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A COMPARATIVE STUDY ON THE TREATMENT OF LANDFILL LEACHATE USING SILVER NANOPARTICLES AND ALGAE

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Abstract – *The study focuses on the treatment of landfill leachate using nanoparticles and algae. The nanoparticles used are silver nanoparticles and the alga used is chlorella vulgaris. Generation of landfill leachate is a major problem and it should be treated properly. Landfill leachate is the highly polluted waste water which is formed as the result of precipitation entering the landfill. It can have severe effects on the groundwater as well as surface water. The amount of COD, Nitrate, ammonia, TDS etc. will be very high. Leachate not only pollutes the ground water but also it generates lot of toxic gases and also it may damage the reinforcement of the nearby buildings. The binding strength of concrete is also affected. In this study, the comparison between silver nanoparticles and chlorella based on their removal efficiency is main focus.*

Key Words: Leachate, silver nanoparticles, chlorella vulgaris, COD, TDS, nitrate, ammonia

1. INTRODUCTION

Leachate is very strong waste water due to its heavy organic loading and its toxic compounds. It affects the water quality and also the nearby buildings. It also affects the surface water as well as ground water. The water in the wells nearby will get polluted as the leachate seeps down into the earth. It imparts bad smell and taste to the water thus making it unfit for drinking. Hence treatment of this leachate is of great concern. Various treatment methods are available. This may include physicochemical methods, biological methods etc. Physicochemical methods include photo catalytic oxidation, adsorption, reverse osmosis etc. Whereas biological methods involves activated sludge, aerobic/ anaerobic systems, rotating biological contactors etc. Here we adopt the adsorption process for the treatment. Nanoparticles are ultra fine particles usually of diameter between 1 and 100 nm. Silver is a very good antimicrobial agent, it can be used in the disinfection of water. The use of algae for the purpose of water treatment is termed as phycoremediation. Treatment of leachate using algae can be considered a promising method. Algae consume pollutants in the waste water as their growth nutrients.

1.1 Objectives

1. To determine the feasibility of nanoparticles and algae in the treatment of leachate.
2. To determine the removal efficiency of both nanoparticles and algae in various parameters of leachate such as pH, COD, Nitrate, Ammonia nitrogen and TDS.
3. To find out the optimum contact time and dosage.
4. To compare the removal efficiency of both.

2. MATERIALS AND METHODOLOGY

2.1 Collection of landfill leachate

- The landfill leachate was collected from Njeliyamparamba landfill site.
- The leachate is collected in a High Density Polyethylene (HDPE) can of 2.5 L capacity.
- As soon as the collection is completed the leachate is stored in refrigerator

Fig 1: Leachate collected in HDPE cans

2.2 Characterizations of the nanoparticles

a) Molecular formula: Ag
b) APS: 30-50 nm
c) Bulk density: 0.312g/cm^3
d) Color: Dark grey
e) Morphology: Spherical
f) Crystallographic structure: Cubic
g) Atomic weight: 107.87g/mol

h) Boiling point: 2212˚C

Fig 2: Silver nanoparticles

2.3 Culture of Algae

Take a sterilized bucket and fill half to two-third of the bucket with distilled water. Add the chlorella culture into the water in the bucket with a spoon. Also add urea fertilizer as a nutrient for the growth of algae. Place the bucket on a sunny spot inside, near a windowsill is perfect. Also attach a thermometer to monitor the temperature of the water in the bucket.

Fig 3: Culture of algae

2.4 Treatment process

2.4.1 Adsorption using Magnetic Stirrer

1. 80ml of leachate sample is taken in a 100ml standard flask.
2. Silver nanoparticle is taken and weighed.
3. It is then added to the sample (initial dosage:500mg/L).
4. Then dissolve the nanoparticles and then make up to 100ml.
5. Transfer the contents into a 250ml beaker and shake using magnetic stirrer at 150rpm for 5min.
6. The process is continued for different contact time (10, 15, 20 min).
7. The efficiency is calculated and the optimum contact time is obtained.
8. Then the treatment is done again with the optimum contact time, 150rpm and varying dosages (500, 1000, 1500, 2000, 2500 mg/L).

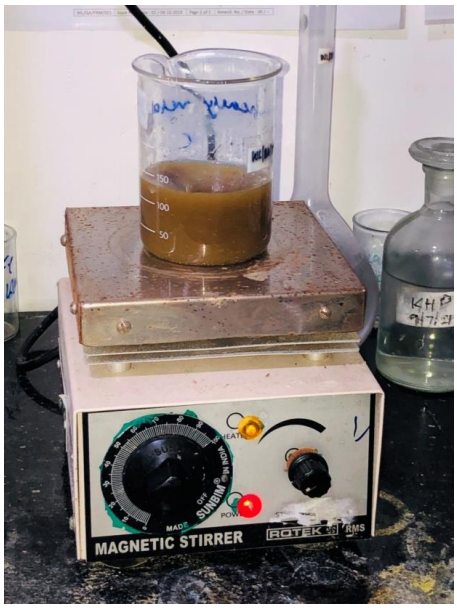

Fig-4: Magnetic Stirrer

Similarly treatment is done using chlorella in a magnetic stirrer with dosage 1000mg/L.

3. RESULTS AND DISCUSSIONS

3.1 Preliminary Analysis

Table-1: Preliminary Analysis

SI.No	Parameter	APHA Method	Unit	Obtained values	CPCB Disposal Limits
1	TDS	2540 C	mg/L	15900	No Limit
2	Conductivity @ 25 °C	2510 B	mS/cm	21.2	No Limit
3	pH@ 25 °C	4500 H^+B	-	4.27	5.5- 9.0
4	COD	5520 B	mg/L	28220	Max 250
5	Ammonia	4500 NH_3 B	mg/L	23	Max 30
6	Nitrate	4500 NO_3 B	mg/L	875	No Limit

3.2 AFTER TREATMENT WITH AgNP & CHLORELLA

3.2.1 Treatment using silver nanoparticles (varying contact time)

Table 2: concentrations of various parameters at varying contact time

Parameters	Contact time (mins)			
	5	10	15	20
pH	4.33	4.68	4.75	4.73
TDS (mg/L)	13800	11860	8299	8028
Conductivity (ms/cm)	18.4	15.9	11.1	10.7
Nitrate (mg/L)	788	723	538	496
COD (mg/L)	22570	18510	12030	10586
Ammonia (mg/L)	20	16.4	11.3	10.9

3.3 Treatment using Chlorella

Table-3: various parameters at varying contact time

Parameters	Contact time (mins)			
	5	10	15	20
pH	4.78	4.89	4.94	5.13
TDS (mg/L)	14950	13460	11844	9119
Conductivity (ms/cm)	19.9	17.9	15.8	12.2
Nitrate (mg/L)	842	811	762	678
COD (mg/L)	25680	22830	19862	15030
Ammonia (mg/L)	22.3	21.2	19.1	13.6

In the above experiment a greater efficiency is shown by AgNP than Green Algae. Among, maximum removal was obtained at 15 mins, 1000 mg/L for AgNP. The removal efficiency for TDS was 5.97% for 5min contact time; it is then increased as 15.34% for 10 min contact time. For 15min contact time the percentage removal was 25.5%. Finally for 20 min the efficiency obtained was 42.64%. Similarly for conductivity, COD, ammonia and nitrate the removal efficiencies increase as the time increases. When compared to silver nanoparticles the efficiency of chlorella is very low.

Further experiment is conducted with varying AgNP concentrations keeping contact time, rpm & settling time constant. The contact time, RPM, settling time are 15min, 150 rpm, 20min respectively. The dosages vary from 500mg/L to 2500mg/L. The results obtained are as follows:

3.4 Treatment using silver nanoparticles (varying dosages)

Table 4: Concentrations of various parameters at varying dosages

Parameters	Dosage (mg/L)				
	500	1000	1500	2000	2500
pH	4.68	4.75	4.78	4.69	4.66
TDS (mg/L)	12830	8299	7980	6460	6331
Conductivity (ms/cm)	16.9	11.1	10.6	8.6	8.44
Nitrate (mg/L)	728	538	505	336	318
COD (mg/L)	13860	12030	11350	8902	8652
Ammonia (mg/L)	18.3	11.3	10.5	7.38	6.93

3.3 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.

$$Efficiency = \frac{initial\ value - final\ value}{initial\ value} x100$$

3.3.1 Removal Efficiency of silver nanoparticles

Table-5: Removal Efficiency obtained with varying contact time (AgNP)

	5 min	10 min	15 min	20 min
TDS	13.20	25.41	47.805	49.51
Conductivity	13.20	25	47.64	49.52
pH	-	-	-	-
COD	20.02	34.408	57.37	62.48
Ammonia	13.043	28.69	50.86	52.60
Nitrate	9.94	17.37	38.51	43.31

3.3.2 Removal Efficiency of chlorella

Table-6: Removal Efficiency with varying contact time (chlorella)

	5 min	10 min	15 min	20 min
TDS	5.97	15.34	25.5	42.64
Conductivity	.13	15.56	25.47	42.45
pH	-	-	-	-
COD	9	19.09	29.61	46.73
Ammonia	3.04	7.86	16.95	40.86
Nitrate	3.77	7.31	12.91	22.51

3.3.2 Removal Efficiency with silver nanoparticles (varying dosages)

Table-7: Removal Efficiency with varying dosages of silver nanoparticles

	500 mg/L	1000 mg/L	1500 mg/L	2000 mg/L	2500 mg/L
TDS	19.30	47.805	49.81	59.37	60.18
Conductivity	20.28	47.64	50	59.43	60.18
pH	-	-	-	-	-
COD	50.88	57.37	59.78	68.45	69.34
Ammonia	20.43	50.86	54.34	67.91	69.86
Nitrate	16.8	38.51	42.28	61.6	63.65

3.3.3 Percentage removal obtained in varying contact time (AgNP)

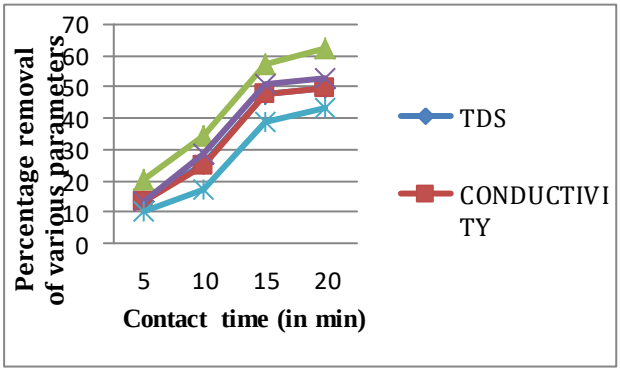

Fig 5: Effect of AgNP on various parameters under varying contact time

3.3.4 Percentage removal obtained in varying contact time (chlorella)

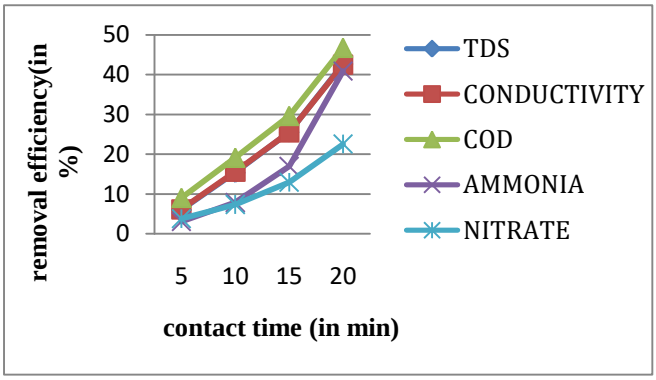

Fig 6: Effect of chlorella on various parameters under varying contact time

3.3.5 Percentage removal obtained in varying dosages (AgNP)

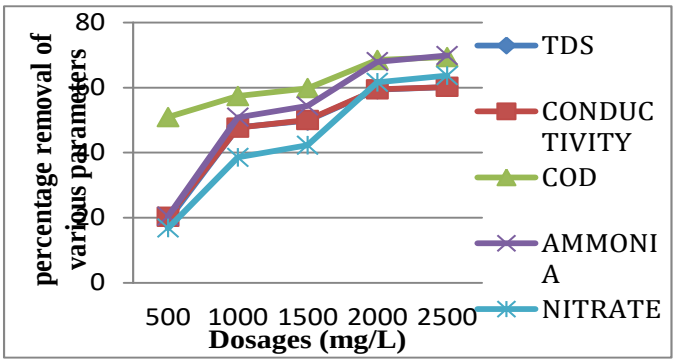

Fig: 7 Percentage Removal of Various Parameters

4. CONCLUSIONS

1. From the study conducted, it is found that silver nanoparticles are more efficient than chlorella.
2. The optimum contact time and dosage are obtained and are 15min and 2000mg/L respectively.
3. Chlorella is found to be less efficient, but also the maximum removal efficiency is attained at 15 min contact time.
4. Removal efficiency for TDS, conductivity, COD, ammonia, nitrate are 59.3%, 59.4%, 68.45%, 67.91%, 61.6% respectively for a dosage of 2000mg/L and contact time 15min.
5. Hence the use of nanoparticles can be mentioned as a promising method for the treatment of leachate.

REFERENCES

1. **Safaa M, Ahmed M and Hala A Hegazi (2013),**Treatment of leachate from municipal Solid Waste landfill,HBRC journal volume 9,issue 2

2. **A. Paskuliakova, S. Tonry and N. Touzet (2016),** Microalgae isolation and selection for the treatment of landfill leachate, Centre for environmental research innovation and sustainability (CERIS)

3. **Emienour-Muzalina Mustafa, Siew Moi Phang and Wan-Loy Chu (2012),** Use of an algal consortium of five algae in the treatment of landfill leachate using the high rate algal pond system, Journal of applied phycology.

4. **Dongjo Kim, Sunho Jeong and Jooho Moon (2006),** Synthesis of silver nanoparticles using the polyol process and the influence of precursor injection, Department of material science and engineering

5. **Azhar Abdul Halim, Noor Nazurah Zainal Abidin, Normah Awang, Anuar Ithnin, MohammedSham Othman and Mohammed Ikram Wahab (2011),** Ammonia and COD removal from synthetic leachate using rice husk composite adsorbent, Journal of urban and environmental engineering.

6. **MeththikaVithanage,S.S.R.M.D.Wijesekara, I.P.L.Jayarathna, Anuradha Prakash, Seema Sharma and Ashok Kumar Ghosh (2014),** Engineered nanomaterials for landfill leachate treatment in the humid tropics : The Sri Lankan perspective, Aqua nanotechnology: Global prospects

7. **Zahra Esfahani Kashitarash, Samadi Mohammad Taghi, and Rahmani Alireza,** Application of Iron nanoparticles in landfill leachate treatment-case study: Hamdan landfill leachate, Iranian journal of environmental health science and engineering.

8. **R.Stegmannv, K.-U.Heyer and R.Cossu (2005),** Leachate treatment, Tenth international waste management and landfill symposium

9. **Tabish Nawaz, Ashiqur Rahman, Shanglei Pan, Kyleigh Dixon, Burgandy Petri and Thinesh Selvaratnam (2020),** A review of landfill leachate treatment by microalgae: current status and future directions

10. **Jeirish Daniel. J, Gajendran. C, Jeyapriya (2019),** Green synthesis of nanoparticles and their application in treating leachate of municipal solid waste landfills, International journal of Civil Engineering and technology (IJCIET)