LEACHATE TREATMENT BY ADVANCED OXIDATION PROCESS

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Abstract— Leachate is the liquid that drains or leaches from a landfill. Leachate contain large amount of organic matter, ammonia-nitrogen, heavy metals, chlorinated organic compounds and inorganic salts. Leachate generation is a major problem for municipal solid waste landfills. If leachate is discharged into the environment without proper treatment, it pollutes the land and water resources and it causes great harm to the health of all life such as bleeding, stomach disorders, blood disorders, birth defect, cancer, etc. Therefore, the leachate should be properly treated before it enters the water resources. In accordant to this literature regarding treatment of leachate was studied and 4 methods such as fenton, solar photo fenton, solar photo catalysis, solar with Hydrogen peroxide, was adopted for Advanced Oxidation Process(AOP). The sample was collected from one of the largest dumping site such as Perungudi getting the permission from Commissioner of greater Chennai Corporation. Parameters such as pH, BOD, COD, turbidity, total solids, hardness, alkalinity, was found out in raw leachate. After this the treatment was carried out by using the 4 methods in AOP. And the parameters such as pH, BOD, COD, turbidity, total solids, hardness, alkalinity, were again found in treated leachate. On comparing the results of various methods of treatment, the most efficient method for the removal of pollutant from the raw leachate can thus be obtained.

Keywords— Leachate, Solar Photo Fenton, Photo Catalysis, BOD, COD, Advanced Oxidation Process.

I. INTRODUCTION

One of the most serious environmental problems in India is the excessive generation of Municipal Solid Waste (MSW), because of rapid industrial and economic development. Nearly 95% of the total MSW collected worldwide is disposed using the landfilling method.

One of the major drawbacks of this method of waste management is the formation of leachate. This high-strength leachate is produced by physiochemical and biological decomposition of solid wastes and percolation of rainwater through the waste layers.

'LEACHATE' is the liquid that drains from a landfill. Leachate contain large amount of organic matter, ammonia-nitrogen, heavy metals, chlorinated organic compounds and inorganic salts. If leachate is percolated through the ground water if affects the quality of the ground water. Ground water polluted with leachate causes many diseases such as cancer, bleeding, birth defect, etc.,

Therefore, it becomes essential that the leachate should be properly treated before it reaches the water resources.

Since early 1970s, laboratory studies have shown the effectiveness of various biological, physical and chemical treatment process on landfill leachate. Biological treatment process, including anaerobic process and aerobic processes, are quite effective for leachate generated in the early stage with a high BOD5/COD. However, they generally fail to treat a leachate with a rather low BOD5/COD, or high concentration of toxic metals. Hence, physical-chemical processes are mostly used for pretreatment or full treatment of landfill leachate. Among the various types of physical-chemical treatments, Advanced Oxidation Process (AOP) has been reported as one of the most effective method to degrade a variety of organic compounds in landfill leachate. Hence the following parameters of raw leachate are to be reduced using the AOP treatment before disposal.

II. pH

pH is a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity, used to specify the acidity or basicity of an aqueous solution. It is roughly the negative of the logarithm to base 10 of the concentration of the hydrogen ions.

III. BOD

Biochemical Oxygen Demand also called biological oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in the sample at certain temperature over a specific time period.

IV. COD

The chemical oxygen demand (COD) is commonly an indirect measure of the amount of organic compounds in the sample. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per litre of solution. It is a measure of the oxygen-depletion capacity of the sample contaminated with organic waste matter or the equivalent amount of oxygen required to chemically oxidize organic compounds in the sample.

V. TURBIDITY

Turbidity is the cloudiness of the sample caused by suspended solids that are invisible to the naked eye. It is a measure of the quality of water. Leachate always

contains suspended solids that consist of many different particles of varying sizes. Some of the particles are large enough and heavy enough to eventually settle to the bottom of a container if a sample is left standing which are settle able solids. The smaller particles will settle slowly which are the colloidal solids. These particles cause the turbidity in leachate.

VI. TOTAL SOLIDS

Total solids are a measure of suspended and dissolved solids in the given sample. Suspended solids is the amount of tiny solid particles that remain suspended in given sample. Dissolved solids refer to the inorganic salts and some small amounts of organic matter that are dissolved in the given sample.

VII. METHODS OF TREATMENT

Leachate can be treated by any of the Biological methods, Physio – Chemical methods as well as by Advanced Oxidation Processes. Compared to all these methods ADVANCED OXIDATION PROCESS, is found to be economical and efficient. Hence the leachate sample has been treated using AOP to improve the ground water quality, to eliminate environmental impacts, to reduce pollution of land and ground water and also to prevent water borne diseases.

The most important among the chemical processes used for treatment of leachate are advanced oxidation process. Advanced oxidation processes are divided into chemical and photochemical oxidation. The most commonly used methods include oxidation with ozone and hydrogen peroxide and Fenton's reagent oxidation. Processes using ozone are usually employed as the third stage of landfill leachate treatment. This process allows discharge of the leachate into a receiver. The largest decreases in the number of pollutants are obtained using combined processes. Some of the best effects were observed after oxidation both with ozone and hydrogen peroxide, helping to additionally enhance this process photo catalytically. AOP proved to be the most effective method of treatment of waste water that contains organic products.

Advanced Oxidation Process refers to a set of chemical treatment procedures designed to remove organic materials in waste water. It is treated by oxidation through reactions with hydroxyl radicals. In this study, the following AOP methods were used to treat the leachate collected from the study area.

- Solar Photo Fenton method
- Solar Photo Catalysis method
- Solar + Hydrogen peroxide method
- Fenton process

VIII. OBJECTIVE OF THE PROJECT

To treat the leachate sample obtained from Perungudi dumping site, Chennai, by using Four Different Advanced Oxidation Process, which are found to be economical and to find the most efficient AOP, which can be adopted to prevent contamination of land and ground water as well as improve the ground water quality.

IX. MATERIAL COLLECTION

9.1. Collection of Leachate

Two dumping sites, one in Kodungaiyur and another in Perungudi are available for the disposal of solid waste in Chennai, Tamil Nadu. For this study leachate sample of 20 litres was collected from the Perungudi municipal solid waste dumping site. The population of the city is about 8.2 billion. Total area of the Perungudi dumping site is around 200 acres. This landfill dumping site receives, nearly 2200 tones to 2400 MT municipal solid waste per day. Sample was collected in plastic containers and was stored in laboratory.

9.2. Collection of Chemicals and Distilled Water

The reagents and chemicals necessary for the experiment along with 20 litres of distilled water was procured. The various chemicals and reagents used for the different treatment process.

Table 1: PARAMETERS OF CHEMICALS

PARAMETERS	VALUE
pH	7.7pH units
BOD	156mg/L
COD	2400mg/L
Turbidity	314NTU
Total solids	214mg/L

X. EXPERIMENTAL STUDY

The raw leachate has been studied to find the characteristics in the form of pH, BOD, COD, Turbidity, and Total Solids

Table 2: REAGENTS USED FOR VARIOUS AOP METHODS

SL. NO	METHODS	REAGENTS USED
1	Solar Photo Fenton	6.75ml of H_2O_2 + 0.5g of ferric chloride
2	Solar Photo Catalysis	0.125g of Titanium dioxide
3	Solar + H_2O_2	13.5ml of Hydrogen per oxide
4	Fenton Dark Process	0.5g of Ferric chloride and 6.75 ml H_2O_2

XI. TREATMENT OF LEACHATE BY 4 TYPES OF AOP PROCESS

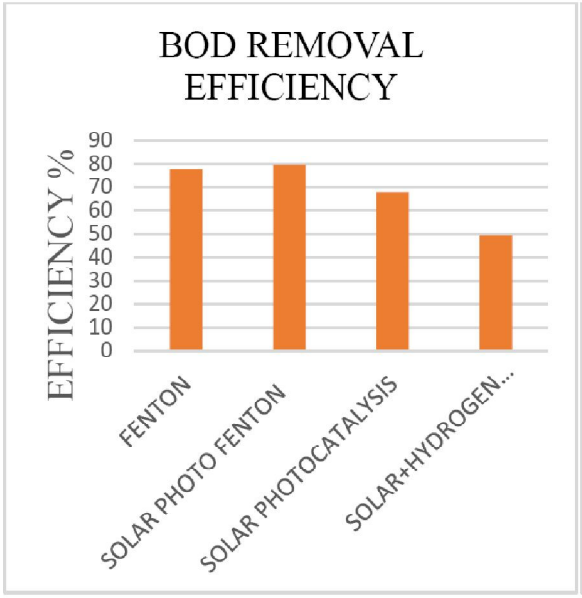
1 litre of leachate, diluted as 100 ml of leachate + 900 ml of water, along with the respective reagent was taken in 4 containers. The container of Fenton Process was kept in a dark room. All other containers were kept in sunlight at 9am. After keeping the containers, 10ml sample of sample was taken in every 15min in test tubes and this process is continued for 60min. When sample is taken in test tube adding 0.5ml of sodium sulphide & 0.5ml of sodium hydroxide to stop the reaction. After adding this reagents, the experiments were conducted in a 1L sample. This treatment to find the parameters in treated sample by using similar raw leachate process.

These are the parameters found in the treated leachate.

XII. RESULTS AND DISCUSSION

Table 3: EFFICIENCY OF THE PARAMETERS

TREATMENT METHODS		EFFICIENCY OF TREATED LEACHATE (%)			
	Time (min)	BOD	COD	Turbidity	Total Solids
FENTON DARK	15	40.32	65.1	68.15	55.61
	30	42.96	72.01	69.75	57.94
	45	43.00	75.29	71.34	59.81
	60	49.10	77.84	74.20	60.62
SOLAR PHOTO FENTON FENTON	15	40.12	78.13	70.70	60.28
	30	46.43	79.72	71.97	61.68
	45	51.20	79.31	72.61	62.15
	60	48.90	79.04	75.06	63.04
SOLAR PHOTO CATALYSIS	15	36.14	60.26	60.51	55.61
	30	37.03	58.83	63.69	57.48
	45	38.72	61.21	68.15	61.21
	60	38.14	67.87	69.42	59.76
SOLAR + H_2O_2	15	30.13	32.34	61.74	57.94
	30	32.63	35.56	68.47	59.35
	45	33.6	40.03	69.42	60.75
	60	37.54	49.52	70.12	61.74



Graph 1: HIGHEST REMOVAL EFFICIENCY BOD OF TREATED LEACHATE

Graph 2: HIGHEST REMOVAL EFFICIENCY BOD OF TREATED LEACHATE

CONCLUSION

In the current study the performance of employing reagents such as Hydrogen peroxide, ferric chloride, titanium oxide as advanced oxidation for the treatment of Chennai municipal solid waste leachate was investigated. It has been found that the efficiency order of the Advanced Oxidation process in this work regarding COD, Turbidity, Total solids, BOD reduction was: Solar Photo Fenton > Fenton > Solar Photo Catalysis > Solar + hydrogen peroxide. The study yielded a good value of COD removal: 79.72% compared with other experiments conducted on leachate treatment. According to this study the maximum removal of COD by Solar Photo Fenton method was observed at a reduced treatment time 30 min compared to the other three AOPs.

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