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LANDFILL LEACHATE DEGRADATION USING ZINC OXIDE UNDER DIRECT SUNLIGHT

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Keywords:

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ABSTRACT: There has been a significant increase in the generation of MSW (Municipal Solid Waste) in India over the last few decades. The degradation of persistent organic pollutant using advanced oxidation processes with sunlight as energy source have a great advantage at lower costs. Pallikaranai wetland is a freshwater marsh in the city of Chennai, India. Pallikaranai marshland is the only surviving wetland ecosystem of the city and is among the few and last remaining natural wetlands of South India. MSW generated in Pallikaranai, Chennai includes 80% of residential waste, 17% of commercial waste, 3% of institutional waste and 2% of industrial waste. The physical and chemical properties of the MSW generated in Chennai, showed that majority of waste composed of green waste (32.3%) and inert materials (34.7%) i.e. stones and glass. The overall aim of the work was to apply an innovative clean technology, namely photocatalytic oxidation, and demonstrate its efficiency in leachate treatment by using solar energy. The study of photo catalytic process was conducted for the removal of parameters like Colour, COD, BOD, alkalinity, turbidity, TDS, conductivity, hardness in leachate. To determine the optimum dosage of ZnO, effect of pH and contact time and to determine the removal efficiency of the pollutant. The solar photocatalytic treatment of leachate with zinc oxide (ZnO) as catalyst dosage of 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 g/500ml was conducted by maintaining pH 4, 5 and 6 of the leachate sample with exposure to sunlight in 5 h of time. The characteristics of leachate sample were monitored for every one hour of time period. It was observed that the maximum pollutant removal was occurred at the pH 5 of the leachate sample than in pH 4 and 6.

INTRODUCTION: Increased population growth has accelerated the generation of solid wastes at the same time available land suitable for proper waste disposal is very limited. The generated municipal solid waste includes residential, commercial, industrial and hospital waste. They constitute both bio-degradable and non-biodegradable material like food waste, industrial and commercial plastic, timber, steel, rags and textiles, paper, rubber, leather, etc.

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The two issues related to the dumping of municipal solid waste are the availability of land for dumping and reclaiming the dumpsite for future development. Among the many of the environmental problem existing in the urbanizing cities of developing countries, MSW management and its impact on groundwater and surface water quality have become the most prominent in the recent years.

There has been a significant increase in the generation of MSW (Municipal Solid Waste) in India over the last few decades. This is largely a result of rapid population growth in the country. The characteristic of MSW collected from any area depends on a number of factors such as food habits, cultural traditions of inhabitants, lifestyles, climate, etc.

Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that it contains [1, 2]. 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 [3]. Additional leachate volume is produced during this decomposition of carbonaceous material producing a wide range of other materials including methane, carbon dioxide and a complex mixture of organic acids, aldehydes, alcohols and simple sugars.

In a landfill that receives a mixture of municipal, commercial and mixed industrial waste but excludes significant amounts of concentrated chemical waste, landfill leachate may be characterized as a water based solution of four groups of contaminants: dissolved organic matter (alcohols, acids, aldehydes, short chain sugars etc.), inorganic macro components (common cations and anions including sulfate, chloride, iron, aluminium, zinc and ammonia), heavy metals (Pb, Ni, Cu, Hg), and xenobiotic organic compounds such as halogenated organics, (PCBs, dioxins, etc.). The risks from waste leachate are due to its high organic contaminant concentrations and high concentration of ammonia. Pathogenic microorganisms that might be present in it are often cited as the most important, but pathogenic organism counts reduce rapidly with time in the landfill, so this only applies to the freshest leachate. Toxic substances may, however, be present in variable concentrations, and their presence is related to the nature of the waste deposited.

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The SIPCOT Area Community Environmental Monitors group analysed an ambient air sample collected downwind of the garbage dump in Pallikaranai and found that it contained at least 27 chemicals, 15 of which greatly exceed health-based standards set by the United States Environmental Protection Agency. Three of the 27 chemicals are also known to cause cancer in humans and were found in quantities as high as 34,000 times above safe levels [4, 5]. A research by the Anna University revealed a large quantity of metallic sedimentation discharged from the Perungudi dumpyard being deposited in the marshland, affecting its biodiversity [6].

Therefore a study was conducted for the removal of parameters like Colour, COD, BOD, alkalinity, turbidity, TDS, conductivity, hardness in leachate using photocatalyst. Main purpose was to determine the optimum dosage of ZnO, effect of pH and contact time. To determine the removal efficiency of the pollutant. Treatment of wastewater in a zinc dioxide suspended reactor has been widely used due to its simplicity and enhanced photo degradation efficiency.

MATERIALS AND METHODS:

Reagents and standards for Analysis:

pH:

- **pH 4 buffer solution:** Dissolve pH 4 tablet in 100ml distilled water.
- **pH 9.2 buffer solution:** Dissolve pH 9.2 tablet in 100ml distilled water.

Turbidity:

- Dissolve 1gm of hydrazine sulphate and dilute to 100ml.
- Dissolve 10gm of hexamethylene tetramine and dilute to 100ml
- Mix 5ml of each of the above solution take in a 100ml flask and allow stand for 10 minutes and dilute to 1000ml is 40 NTU.

Conductivity:

- Dissolve 0.5g of potassium chloride solution in 1litre is 1milli mho/cm.

Alkalinity:

- **0.1N of hydrochloric acid:** 8.9ml of con. Hcl mix with 991ml distilled water.
- **Methyl orange indicator:** 1gm of methyl orange dissolved in 100ml ethanol.
- **Phenolphthalein indicator:** 1gm of phenolphthalein dissolve in 100ml ethanol.

Hardness:

- **Buffer solution:** Dissolve 16.9g NH_4Cl in 143mL NH_4OH. Add 1.25g magnesium salt of EDTA to obtain sharp change in colour of indicator and dilute to 250mL. If magnesium salt of EDTA (AR grade) and 780mg $MgSO_4.7H_2O$ or 644mg $MgCl_2.6H_2O$ in 50mL distilled
- **Eriochrome black T indicator:** Mix 0.5g dye with 100g NaCl to prepare dry powder.
- Standard EDTA solution 0.01 M: Dissolve 3.723 g EDTA sodium salt and dilute to 100mL.

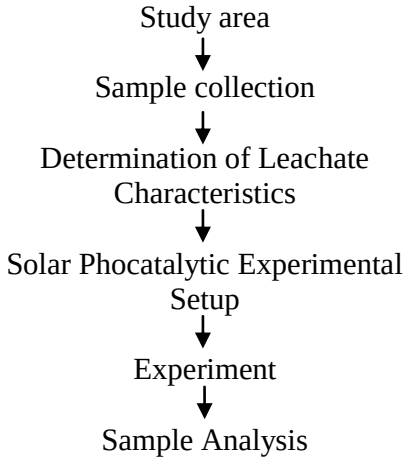
Dissolved Oxygen:

- **N of sodium thiosulphate:** 2.48gm of sodium thiosulphate is dissolved in 1litre of distilled water.
- **N of potassium dichromate:** 0.49gm of potassium dichromate is dissolved in 1litre of distilled water.
- **Potassium iodide solution:** 10gms of Potassium iodide is dissolved in 90ml of distilled water.
- **Manganese sulphate hydrate:** 5gms of Manganese sulphate hydrate is dissolved in 95ml of distilled water.
- **Alkali iodide mixture:** 100gms of potassium iodide (20%) and 40gms of sodium hydroxide is dissolved and made up to 500ml.
- Concentrated sulphuric acid.
- **Dil. sulphuric acid 4N:** 112ml of conc. sulphuric acid is dissolved in 910ml of distilled water.
- **Starch solution:** 1gm of starch powder is made into a paste and dissolved in 100ml of boiled water.

Chemical Oxygen Demand:

- **Standard potassium dichromate solution, 0.25N (0.04167 M):** Dissolve 12.259g $K_2Cr_2O_7$ dried at 103 °C for 24 h in distilled water and dilute to 1000mL.
- **Sulphuric acid reagent:** Add 10g of Ag_2SO_4 to 1000mL concentrated H2SO4 and let stand for one to two days for complete dissolution.
- **Standard ferrous ammonium sulphate approx. 0.25N (0.25M):** Dissolve 98g Fe $(NH_4)2(SO_4)_2.6H_2O$ in about 400mL distilled water. Add 20mL concentrated H_2SO_4 and dilute to 1000mL.
- **Ferroin indicator:** Dissolve 1.485g 1, 10-phenanthroline monohydrate and 695mg $FeSO_4.7H_2O$ in distilled water and dilute to 100mL.
- **Mercuric Sulphates:** $HgSO_4$, crystals, analytical grade.
- **Potassium hydrogen phthalate (KHP) Standard:** Dissolve 425mg lightly crushed dried potassium hydrogen phthalate ($HOOC.C_6H_4.COOK$) in distilled water and dilute to 1000mL. This solution has a theoretical COD of 500µg O_2/mL. This solution is stable when refrigerated, up to 3 months in the absence of visible biological growth.

Methodology: The methodology which was adopted in this research work is given in the figure



Sample Collection: The leachate samples were collected from the Pallikaranai dumping yard in Chennai. The sample bottles were rinsed two or three times with the water well. The container was filled with leachate sample without air space. The container was closed with the inner cap. The leachate sample was collected in the two five litre container separately and they are properly labelled and analysed for physical, chemical parameters in the laboratory.

Solar Photo catalytic Experimental setup: The process involved mainly two steps. First, the 500 mL of sample were taken in a 1000mL glass beaker to which catalyst was added and the proper mixing was carried out. The mixing task were performed with the help of jar test equipment comprising four paddle rotors, equipped with one beaker of each. The mixing was continued for 20 minutes of time at 100 rpm. Secondly, followed by mixing process, the leachate sample was exposed in the sunlight to allow for the photo catalytic process to occur in 5 h of time interval. By varying the catalyst concentration and pH value (4-6) were studied in this experiment.

While the leachate sample was exposed in sunlight after the catalyst dosage for photocatalytic process, after a certain interval of time the sample was collected and analysed for parameter testing i.e., at 60min, 120min, 180min, 240min, and 300min.Experimental setup was shown in **Fig. 1** and **2**.

Photo catalytic degradation of pollutant in the leachate sample (pH= 4, 5, 6) by ZnO:

Sample taken = Leachate
Volume of the sample = 500ml
Catalyst dosage (ZnO) = 0.2g to 1.2g
Mixing arrangement = Jar test apparatus
Exposure time to sunlight = 5 hours

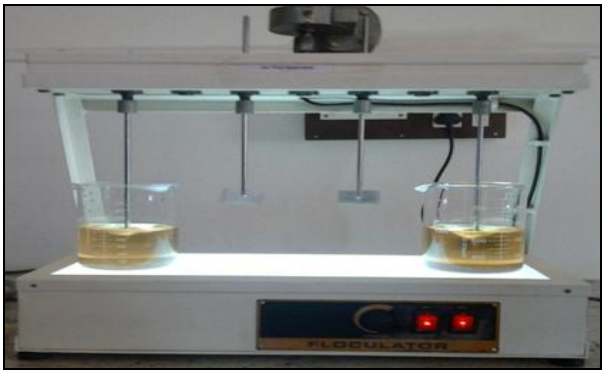


FIG. 1: MIXING OF SAMPLE AFTER ADDITION OF CATALYST DOSAGE

FIG. 2: PHOTOCATALYTIC TREATMENT OF LEACHATE WITH SUNLIGHT

TABLE 1: CHARACTERISTICS OF LEACHATE SAMPLE (pH=4) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.2 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	376	378	320	275	278
3	Total solids (mg/lit)	15318	15103	14845	13859	13850
4	Hardness (mg/lit)	2607	2597	2406	2281	2274
5	BOD_5 (mg/lit)	450	442	412	392	391
6	COD (mg/lit)	1133	1112	1104	1088	1086

TABLE 2: CHARACTERISTICS OF LEACHATE SAMPLE (pH=4) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.4 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	361	278	253	195	194
3	Total solids (mg/lit)	14254	13980	13204	11426	11420
4	Hardness (mg/lit)	2596	2429	2314	2104	2100
5	BOD_5 (mg/lit)	448	408	354	279	276
6	COD (mg/lit)	1098	1094	995	734	729

TABLE 3: CHARACTERISTICS OF LEACHATE SAMPLE (pH=4) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.6 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	350	251	211	131	129
3	Total solids (mg/lit)	13101	11154	11100	9575	9568
4	Hardness (mg/lit)	2558	2300	2109	1182	1178
5	BOD_5 (mg/lit)	438	398	348	265	263
6	COD (mg/lit)	1116	1026	847	650	649

TABLE 4: CHARACTERISTICS OF LEACHATE SAMPLE (pH=4) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.8 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	341	246	204	118	115
3	Total solids (mg/lit)	12340	10948	9985	9266	9242
4	Hardness (mg/lit)	2553	2294	2102	1178	1174
5	BOD_5 (mg/lit)	438	396	344	262	260
6	COD (mg/lit)	1099	1025	844	653	646

TABLE 5: CHARACTERISTICS OF LEACHATE SAMPLE (pH=4) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 1.0 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	335	242	198	115	110
3	Total solids (mg/lit)	12310	10920	9950	9253	9218
4	Hardness (mg/lit)	2533	2264	2088	1134	1120
5	BOD_5 (mg/lit)	435	392	340	258	252
6	COD (mg/lit)	1092	1020	840	652	642

TABLE 6: CHARACTERISTICS OF LEACHATE SAMPLE (pH= 4) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 1.2 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	339	241	198	118	109
3	Total solids (mg/lit)	12315	10924	9953	9262	9218
4	Hardness (mg/lit)	2540	2273	2093	1140	1128
5	BOD_5 (mg/lit)	438	397	346	262	258
6	COD (mg/lit)	1102	1032	838	656	650

TABLE 7: CHARACTERISTICS OF LEACHATE SAMPLE (pH= 5) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.2 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	374	371	309	269	265
3	Total solids (mg/lit)	15301	14963	14525	13634	13551
4	Hardness (mg/lit)	2602	2587	2392	2265	2258
5	BOD_5 (mg/lit)	447	433	409	388	383
6	COD (mg/lit)	1130	1104	1096	1076	1071

TABLE 8: CHARACTERISTICS OF LEACHATE SAMPLE (pH=5) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.4 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	354	270	246	191	190
3	Total solids (mg/lit)	14052	13740	13019	11298	11294
4	Hardness (mg/lit)	2584	2418	2304	2091	2088
5	BOD_5 (mg/lit)	443	402	350	271	269
6	COD (mg/lit)	1085	1075	978	718	715

TABLE 9: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=5) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH ZnO CATALYST DOSAGE OF 0.6 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	344	249	208	130	124
3	Total solids (mg/lit)	12923	11008	10906	9396	9368
4	Hardness (mg/lit)	2547	2289	2100	1170	1167
5	BOD_5 (mg/lit)	432	389	341	258	254
6	COD (mg/lit)	1110	1012	835	640	637

TABLE 10: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=5) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.8 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	335	238	197	110	108
3	Total solids (mg/lit)	12141	10774	9852	9140	9122
4	Hardness (mg/lit)	2541	2280	2088	1168	1165
5	BOD_5 (mg/lit)	434	392	338	259	255
6	COD (mg/lit)	1087	1016	832	638	632

TABLE 11: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=5) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH ZnO CATALYST DOSAGE OF 1.0 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Cleared	Cleared	Cleared
2	Turbidity (NTU)	300	210	150	75	70
3	Total solids (mg/lit)	11013	8058	7320	7163	6098
4	Hardness (mg/lit)	2300	1886	1528	750	705
5	BOD_5 (mg/lit)	401	362	305	228	220
6	COD (mg/lit)	1032	920	760	586	580

TABLE 12: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=5) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 1.2 G/500ML.

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	310	221	156	84	82
3	Total solids (mg/lit)	11035	8076	7342	6118	6113
4	Hardness (mg/lit)	2410	1924	1559	732	730
5	BOD_5 (mg/lit)	408	368	324	241	238
6	COD (mg/lit)	1040	932	782	598	593

TABLE 13: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=6) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.2 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	375	378	318	273	274
3	Total solids (mg/lit)	15305	15087	14698	13749	13780
4	Hardness (mg/lit)	2607	2594	2409	2389	2382
5	BOD_5 (mg/lit)	449	438	413	387	386
6	COD (mg/lit)	1134	1109	1094	1083	1080

TABLE 14: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=6) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.4 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	358	270	253	191	195
3	Total solids (mg/lit)	14103	13792	13158	11368	11346
4	Hardness (mg/lit)	2590	2425	2314	2096	2096
5	BOD_5 (mg/lit)	442	402	353	279	269
6	COD (mg/lit)	1120	1086	978	756	724

TABLE 15: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=6) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH ZnO CATALYST DOSAGE OF 0.6 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	348	246	208	130	128
3	Total solids (mg/lit)	13034	11089	10987	9621	9454
4	Hardness (mg/lit)	2568	2294	2111	1179	1179
5	BOD_5 (mg/lit)	438	394	341	263	265
6	COD (mg/lit)	1110	1025	845	659	659

TABLE 16: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=6) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 0.8 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Light brown	Cleared
2	Turbidity (NTU)	339	248	220	136	120
3	Total solids (mg/lit)	12256	10863	9893	9320	9201
4	Hardness (mg/lit)	2538	2280	2096	1178	1179
5	BOD_5 (mg/lit)	434	396	341	261	268
6	COD (mg/lit)	1086	1023	846	659	644

TABLE 17: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=6) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH ZnO CATALYST DOSAGE OF 1.0 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	322	235	187	108	105
3	Total solids (mg/lit)	11673	8381	7592	6554	6320
4	Hardness (mg/lit)	2452	1920	1203	1108	1010
5	BOD_5 (mg/lit)	423	380	335	275	268
6	COD (mg/lit)	1078	963	824	653	640

TABLE 18: THE CHARACTERISTICS OF LEACHATE SAMPLE (PH=6) AFTER SOLAR PHOTOCATALYTIC PROCESS WITH THE ZnO CATALYST DOSAGE OF 1.2 g/500ml

S. no	Parameter	60 min	120 min	180 min	240 min	300 min
1	Color	Brown	Light brown	Light brown	Cleared	Cleared
2	Turbidity (NTU)	326	241	188	111	105
3	Total solids (mg/lit)	11688	8392	7598	6568	6340
4	Hardness (mg/lit)	2456	1932	1209	1056	1021
5	BOD_5 (mg/lit)	427	382	339	278	275
6	COD (mg/lit)	1082	968	829	661	654

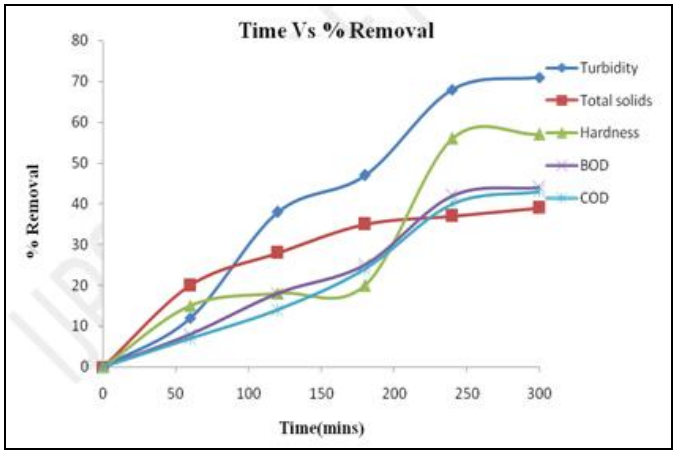


FIG. 3: EFFECT OF ZnO CATALYST CONCENTRATION (1g/500ml) AND TIME ON REMOVAL EFFICIENCY OF TURBIDITY, TOTAL SOLIDS, HARDNESS, BOD AND COD IN THE LEACHATE SAMPLE (PH= 4)

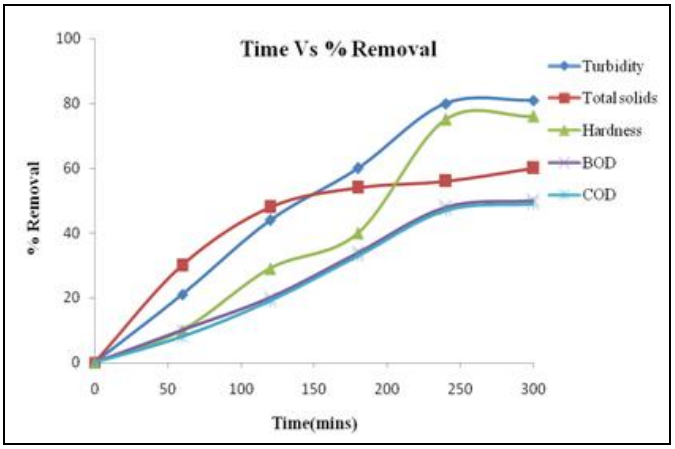


FIG. 4: EFFECT OF ZnO CATALYST CONCENTRATION (1g/500ml) AND TIME ON REMOVAL EFFICIENCY OF TURBIDITY, TOTAL SOLIDS, HARDNESS, BOD AND COD IN THE LEACHATE SAMPLE (PH=5)

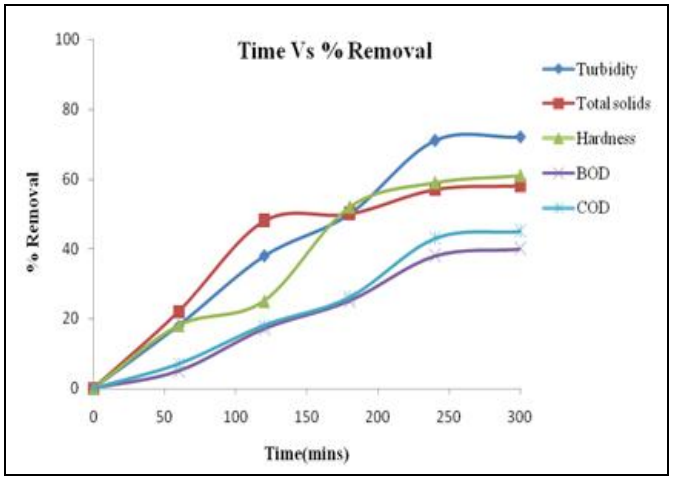


FIG. 5: EFFECT OF ZNO CATALYST CONCENTRATION (1g/500ml) AND TIME ON REMOVAL EFFICIENCY OF TURBIDITY, TOTAL SOLIDS, HARDNESS, BOD AND COD IN THE LEACHATE SAMPLE (PH=6).

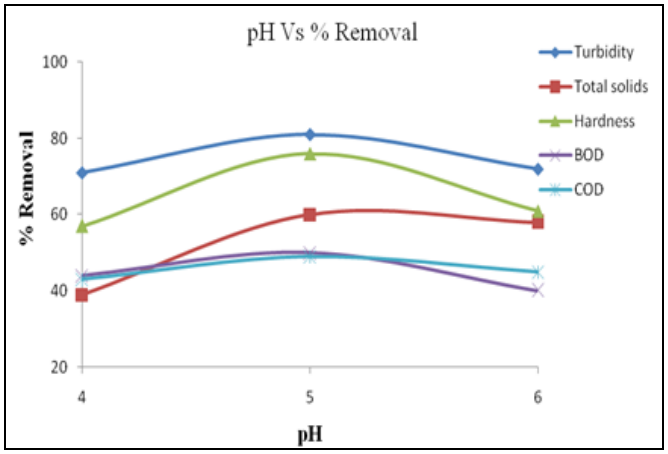


FIG. 6: EFFECT OF PH ON THE REMOVAL EFFICIENCY OF TURBIDITY, TOTAL SOLIDS, HARDNESS, BOD AND COD IN THE LEACHATE SAMPLE WITH THE ZNO AS CATALYST CONCENTRATION OF 1.0g/500ml AND REACTION TIME 300MIN

RESULTS AND DISCUSSION: The landfill leachate study was conducted to study the photo catalytic process for the removal of parameters like Colour, COD, BOD, alkalinity, turbidity, TDS, conductivity and hardness in leachate. The leachate samples were collected from the Pallikaranai dumping yard in Chennai. The collected leachate from the dumpsite are analysed in the laboratory to examine the characteristics of the leachate with the standard CPCB procedure. While the leachate sample was exposed in sunlight after the catalyst dosage for photo catalytic process, after a certain interval of time the sample was collected and analysed for parameter testing *i.e.,* at 60min, 120min, 180min, 240min, and 300min.

The **Table 1-6** concludes that, at pH 4 of the leachate sample with the ZnO catalyst concentration ranging from 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 g/500ml were used in this experiment. In which the maximum removal efficiency of turbidity, total solids, hardness, BOD and COD was resulted as 71%, 39%, 57%, 44% & 43% are occurred at the catalyst concentration of 1.0 g/500ml and optimum reaction times with exposure to sunlight was observed as 300 min. The percentage of removal vs time for the sample was represented in **Fig. 3.**

The **Tables 7-12** concludes that, at pH 5 of the leachate sample with the ZnO catalyst concentration ranging from 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 g/500ml were used in this experiment. In which the maximum removal efficiency of turbidity, total solids, hardness, BOD and COD was resulted as 81%, 60%, 72%, 51% & 48% are occurred at the catalyst concentration of 1.0 g/500ml and optimum reaction times with exposure to sunlight was observed as 300 min. The percentage of removal vs time for the sample was represented in **Fig. 4**.

The **Tables 13-18** concludes that, at pH 6 of the leachate sample with the ZnO catalyst concentration ranging from 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 g/500ml were used in this experiment. In which the maximum removal efficiency of turbidity, total solids, hardness, BOD and COD was resulted as 72%, 58%, 61%, 40% & 43% are occurred at the catalyst concentration of 1.0 g/500ml and optimum reaction times with exposure to sunlight was observed as 300 min. The percentage of removal vs time for the sample was represented in **Fig. 5** and **6.**

S.M.Z. Makhtar, N. Ibrahim and M.T. Selimin [7] has conducted study to examine the % of colour removal of leachate using coagulation as pretreatment, followed by effects of ZnO, pH, stirring time and solar photocatalytic as final treatment. Using 1.0g/L ZnO at pH 5 capable of removing 97% colour after 120 min exposure in sunlight. He concluded that pH is a very important parameter for photocatalytic removal for colour in landfill leachate. L. Mansouri, L. Bousselmi and A. Ghrabi [8] studied that biological pre-treated landfill leachates contains macromolecular organic

substances that are resistant to biological degradation J. Rajesh Banu, Sudalyandi Kaliappan, *et al.,* [9] has studied that anaerobic and solar photocatalytic method for the treatment of domestic wastewater. The optimum pH and TiO_2 catalyst loading for the solar photochemical oxidation were found to be 5 and 2 g/L, respectively. The combined COD removal due to the combination of these two technologies was found to be 96% at 5 hour exposure time. Josmaria Lopes de Morais, *et al.,* [10] studied that mature landfill leachates contain some macromolecular organic substances that are resistant to biological degradation. Zhao Meng, *et al.,* [11] suggested that ZnO is an excellent photocatalytic oxidation material. It has been widely used to deal with wastewater, such as pharmacy wastewater, printing and dyeing wastes, papermaking wastewater, leachate and so on.

The catalytic activity of nano-ZnO is much better than normal materials. It can also absorb the light in wider spectrum. Its catalytic activity is mostly affected by the dosage of the catalyst, the original concentration of reactants, illumination time, intensity of illumination, pH value and atmosphere (oxygen) flow, etc. Falah H. Hussein, *et al.,* [12] investigated experimentally the removal of the dyestuff from dyeing textile industrial wastewater by photo-sensitization process, for reusing it in the same industry or for domestic purpose and/or irrigation. The decolourization was 100% after different periods of time ranging from 10 to 100 minutes. The results indicate clearly that titanium dioxide and zinc oxide could be used efficiently in photocatalytic treatments of textile industrial wastewater. Falah H. Hussein, Thekra A. Abass [13] observed that the existence of catalyst and lights are essential for photocatalytic degradation of colored dyes. Complete decolorization of textile industrial wastewater could be obtained, after less than one hour of irradiation (mercury lamp) at 320 K, when 3.5 g/L ZnO was used and in less than 1.5 hours, when 1.75 g/L of anatase was used at the same temperature.

Hamza A., Fatuase J.T., *et al.,* [14] has studied that the solar photocatalytic degradation of phenol using nanosized ZnO and α-Fe_2O_3 synthesized via precipitation route. The synthesized ZnO and α-Fe_2O_3 were characterized using XRD, UV/Vis and surface area analysis. α-Fe_2O_3 was found to exhibit better solar photocatalytic activity than ZnO under identical experimental conditions due to the larger surface area and low band gap of α- Fe_2O_3. S. Shanmuga Priya, *et al.,* [15] investigated experimentally the solar photocatalytic treatment, using 100 ppm of phenol wastewater employing 0.2 g/L of $Ti0_2$ as catalyst an experiment was conducted in the month of December in repeated trials under actual solar radiation in Tiruchirappalli field conditions. The COD was monitored for every one hour time period and complete degradation of phenol wastewater was possible in 4 hours. The results indicate that even in the month of December when the solar intensity was quite low it proved that the degradation of phenol was possible in 4 hours by employing agitation of the reaction mixture.

CONCLUSION: The landfill leachates contain large quantities of organic and inorganic matters, heavy metals and it is high strength wastewater exhibiting acute and chronic toxicity. Untreated leachates can permeate ground water or mix with surface waters and contribute to the pollution of soil, ground water, and surface water. So the proper leachate treatment process is mandatory one. These leachate treatment processes are carried out efficiently by solar photocatalysis process by using ZnO as catalysts. Solar photocatalytic treatment has proved as an efficient technique for leachate treatment through a photocatalytic process.

The solar photocatalytic treatment of leachate with zinc oxide (ZnO) as catalyst dosage of 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 g/500ml an experiment was conducted by maintaining pH 4, 5 and 6 of the leachate sample with exposure to sunlight in 5 h of time. The characteristics of leachate sample were monitored for every one hour of time period. From this project it was observed that the maximum pollutant removal was occurred at the pH 5 of the leachate sample than in pH 4 and 6.

At controlled pH 5 of the sample, the optimum removal percentage of turbidity, total solids, hardness, BOD, and COD was noted as 81%, 60%, 72%, 51% and 48% respectively in the leachate sample was observed with the ZnO as catalyst concentration of 1.0 g/500ml after 300 min of exposure time in sunlight. Semiconductor catalysts ZnO have been widely used to mineralize harmful

organic pollutants in wastewater into less damaging inorganic nontoxic compounds like CO_2, HCl and water [16]. Several studies have been carried out for decolonization of industrial wastewater by using photocatalysis and bacteria treatment [17-19]. The pH value of the aqueous solution is a key parameter for photocatalytic degradation of wastewater and dyes because it affects the adsorption of pollutants that happens at the surface of photocatalysts [20-22].

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