researches which direct to the problem of management of hazardous wastes from the institutions. Due to new researches coming up each day, new molecules and compounds are being formed and this varies the quantity and quality of the hazardous wastes. The new researches cause the formation more hazardous wastes as side products of these reactions.

Presently, in most of the cases, the waste from the institutions like colleges, laboratories, research organizations, etc get mixed to the usual wastes such as sewage, MSW and goes to the conventional municipal waste disposal systems without consideration of any formation of toxicity. Hazardous wastes above the permissible limit when allowed to mix with sewage would affect the treatment and other related processes. Hence, the waste water treatment plant must have restrictions on the hazardous wastes they handle. This limit should be kept on the hazardous content in the waste to protect from damage and to protect the quality of sludge generated by these plants.

The usual problems which happen when hazardous wastes mixes with conventional waste are:

(i) The hazardous content in the waste water could either prevent safe application of sludge as fertilizer or threaten aquatic life and environment in rivers and ocean waters where waste is discharged into.

(ii) According to a study by Hammett (1996) on the disposal of hazardous household waste, hazardous waste poured down the drain could corrode the plumbing and release fumes through the drains. Some of these toxic materials may drain down through the soil untreated or unchanged. This leads to the contamination of ground water or surface waters. [2]

(iii) Biological treatment processes are hampered by the presence of chemicals in sewage. They act as toxicants and delay the degradation process.

(iv) Oxygen Uptake Rate reduces when toxic load increases in the wastes.[6]

(v) The mixing of hazardous content in the usual solid wastes results in unfavourable amounts of hazardous materials seeping into the ground. These chemicals slowly enter natural hydrologic systems. Many landfills now require measures to prevent groundwater contamination, an example being installing a barrier along the foundation of the landfill to contain the hazardous substances that may remain in the disposed waste.

This paper includes a work done to study the effects of mixing of the institutional wastes with the conventional sewage. The study was done in one of the laboratories of IIT Delhi.

2. OBJECTIVES AND SCOPE

The main objective was to assess the extent of intuitional hazardous wastes generated in one of the laboratories of Indian Institute of Technology Delhi and the effects of these wastes getting mixed up with conventional wastes like sewage. The study was limited to liquid wastes only although gaseous and solid wastes are also generated in the same laboratory.

3. METHODOLOGY

The workwas restricted to one of the laboratories of Indian Institute of Technology Delhi. The project was done to manage the hazardous wastes present or formed in the liquid wastes. The study included 3 main steps:

Quantification and sampling.The amount of the hazardous wastes was quantified and sampled from the laboratory for low, medium and high activity days.The sampling was done from the waste water collected during the quantification, by collecting 20ml samples from each litre of waste water and mixing it together and was preserved in refrigerator.

Characterization. The different characters of the samples collected were determined like pH, alkalinity/acidity, hardness, electrical conductivity, total solids, total suspended and dissolved solids, COD etc., were measured.

Toxicity Assessment. Tests were conducted to determine the toxicity of the samples collected from the lab.Tests are conducted for assessment of the toxicity like Bioassay test and BOD exertion test.

Bioassay test. Bioassay (commonly used shorthand for biological assay), or biological standardization is a type of scientific experiment used for detection and quantification of bio chemicals. [5] The fish used for the bioassay test were of the category Guppi (Poeciliareticulata). The fishes were acclimatised to the laboratory environment for 24 hours. The fishes were fed with fish feed (pellets). The test was conducted in 2 phases. Acute toxicity testing was conducted for 96 hours with mortality as the end point. In the first phase, fishes were exposed to the samples collected from the laboratory to find the range of the LC 50 (% concentration causing 50% mortality) and in the second phase, fishes were exposed to the samples collected from the laboratory in particular concentrations depending on the results obtained from the range finding tests.[8] For each range finding test, the fishes were exposed to different concentrations and control was also maintained. For the first phase, seven fishes are selected for each test concentration. Fishes were not fed 24 hours prior to or during the experiment so as to reduce the chance of the sample getting adsorbed to the food or faecal material, and to help maintain water quality. [1]

Mortalities (i.e., percentage of organisms dead) were recorded at 24, 48, 72 and 96 hours after initiation of the exposure. Dead individuals were removed from the tank immediately. Though mortality is the final point for the experiment, behavioural changes in fishes like loss of equilibrium, erratic swimming and staying motionless at a certain location for prolonged periods were recorded during exposure studies. [3]

BOD Exertion Test. The addition of hazardous wastes into the usual wastes could cause change in the rate of the organic matter removal. If a given percentage of organic matter removal from the sewage left for treatment must be achieved to meet regulatory permit limits, then the changes caused due to addition of these hazardous wastes should be minimised. So to find out the change in the rate of removal, the values of k (BOD rate constant) and Ultimate BOD (U-BOD) was calculated for with and without addition of the hazardous wastes into the sewage. Then these values were compared and checked whether the addition has caused changes. The usual procedure was followedto determine the BOD values of usual sewage for 10 days. Then these values were used to determine k_1 and U-BOD from a series of BOD measurements. The method used for determining k and U-BOD from the results of a series of BOD measurements was the method of least squares. The least-squares method involves fitting a curve through a set of data points so that the sum of the squares of the residuals (the difference between the observed value and the value of the fitted curve) must be a minimum.[4]

4. RESULTS AND DISCUSSIONS

Quantification. Figure 1 shows the volume of water required for washing different utilities in the laboratory.

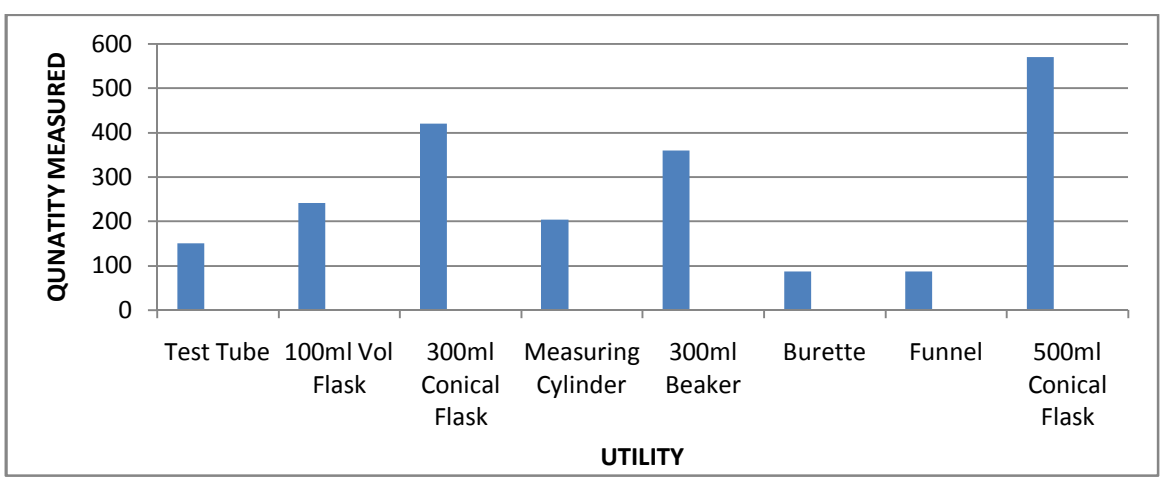

Figure 1 Quantification – Water utilized per utility

This was done to find out the amount of waste water coming out of the laboratory in terms of washing of utilities. The Figure 2 shows the waste generated from the laboratory on low, medium and high activity days.

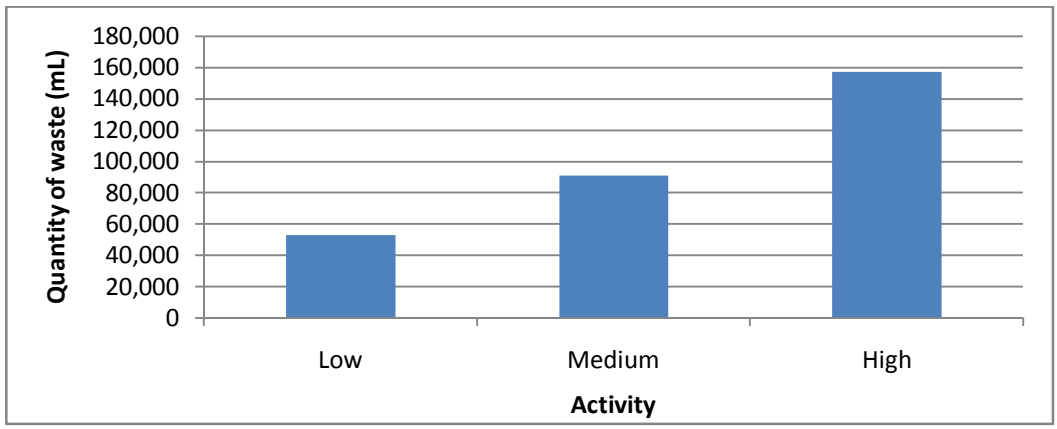

Fig. 2 Quantity of waste produced per day

Characterization

The water quality parameters: pH, acidity/alkalinity, conductivity, hardness, total solids and COD were measured for the sample. The values obtained are shown in Table 1.

Table 1.Physical and chemical properties of the sample collected

Sl No.	PROPERTIES	VALUES
1.	pH	2.23(Acidity=2875 mg/L of $CaCO_3$)
2.	Conductivity	18.52 mS/m
3.	Hardness	680 mg/L of $CaCO_3$
4.	Total Solids	2280 mg/L
5.	COD	2947.84 mg/L

Toxicity Assessment.

Bioassay Test. The Bioassay test was done in different iterations. The concentration ranges were reduced gradually and bracketing was done first. Then the values near to 50% were found and graph plotted(Fig 3). From the graph, the Bioassay test result is obtained as LC 50, i.e., the % concentration of the sample corresponding to 50% mortality is 8.112%. This shows that if more

than 8.112% concentration of laboratory waste is present in the water, 50% of fishes present would die.

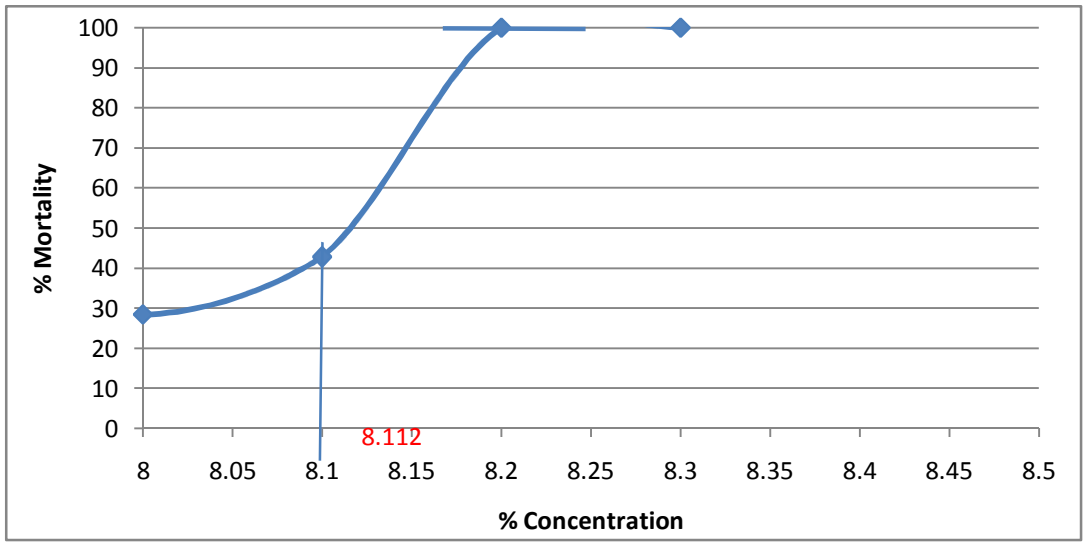

Fig 3. Bioassay Test – Graph - % Concentration vs % Mortality

BOD Exertion Test. The BOD values were found out for 2,4,6,8 and 10 days for both sewage and sewage mixed with the sample in a particular estimated ratio. Then from these values, using the least square method, the rate constants (k) were estimated as 0.477/ day for sewage and 0.011/day for sewage mixed with laboratory waste water. Also, Ultimate BOD values as 142.33 mg/L for sewage and 1597.36 mg/L for the sewage mixed with laboratory waste water.

Table 2 - BOD exertion test results.

	BOD Values [mg/L]	
	Usual Sewage	Sample mixed with Sewage
0^{th} Day	0	0
2^{nd} Day	81	143
4^{th} Day	117.5	174.5
6^{th} Day	129.5	188.5
8^{th} Day	136	204.5
10^{th} Day	146.5	216.5

This BOD exertion test result shows that the addition of the wastes from the laboratory to the usual sewage causes change in the rate constant and the Ultimate BOD which shows that the hazardous content causes serious change in the waste degradation processes.

Hence, the results from the Bioassay test and the BOD Exertion Test make it very clear that the mixing of the laboratory wastes (institutional wastes) to the usual sewage is likely to cause different problems in the waste degradation processes, which in turn may affect the working of the waste treatment plants and the treated effluent coming out.

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