

# Study of Ammoniacal Nitrogen Removal from Leachate of Sanitary Landfills in Hilly Terrain

Atul Sharma<sup>1</sup>, Dr. Surjit Singh Katoch<sup>2</sup>

<sup>1</sup>M.Tech. Student NIT Hamirpur (H.P.) INDIA

<sup>2</sup>Associate Professor, CEEE, NIT Hamirpur (H.P.) INDIA

**Abstract** – Nearness of ammoniacal nitrogen in the leachate is one of the serious issue looked by administrators of landfill. Generally, quantity of organic waste present at landfill site is high; the slow leaching of this organic waste produces nitrogen in high concentration also there is no significant mechanism for the alteration of ammoniacal nitrogen. This cause very high amount of ammoniacal nitrogen concentration in landfill leachate over a long period. A literature review regards this shows that, ammoniacal nitrogen removal from landfill leachate is not well defined and to date, especially in the adsorption treatment. In addition, there are limited studies in hilly terrain of India on this regards.

The principle goal of this study was to research the appropriateness of brick dust, Activated carbon and mixture of these two materials as adsorption medium for the elimination of ammoniacal nitrogen from leachate, which present in significant amount (around 500 to 1600 mg/L). Adsorption experiments were performed in batch mode. This choice for using brick dust was motivated primarily from economic consideration and their abundance. Activated carbon has good adsorption capability. Brick dust also has higher adsorption capability and hence a mixture of brick dust and activated carbon allows us to combine good adsorption property with lesser cost as brick dust can be procured at negligible amount. The aftereffect of this investigation demonstrates that around 40%-80% of ammoniacal nitrogen (with focus around 1000 mg/L) can be expel financially by blending initiated carbon with brick dust and can be actually useful as a financially savvy medium to substitute activated carbon for the expulsion of ammoniacal nitrogen from procured landfill leachate at a considerable low cost.

**Key Words:** Leachate, Ammoniacal Nitrogen, Brick dust

## 1. INTRODUCTION

Nowadays, municipal solid waste is a big threat arising in most the countries including India. Almost every societal element is responsible for this problem, due to low public

awareness and community sensitization. Municipal solid waste contains a big portion of biodegradable waste that creates smell and other problems if not handled properly. Most of this organic waste comes from house, restaurants, pulp and paper industries, which if not collected separately end up in solid waste along with the other non-decomposable waste leading to larger quantity to be handled at treatment and dumping site. Also segregation of this decomposable waste at processing site is almost impossible or the efficiency remains very low. With proper management planning and peoples cooperation waste segregation at source could help by reducing burden on treatment facilities in terms of waste and leachate quantity.

Solid waste administration is a troublesome undertaking, which incorporates the control of waste production, storage, gathering, exchange and transfer of Solid waste in an earth safe way. In India as of now transfer of Solid waste depends chiefly on landfills. Landfill of MSW is the easiest, least expensive and most practical strategy for transfer of Solid waste in both under-developed and developing countries of the world. Most landfills are normally open dumps or unlined landfills. These sort of landfills results to groundwater sullyng, which further can make different ailments their client. The degree of this risk relies upon the fixation and lethality of poisons present in leachate, type and penetrability of topographical strata, profundity of water table and the heading of groundwater stream.



**Fig -1:** Landfill site Located at Dugnehri, Hamirpur (H.P.)

## 1.1 Landfill Leachate

Leachate produced from metropolitan solid waste landfill site and characterized as an intensely contaminated wastewater. Landfill leachate is a heterogeneous blend of refracting natural compound, inorganic contaminants, acids, substantial metals and high nitrogen content. After the leachate generation, consideration of leachate management is an important parameter related to significant arranging, structuring, and task, powerful and long haul viewpoint for the solid waste landfill site.

There are four phases of degradation of Solid waste dumped at a landfill site. These stages are described as Aerobic (oxygen consuming), acidogenic and methanogenic debasement stages which pursued by adjustment. Leachate created in the four stages varies altogether in its structure and amount. At first leachate is high in degradable natural or organic substances and solvent metal salts, and in later stages, it progresses toward becoming non-biodegradable inorganic poisons.

## 1.2 Leachate Treatment

Adsorption is a conventional method for wastewater treatment. It is a physical procedure where accumulation or progression of different contaminants happen on the boundary or surface of adsorbent. The contaminant, which is adsorbed on the interface of adsorbent is called adsorbate. For the extreme adsorption, Adsorbent ought to have an extraordinary level of sweeping surface area on which the obligation of noxious waste can occur. Adsorption phenomena involves two phases from which one phase adsorb the impurity of the other phase. These phases can be liquid- solid, gas- solid and gas- liquid. For the expulsion of noxious waste generated in wastewater which is collected from various sources, adsorbent is the powerful material over which unsafe cations or debasements are adsorbed on the outside of adsorbent.

## 1.3 Scope of Work

There is a requirement of leachate treatment in an efficient manner, so that contamination of ground water and other natural sources could not happen. Drinking of this contaminated water also cause various diseases, so there is a need to treat the leachate with proper and requisite manner. Treatment of leachate with composite mix is a conventional and effective method, so there is a huge possibility to try

various natural and artificial adsorbents to form composite mix.

In this study, the effectiveness of brick dust, which is a waste product of brick kiln industry, checked and compare with other adsorbent's capacity. So that the cost of treatment facility could reduce.

## 2. MATERIAL

### 2.1 Brick Dust

The Brick dust collected from brick kiln, which is located in kutharli village, Hamirpur (H.P.). Brick dust can be categorize according to their particle sizes. Different particle sizes of brick dust have different adsorption capacity. To find the maximum adsorption, sieving of brick dust is done in laboratory. After that, brick dust categorized according to their particle sizes. For this purpose, Brick dust is passing through 1.15nm, 600 $\mu$ m, 300 $\mu$ m and 150 $\mu$ m sieves. After the sieving, Brick dust was dried at 105°C for around 2 hours in the hot air oven.



Fig -2: Sieved Brick Dust

### 2.2 Activated Carbon

In this study, activated carbon (powder) is used as an adsorbent medium along with brick dust for composite mix batch study.

### 2.3 Chemicals

There are various chemicals and reagents used to perform various experiments in this study to attain the objectives of the work. Some chemicals used in the study are listed below:

- Ammonium Sulphate
- Disodium Dihydrogen EDTA dihydrate
- Hexa-Methylenetetramine

- Hydrazine Sulphate
- Mercuric Iodide
- Sodium Hydroxide
- Sodium-Potassium Tartrate Tetra-hydrate
- Zinc Sulphate Heptahydrate etc.

### 2.4 Reagents used for Ammoniacal nitrogen removal

- Ammonia Nitrogen Solution
- Disodium Dihydrogen Ethylene-diamine Tetra acetate Solution (500 g/L)
- Nessler Reagent
- NaOH Solution (240 g/L)
- Sodium Potassium Tartrate Solution (300 g/L)
- Zinc Sulphate Solution (100 g/L)



Fig -3: Nessler reagent

### 3. SPECTROPHOTOMETRIC DETERMINATION OF AMMONIACAL NITROGEN (N-NH<sub>3</sub>)

According to the maximum or standard wavelength, absorption values of serial diluted standard solution of known amount of interested quantity was determined, and these values were plotted, on graph so that a trend line may develop.

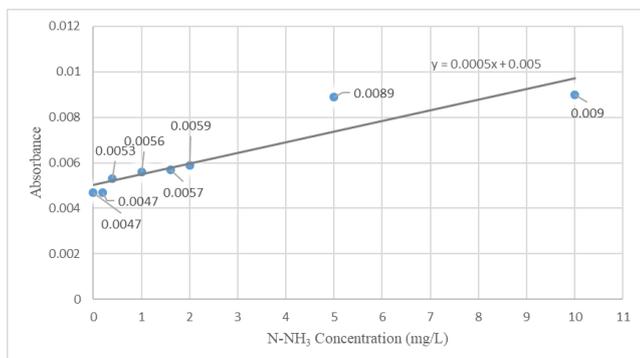


Chart -1: Maximum wavelength of standard solution

After that, the absorption value of samples were determined with the help of interpolation or extrapolation on linear line and ammoniacal nitrogen concentration were determined.

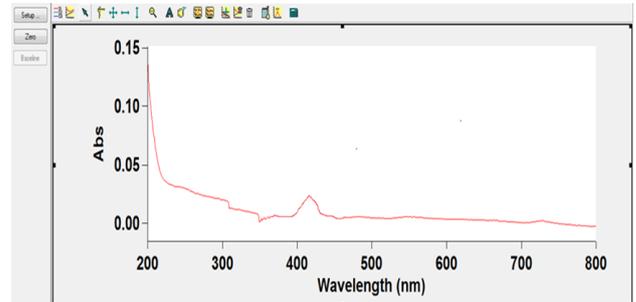


Chart -2: Maximum wavelength of standard solution

Maximum wavelength: 425 nm

Absorbance of leachate sample: 0.3832

Ammoniacal nitrogen concentration in sample: 756.40 mg/L

## 4. RESULTS

### 4.1. Brick Dust as Adsorption Material

We can use the Brick dust as an effective medium for adsorption. In addition, different particle size of brick dust have different absorption capacity. This is because of their different surface area, texture and structural behaviour.

Based on the experiment results a comparative study of leachate samples are performed, which is graphically mentioned below

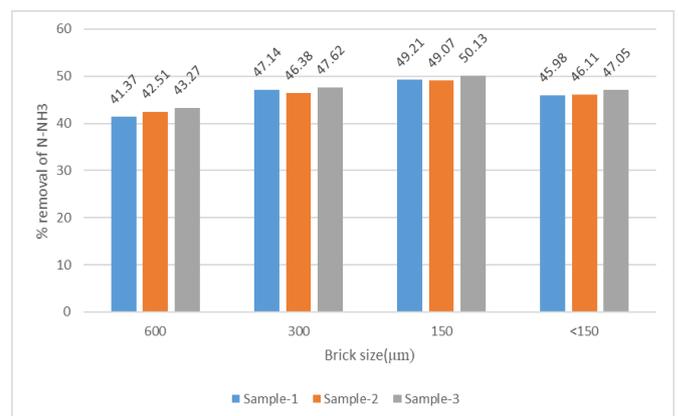


Chart -3: Comparison of removal efficiencies of leachate samples

According to the adsorption experiments performed on brick dust, the most effective size of brick dust for adsorption of

ammoniacal nitrogen is 150 µm for all experimented leachate samples.

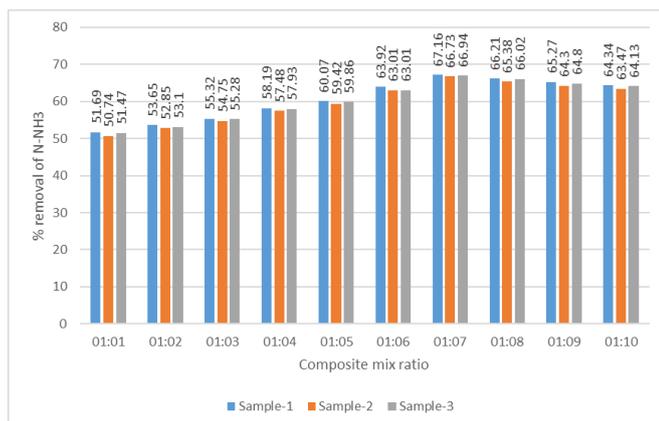
This particular size of brick dust is further used in experiments as composite material with activated carbon for removal of ammoniacal nitrogen as an adsorbent material.

#### 4.2. Adsorption with Composite Mix of Activated Carbon and Brick Dust (150 µm)

**Table -1:** Effectiveness of Composite Mix to Remove Ammoniacal Nitrogen (*Sample-1*).

Composite Mix Ratio (Activated Carbon : Brick Dust)	Initial Concentration (mg/L)	Final Concentration (mg/L)	% Removal of N-NH <sub>3</sub>
1:1	756.40	368.01	51.69
1:2	756.40	350.59	53.65
1:3	756.40	337.95	55.32
1:4	756.40	316.25	58.19
1:5	756.40	302.03	60.07
1:6	756.40	272.90	63.92
1:7	756.40	248.40	67.16
1:8	756.40	255.58	66.73
1:9	756.40	262.69	65.38
1:10	756.40	269.73	64.13

Similar result table for sample 2 and 3



**Chart -4:** Comparison of composite mix and % removal of ammoniacal nitrogen

This experimental study shows that, the presence of brick dust with activated carbon in various proportions affects the efficiency of ammoniacal nitrogen removal.

However, efficiency of removal is increasing with higher proportion of brick dust in composite mix, until the mix ratio reaches 1:7 of activated carbon and brick dust. After that, there is gradual change occur in efficiency and a sudden drop found in efficiency.

### 3. CONCLUSIONS

During the physic-chemical analysis, leachate samples collected was found as basic and possesses high turbidity with high suspended solids that means disposal or introduction of leachate into groundwater may result high organic content which will reduce the dissolve oxygen in water and make it unfit for many natural process. This requires proper treatment of leachate produced from landfill or disposal sites. Conventionally for ammoniacal nitrogen removal from leachate sand bed, clay, zeolite, limestone, activated carbon is used.

In this study brick dust was used to verify its potential to use as adsorbent. Adsorption experiments were performed in batch mode. This choice for using brick dust was motivated primarily from economic consideration and their abundance. Activated carbon has good adsorption capability. Brick dust also has higher adsorption capability and hence a mixture of brick dust and activated carbon allows us to combine good adsorption property with lesser cost as brick dust can be procured at negligible amount.

The maximum adsorption capacity for brick dust was found to be higher for 150 mm and when used with activated carbon the best performing ratio of these was 1:7. The reason for the increase in adsorption capacity is the higher specific surface area provided by brick dust. To conclude brick dust by itself is not an effective adsorbent. However, we can mix brick powder with activated carbon to increase the efficiency. Economic feasibility of brick dust for the stabilized landfill leachate can be assess under tropical climatic condition.

### ACKNOWLEDGEMENT

Firstly, I would like to express my sincere gratitude to my supervisor Dr. Surjit Singh Katoch for the continuous support for my study and research, for his patience, enthusiasm, and immense knowledge.

Besides my supervisor, I would like to thank and express my gratitude to other faculty members for their insightful comments and encouragement, but also for the hard question, which incented me to widen my research from

various perspectives. I am thankful to all the staff of CEEE, NIT Hamirpur for providing me the necessary support.

Last but not the least, I would like to thank my parents and friends for supporting me spiritually throughout this research work.

## REFERENCES

- [1] Abdelwaheb, A., Moncef, Z., and Hamed, B.D., (2012). Landfill Leachate Generation and Its Impact on Water at an Urban Landfill (Jebel Chakir, Tunisia). *Hydrology Current Research*, 3: 128. Doi: 10.4172/2157-7587.1000128
- [2] Aziz, H.A, Adlan MN, Zahari MSM, and Alias S., (2004). Removal of ammoniacal nitrogen (N-NH<sub>3</sub>) from municipal solid waste leachate by using activated carbon and limestone. *Waste Management and Research*, 22:371-5.
- [3] Bhalla B, Saini MS, and Jha MK, (2012). Characterization of leachate from Municipal Solid Waste (MSW) Landfilling Sites of Ludhiana, India. A Comparative Study. *International Journal of Engineering Research and Applications*, 2 (6) 732-745.
- [4] Carrera, J., Baeza, J.A., Vicent, T., and Lafuente, T., (2003). Biological nitrogen removal of high-strength ammonium industrial wastewater with two-sludge system. *Water Research*, 37 4211-4221.
- [5] Daud, Z., Hijab Abubakar, M., Abdul Kadir, A., Abdul Latiff, A., Awang, H., Abdul Halim, A., and Marto, A., (2016). Optimization of Leachate Treatment with Granular Biomedia: Feldspar and Zeolite. *Indian Journal of Science and Technology*, 9(37). doi:10.17485/ijst/2016/v9i37/91845
- [6] Foo, K.Y., and Hameed, B.H., (2009). An overview of landfill leachate treatment via activated carbon adsorption process. *Journal of Hazardous Materials*, 171 (1), 54-60.
- [7] Halim, A.A., Aziz, H.A., Johari, M.A.M., Ariffin, K.S., and Adlan, M.N., (2010a). Ammoniacal nitrogen and COD removal from semi-aerobic landfill leachate using a composite adsorbent: Fixed-bed column adsorption performance. *Journal of Hazardous Materials*, 175, 960-964.
- [8] Halim, A.A., Aziz, H.A., Megat Azmi, M.J., and Ariffin, K.S., (2010b). Comparison study of ammonia and COD adsorption on zeolite, activated carbon and composite materials in landfill leachate treatment. *Desalination*, 262, 31-35.
- [9] Heavey, M., (2003). Low-cost treatment of landfill leachate using peat. *Waste Management*, 23, 447-454.
- [10] Ishak, A.R., Hamid, F.B., Mohamad, S., and Tay, K.S., (2017). Removal of organic matter from stabilized landfill leachate using Coagulation-Flocculation-Fenton coupled with activated charcoal adsorption. *Waste management and research: the journal of the International Solid Wastes and Public Cleansing Association, ISWA*, 35-7, 739-746.
- [11] Jokela, J.P.Y., Kettunan, R. H., Sormunen, K.M., and Rintala, J.A., (2002). Biological nitrogen removal from municipal landfill leachate: low-cost nitrification in biofilters and laboratory scale in-situ denitrification. *Water Research*, 36, 4079-4087.
- [12] Kumar, G. S., Bharadwaj, J., Lakshmi S. P., and Chandra S. M., (2016). Removal of Ammonia Nitrogen (NH<sub>4</sub>-N) from Landfill Leachate by Chemical Treatment. *Indian Journal of Science and Technology*, 9(30). doi:10.17485/ijst/2016/v9i30/99174
- [13] Li, X.Z. and Zhao, Q.L., (2001). Efficiency of biological treatment affected by high strength of ammonium-nitrogen in leachate and chemical precipitation of ammonium-nitrogen as pre-treatment. *Chemosphere*, 44, 37-43.
- [14] Martínez-Gallegos S, Rosano-Ortega G, González-Juarez J, Perez-Armendáriz B, Macedo-Miranda G, et al., (2016). Organic Matter Removal from Leachate Using a Mixed Soil-Activated Carbon. *Journal of Pollution Effects and Control*, 4: 174. doi: 10.4174/2375-4397.1000174.
- [15] Michael, E.I., (2017). Evaluation of Leachate Contamination Index Obtained from Dumpsite in Onitsha, Nigeria. *Journal of Environmental and Analytical Toxicology*, 7: 525. DOI: 10.4172/2161-0525.1000525
- [16] Renou S., Givaudan JG, Poulain S., Dirassouyan F., and Moulin P., (2008). Landfill leachate treatment: Review and opportunity. *Journal of Hazardous Materials*, 150: 468-471.
- [17] Rozic, M., Cerjan-Stefanovic, S., Kurajica, S., Vancina, V., and Hodzic, E., (2000). Ammoniacal nitrogen removal from water by treatment with clays and zeolites. *Water Research*, 34(14), 3675-3681.
- [18] Saleem, M., Hameed, I., and Kashif, S.R., (2017). Characterization of Lakhodair Landfill Leachate. *Journal of Environmental Analytical Chemistry*, 4: 219. DOI: 10.4172/2380-2391.1000219
- [19] Selvaraju, N., and Pushpavanam, S., (2009). Adsorption characteristics on sand and brick beds. *Chemical Engineering Journal*, 147(2-3), 130-138. doi:10.1016/j.cej.2008.06.040
- [20] Singh, S., Raju, N.J., Gossel, W., and Wycisk, P., (2016). Assessment of pollution potential of leachate from the municipal solid waste disposal site and its impact on groundwater quality. Varanasi environs India. *Arab Journal of Geoscience*, 9: 131.
- [21] Zhang, T., Ding, L., and Ren, H., (2009). Pre-treatment of ammonium removal from landfill leachate by chemical precipitation, *Journal of Hazardous Materials*, 166 911-915.