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Study on the Treatment of Landgfill Leachate Using Nanoparticles of Titanium Oxide

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Abstract- Landfill leachate is the liquid that leaches or drains from a landfill. Leachate results from precipitation entering the landfill from moisture that exists in the waste when it is composed. It can be a toxic liquid, a chemical or any liquid material otherwise unsuitable for use. Nanotechnology has the efficiency in removing contaminants present in water including heavy metals e.g.: (cadmium, arsenic, copper, lead, Mercury, nickel, zinc etc.). Nanoparticles attract water and are repellent towards impurities and also repel organic matter and bacteria. Titanium dioxide or TiO2 has characteristics that make it suitable to many different applications. Ultrafine titanium dioxide nanoparticle has strong absorption against both UV- A and UV- B radiation. The photo catalytic activity of TiO^2 can be used to decompose impurities in wastewater. The study of titanium dioxide on leachate as treatment is observed and the results are obtained by conducting an experiment.

Keywords- Landfill Leachate, Nano Particles, Titanium Oxide, Heavy Metals, COD, BOD, TDS.

I. INTRODUCTION

Solid-waste management, the collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease that is, diseases spread by rodents and insects.

Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that it contains. It usually contains both dissolved and suspended material. The generation of leachate is caused principally by precipitation percolating through waste deposited in a landfill. Once in contact with decomposing solid waste, the percolating water becomes contaminated, and if it then flows out of the waste material it is termed leachate.

Leachate can also be produced from land that was contaminated by chemicals or toxic materials used in industrial activities such as factories, mines etc. Composting sites in areas is associated with stockpiled coal and with waste materials from metal ore mining and other rock extraction processes, especially those in which sulfide containing materials are exposed to air producing sulfuric acid, often with elevated metal concentrations.

The high value of COD of 6000-20000 mg/l, total solids of 24000- 50000mg/l and high concentration of heavy metals in leachate of India raise concern over its proper disposal and treatment system employed.

1. Objectives:

- To find the initial concentration of heavy metals in leachate.
- To find out the concentration of heavy metals present in soil, groundwater and surface water from surrounding area.
- To study impact of heavy metals to the environment and human.
- Treatment of leachate by nano technology method.
- To evaluate the removal efficiency of heavy metals from leachate by using different dosage of nano particle, and different contact time

II. MATERIALS AND METHODOLGY

1. Collection of Sample:

- The landfill leachate is collected from areas near vellalore landfill site.
- The leachate is collected in a high density can of 2.5 litres capacity.
- As soon as the collection is completed it is stored in a refrigerator under suitable temperature.

2. Characterization of Nano Particles:

- Molecular formula: TiO^2
- Molecular weight: 79.866g/ mol
- APS: 50nm
- Colour: white
- Odour: odourless
- Morphology: spherical
- Bulk density: 4.23g/cm^3
- Thermal conductivity: 8.4 wm^{-1}k^{-1}
- Boiling point: 2972°c
- Melting point: 1843°c

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Fig 1. Nano Particals.

3. Treatment Process:

- Leachate sample collected is given for testing to check the level of parameters and heavy metals present in sample.
- The different concentration of TiO^2 nano powder is added as an adsorbent to 500ml of leachate.
- Then dissolve the nano particles and then make up to 100ml.
- Transfer the contents in a 250ml beaker, and shake using magnetic stirrer at 150rpm for 5 min.
- The process is continued for different contact time and different dosages.
- The efficiency is calculated and optimum contact time is calculated.

III. RESULTS AND DISCUSSIONS

1. Preliminary Analysis:

Table 1. Preliminary analysis.

Parameters	Obtained Value	Tolerance Limits
COD	7145	250
NH3	95	30
Na	2100	60
Zn	1.027	15
Cd	0.051	1
Fe	5.642	3
K_2O	81.72	13-20
TDS	9650	No limits
Conductivity	21.2	No limits
pH @25°c	4.27	5.5-9.0

The above report shows that, the parameters obtained are exceeding the ISO standards of water quality for sewer water.

1.1 Treatment using TiO2 (varying dosages):

Table 2. Concentration of various parameters at varying dosages.

Para meters	Obtained Value	500 mg/l	1000 mg/l	1500 mg/l	2000 mg/l
COD	7145	5480	3152	2100	1652
NH3	95	65	45	32.1	15.3
Na	2100	1753	620	256	56
Zn	1.027	0.76	0.42	0.13	0.005
Cd	0.051	0.04	0.021	0.019	0.010
Fe	5.642	4.62	3.95	3.54	3.02
K_2O	81.72	61.2	49	31	18.5
TDS	12500	10230	7820	6390	6120
Conduc tivity	21.2	16.7	10.2	8.1	7.9
pH	4.27	4.68	4.78	4.69	4.66

1.2 Treatment using TiO2 (varying contact time):

Table 2. Concentration of various parameters at varying contact time.

Para meters	Obtained Value	5 mins	10 mins	15 mins	20 mins
COD	7145	6420	5430	3950	3540
NH3	95	75	50	46	38.7
Na	2100	1985	1652	1345	1020
Zn	1.027	0.960	0.542	0.250	0.015
Cd	0.051	0.004	0.003	0.002	0.001
Fe	5.642	5.120	4.862	4.320	4.12
K_2O	81.72	75.62	60.32	49.31	32.10
TDS	12500	10500	9700	7800	7150
Conduc tivity	21.2	18.4	15.9	11.1	10.7
pH	4.27	4.33	4.689	4.75	4.83

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1.3 Removal Efficiency:

Efficiencies for all the treatment conditions were calculated and the corresponding graphs are to be plotted for all the above conditions. Then we could clearly see the changes occurred under each condition.

The removal efficiency is calculate using,

%removal = [(Ci – Cf) / Ci] x 100

Where, Ci is the initial concentration of heavy metals in leachate and Cf is the final concentration of heavy metals in leachate.

2. Heavy metal adsorption analysis

The concentration of heavy metals was measured by atomic absorption spectroscopy. Atomic adsorption spectroscopy is an analytical technique that measures the concentration of elements. It is so sensitive that it can measure down to parts per million of gram in the sample.

2.1 Removal Efficiency of Titanium oxide:

Table 4. Removal Efficiency obtained with varying dosages

Para meters	500 mg/l %	1000 mg/l %	1500 mg/l %	2000 mg/l %
COD	23	56	71	77
NH3	31	53	66	84
Na	17	21	36	51
Zn	26	59	63	80
Cd	21	59	63	80
Fe	18	30	37	46
K_2O	25	40	62	77
TDS	18	37	49	51
Conduc tivity	21	52	62	63
pH	-	-	-	-

The above report shows that the concentrations of dosages added and their efficiencies. In this, sodium, zinc and cadmium are efficiently remove with 80% shows better results.

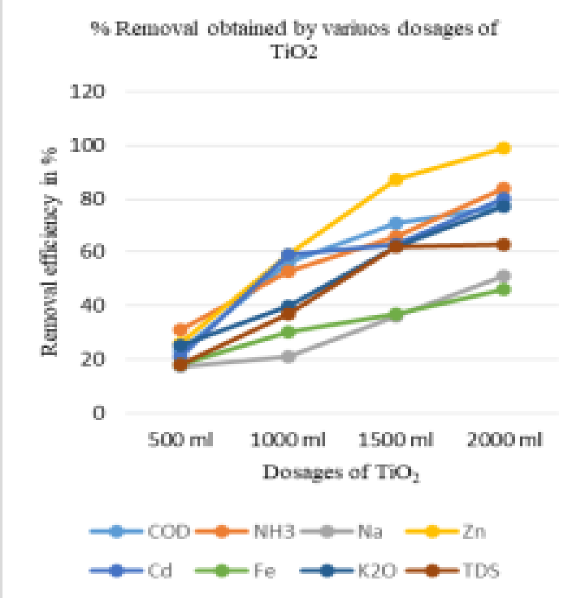

Fig 2. Percentage removal of various parameters.

The above graph shows that, as the dosage increases, the removal efficiency also increases due to the increase in surface area between absorbent and metals.

Table 5. Removal Efficiency obtained with varying contact time.

Parameters	5 mins	10 mins	15 mins	20 mins
COD	10	24	45	51
NH3	21	47	52	52
Na	5	42	58	75
Zn	7	47	76	98
Cd	92	95	96	98
Fe	9	14	24	28
K_2O	7	26	40	61
TDS	16	22	38	43
Conductivity	13	25	48	50
pH	-	-	-	-

The above report shows that the concentrations in varying contact time and their efficiencies. In this, zinc and cadmium is efficiently remove with 98% shows better results.

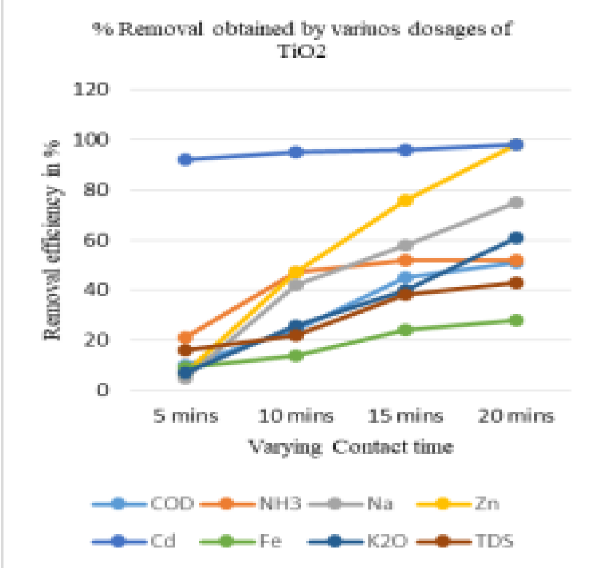

Fig 3. Percentage removal of various parameters.

The above graph shows that the efficiency increases with increasing contact time due to higher reaction between adsorbent and the metals.

IV. CONCLUSION

- The test results of initial concentration of parameters in leachate is obtained shows that COD, ammonia, sodium, iron, potassium, TDS exceeded the standard tolerance limit.
- Leachate was treated using TiO2 nano powder as an adsorbent effectively.
- From the study, it is found that titanium dioxide nanoparticles work more efficient at varying dosages and contact time.
- Zinc and cadmium had a good adsorption effect of 98% efficiency at 20min contact time.
- And also it shows good results at 80% efficiency in varying dosages.
- Hence the use of nano particles can be used to remove heavy metals and parameters in landfill leachate effectively.

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