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TREATMENT OF LANDFILL LYSIMETER LEACHATE AND EVALUATING LEACHATE TREATMENT TECHNIQUE

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ABSTRACT

In this paper, leachate treatment efficiency was evaluated by using natural coagulant *Zea mays* powder (Corncob) and conventional Fenton process. Leachate treatment value can be used to estimate the leachate pollutant potential of landfill sites, especially in areas where there is a significant danger of leachate migration and groundwater pollution. Corncob powder is a natural coagulant and locally available waste materials, which can be used to treat landfill leachate contamination. Conventional Fenton process is also a modern technology for treating Leachate at a high level of purification. For this study, leachate sample was collected from landfill Lysimeter adjacent to the waste management plant at KUET campus. This leachate was analysed 6 significant parameters pH, BOD_5, COD, NH_4-N, Turbidity and TDS. The concentration of all the studied leachate pollutant parameters exceeded the permissible limits. *Zea mays* Powder and the Fenton reagent are both effective at reducing pollutant concentrations in landfill Lysimeter leachate.

***Key words**: Corncob, Leachate, Fenton process, Lysimeter, Coagulant, Pollutant*

Introduction

Environmental protection has recently become a major source of concern, particularly from a global standpoint. The pollution of the environment has reached a point where it needs to be examined and addressed, or it will cause disasters within civilizations. Waste management has become one of today's major environmental challenges as a result of increased waste production. For many decades, landfills have served as the final disposal site for residential, commercial, and industrial (both innocuous and hazardous) wastes (John Edward Riester and Jr,1994). Leachate from landfills also seriously pollutes groundwater and surface waters. The chemical characteristics of leachate vary significantly and are typically different from one country to another and from one residential area to another as a function of various factors, including waste composition, the degree of waste degradation, moisture content, hydrological conditions, and climatic conditions (Wang Z. Z. et al. 2002). Leachate from modern sanitary landfills has been reported to pollute groundwater. Municipal solid waste (MSW) disposed of in landfills occasionally leaks liquid, known as landfill leachate, into the environment. This liquid might already be present in the landfill or it might form as a result of rainwater interacting with the chemical waste there (Rafizul et al. 2009). It is generally dark in colour and has a strong odour (Azmi et al. 2015). It is produced by excess water percolating with a mixture of organic and inorganic loads within the waste layers of the landfill, yielding a quantity of leachate depending on the amount of rainfall. (Azmi et al. 2015). This leachate is a highly concentrated complex effluent containing dissolved organic matter, inorganic compounds, heavy metals, and xenobiotics substances. (M. Vinodh Kumar et al. 2018). The management of leachate is one of the most important factors to consider when planning, designing, operating, and long-term management of an MSW landfill (M. Vinodh Kumar et al. 2018). The processes for collecting and treating leachate are complex, and the costs are usually quite high. In this situation we can develop a device named Lysimeter. It is a device which can produce Leachate. This Lysimeter has already been installed adjacent to the waste management plant at KUET campus. In this paper, we used landfill Lysimeter leachate for our leachate treatment purpose.

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Leachate collection and treatment are now standard procedures to avoid environmental pollution. In this study, Fenton reagent and natural coagulant as *Zea mays* powder (Corncob) were used to characterize the leachate that was collected from the leachate collection chamber of the sanitary landfill Lysimeter on the KUET campus. The best dosages of the Fenton and Corncob powder were initially determined for the removal of the pollutant parameters, and these doses were then chosen for the treatment of leachate at pH ranges of 4 to 9. Conventional lab methods were used to analyse leachate samples and a number of variables were measured and monitored. The primary goals of this study are as follows (i) to determine the characteristics of untreated leachate; (ii) to study the effectiveness of treating leachate using: Fenton reagent and Corncob powder (iii) to compare the efficiencies of the used materials to reduce the different Leachate pollutant parameters.

ALTERNATIVES TECHNIQUES OF LEACHATE TREATMENT

There are three main ways to treat leachate that has been extracted from MSW that has been disposed in landfills: physical, chemical, and biological treatments. A treatment plan may combine two or three of the existing techniques. The two primary physical leachate treatment methods are air-stripping and adsorption (Amokarane et al. 1997; Bohdziewicz et al. 2001; Morawe et al. 1995; Trebouet et al. 2001). Some other techniques used to treat landfill leachate include coagulation-flocculation, chemical precipitation, chemical and electrochemical oxidation (Amokarane et al. 1997; Ahn et al. 2002; Chiang et al. 2001; Lin and Chang C.H, 2000); Steensen and M., 1997; Marttinen et al. 2002). Leachate characteristics (organic and inorganic contents) are one factor that affects the choice of the best leachate treatment methods: hazardous nature (concentration of toxic metals, both organic and inorganic); Treatment intensity (leachate properties, legal requirements and discharge alternatives). Depending on the age of the leachate from the landfill, the efficiency of the leachate treatment processes varies (Loudidou et al. 2000). These are shown below-
Biological treatment process: It is suitable for young landfill leachate. But this is not suitable for old leachate having high range of COD value.

Coagulation-flocculation process: It is usually used for treating fresh leachate and it is applied as a pre-treatment before biological treatment. But it gives a satisfactory result when it is used combined with other processes such as reverse osmosis (Ozturk et al. 2003), photo-oxidation and biological treatment. In these study natural coagulant such as *Zea mays* powder has been used.

Chemical oxidation: It is suitable for all types of landfill Lysimeter leachate. The efficiency of chemical oxidation is much higher than other type of treatment process. Many types of chemicals have been used for chemical oxidation and Fenton reagent is one of them. Although the Fenton reaction has been used to destroy hazardous organic materials since the late 1960’s (Huang et al. 1993) leachate treatment using this method has only recently been reported. In this study, Fenton reagent is used to treatment of landfill Lysimeter leachate. Recent years have seen the development of advanced oxidation processes (AOP), such as UV/Fe^{2+} + H_2O_2 and UV/TiO_2, as a viable alternative to mineralization of recalcitrant organics in wastewater and landfill leachates (Watts et al. 1999; Cho et al. 2002; Teel et al. 2002; Wang F. S.-D et al. 2003).

MATERIALS AND METHODS

To determine the average characteristics of leachate, raw leachate collected from a leachate collection chamber was taken for laboratory analysis. Among the results of the laboratory analysis of leachate are:

1. pH by pH meter (HACH, Model No. Sens ion 156),
2. Total Dissolved Solid by manually,
3. Turbidity by using turbidity meter,
4. Biochemical Oxygen Demand at 5 days (BOD_5) by Winkler method,
5. Chemical Oxygen Demand (COD) by spectrophotometer
6. NH_3-N by spectrophotometer

Two types of materials namely Fenton reagent and *Zea mays* powder were used. Among them Fenton reagent is well tested and widely used. Fenton reagent is a mixer of Ferrous Sulphate ($FeSO_4$) and Hydrogen Peroxide (H_2O_2). The conventional Fenton process is mainly involves the sequence of reactions below

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + {}^{*}OH + OH^{-} \quad (1)$$

$$Fe^{3+} + H_2O_2 \rightarrow Fe^{2+} + HO^{*}_2 + H^{+} \quad (2)$$

$${}^{*}OH + H_2O_2 \rightarrow HO^{*}_2 + H_2O \quad (3)$$

$${}^{*}OH + Fe^{2+} \rightarrow Fe^{3+} + OH^{-} \quad (4)$$

$$Fe^{2+} + HO^{*}_2 \rightarrow Fe^{2+} + O_2H^{+} \quad (5)$$

$$Fe^{2+} + HO^{*}_2 + H^{+} \rightarrow Fe^{3+} + H_2O_2 \quad (6)$$

$$2HO^{*}_2 \rightarrow H_2O_2 + O_2 \quad (7)$$

Through Equation (1) hydroxyl radicals are quickly produced. Iron cycles between Fe^{2+} and Fe^{3+} in the above reactions, acting as a catalyst. Net reaction of equation (1–7) is the iron-catalyzed breakdown of H_2O_2 into water and oxygen.

$$2H_2O_2 \rightarrow 2H_2O + O_2 \quad (8)$$

Hydroxyl radicals can attack organic materials in the presence of organic compounds using the following four methods: radical addition, hydrogen abstraction, electron transfer, and radical combination (SES, 1994). When hydroxyl radicals and organic compounds react, carbon-centered radicals (Rd) are created. Rd can quickly and typically irreversibly react with O_2 in water.

$$R^{*} + O_2 \rightarrow \rightarrow R(-OH^{+}) + HO^{*}_2 \quad (9)$$

$$R^{*} + O_2 \rightarrow R\text{--}OO^{*} \rightarrow\rightarrow R\text{----}O^{*} \quad (10)$$

These radicals R^*, R-OO*, and R-O* can couple or deviate from one another to create relatively stable molecules, or they can react with iron ions (Pignatello and JJ, 1992). The produced organic intermediates may continue to react with hydroxyl radicals and O_2, thus leading to further decomposition and even final mineralization to water and CO_2.

On the other work *Zea mays* were collected (figure 1) locally and repeatedly washed with water to get rid of any dirt or soluble impurities. It spent nearly a week being dried in direct sunlight. By heating the coagulant to a temperature of about 200˚C without any oxygen present, the coagulant was carbonized. The adsorbent was then broken down into smaller particles using a grinding machine (figure 2). After that, the adsorbent was sieved and turned on. Then coagulation method was used as *Zea mays* (Corncob) powder is a natural coagulant.

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Figure 1 Collection of *Zea mays*

Figure 2 Grinded *Zea mays* and convert Corncob powder

RESULS AND DISCUSSION

Treatment with Fenton system and Corncob powder

Initial pH and Fenton reagent dosage were essential controls of the Fenton reagents methods in Fenton reagent oxidation (Kang and Hwang, K.Y, 2000). Ferrous Sulphate and Hydrogen Peroxide doses were selected based on the COD removal efficiency of the raw leachate. The trial doses of Ferrous Sulphate and Hydrogen Peroxide were shown in figure 3 and the highest COD removal efficiency was observed at the doses of Hydrogen Peroxide 10 gm and Ferrous Sulphate 5gm.

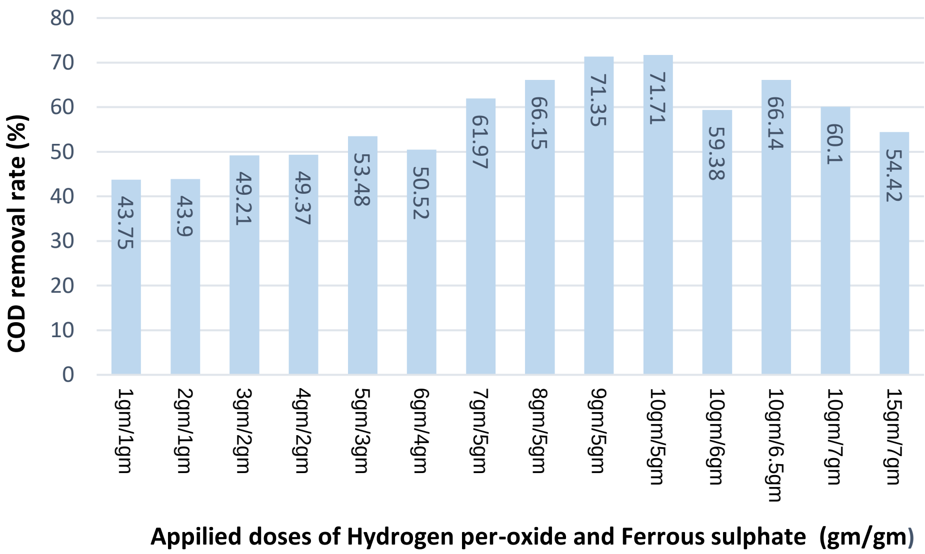

Figure 3 Selection of H_2O_2 and $FeSO_4$ doses for Fenton reagent

Table 1 Results of concentration for treating leachate using Fenton

Parameters	Initial Leachate value	Doses of Fenton reagent per 100 ml of treated leachate					
		5	10	15	20	25	30
pH	7.8	7.2	6.8	6.5	5	4.9	-
BOD_5(mg/l)	290	33	24	22	23	33	38
COD(mg/l)	1920	543	332	335	421	418	421
TDS(mg/l)	5540	1120	835	994	1035	1132	
Turbidity(NTU)	292	98	82	77	89	-	-
NH_3-N(mg/l)	350	98	90	92	92.5	92.73	-

Note: BOD=Biochemical Oxygen Demand, COD=Chemical Oxygen Demand, TDS=Total Dissolved Solid, NH_3-N= Ammonia Nitrogen

After preparing the Fenton reagent it was then applied in different doses on raw leachate. The doses and initial leachate parameter values were shown in table 1.

Findings of optimization value using different Fenton and Corncob powder doses

The removal of various parameters, including pH, BOD, COD, TDS, Turbidity and NH_3-N was tested using Fenton reagent and Corncob powder at various doses. Figures 4-5 shows the effect in the leachate. The percentage of pollutants removed from leachate after Fenton treatment at various concentrations was examined and is shown in Figure 4 as a function of increasing Fenton dosages. It is interesting to note from Figure 4 that the trend of increasing removal efficiency with increasing Fenton dosages persisted until the optimum dosage, at which point the reduction rate gradually started to decrease. Based on figure 4 it can be concluded that when 10ml of Fenton used for removal efficiency of all parameters were almost in optimum conditions. Here the different parameters like BOD, COD, TDS, Turbidity and NH_3-N were found that 91.92%, 82.7%, 84.92%, 71.91%, 74.28% by using Fenton 10ml/100ml without pH adjustment. Previous studies showed that the Fenton oxidation process can alter the molecular structures of organic compounds and change non-biodegradable organic materials into forms that are more amenable to breakdown (Lopez et al. 2004). From (B. Xie et al. 2010), it was found that the removal of BOD, COD, NH_3-N was 84.82%, 90.60% and 74.74% respectively at the use of Fenton 0.01

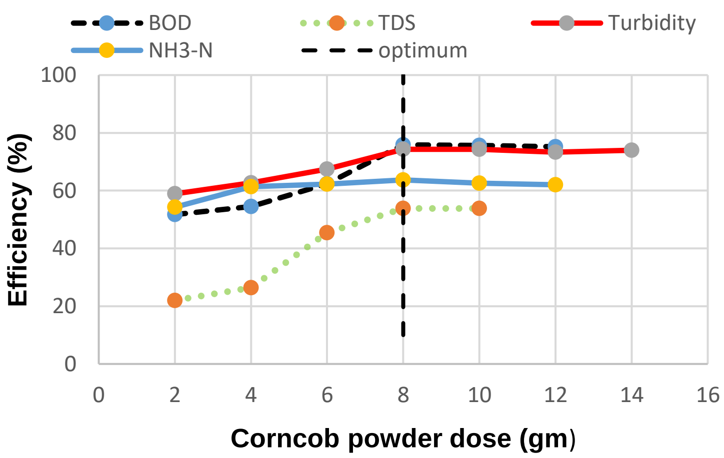

Figure 4 Effect of doses of Fenton on the removal of pollutant in the leachate.

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ml/1000ml. However another researcher (Yang Deng et al. 2006) found that maximum COD removal efficiency was 79.82% by using Fenton. The dosage of Fenton used depend on the concentration of pollutants in leachate and its initial conditions. In view of this, it can be said that the findings of this study is consistent with the results of other researchers.

According to figure 5, it can be stated that when 8gm of Corncob powder has been used for removal efficiency of all parameters were almost in optimum conditions. BOD, TDS, Turbidity and NH_3-N removal efficiency were found that 75.86%, 53.79%, 74.31%, 61.42% by using 8gm/100ml of Corncob powder. Interesting things can be noted that there was few effect of pH by using Corncob powder as a coagulant. However it can increase treated leachate pH at a small quantity. Similar study by (M. Vinodh Kumar et al. 2018) found that BOD, TDS, Turbidity, NH_3-N removing efficiency were 68.49%, 60.86%, 73.88%, and 61.29% respectively. The efficiency and doses of Corncob powder can be changed depending on the leachate condition. It can be concluded that the findings of this study is almost similar with the result of the mention study.

Regression Coefficient for Optimum Dosage

According to (Rivas et al. 2004), the regression coefficient (R^2) may be used to investigate the effectiveness of contaminant removal in leachate using coagulants at different concentrations. Figures 6-7 show the results of the analysis of the regression coefficients used in the current study to determine how effectively pollutants were removed from leachate. Figure 6 demonstrates the relationship between how different Fenton concentrations affect the removal efficiency of BOD, COD and TDS from leachate. The curve increased up to optimum point (10ml/100ml) and then it was decreased slowly. It's interesting to note that regression analysis was carried out after splitting the curve into two lines Figures 6(a) and 6 (b). It showed that they are straight line and R^2=1 for BOD, COD, TDS. After optimum R^2 range between 0.9247, 0.9891, 0.5993 for BOD, COD and TDS respectively. However, the curve (Figure 6) was then split into two parts shown in Figure 6(a) and Figure 6(b). Similar trend was also found in figure 7. Figure 7 shows that the curve increased to optimum point (8gm/100ml) and then decreased slowly. Figure 7 also represented that a relation among Turbidity, NH_3-N and BOD with the doses of Corncob powder. In figure 7(a), here R^2 values before optimum were 0.9953, 0.8296, 0.9187 for Turbidity, NH_3-N and BOD respectively. After the optimum point in figure 7(b), R^2 values found as 0.1049, 1, 0.9802 for Turbidity, NH_3-N and BOD respectively.

Figure 5 Effect of doses of Corncob powder on the removal of pollutant in the leachate

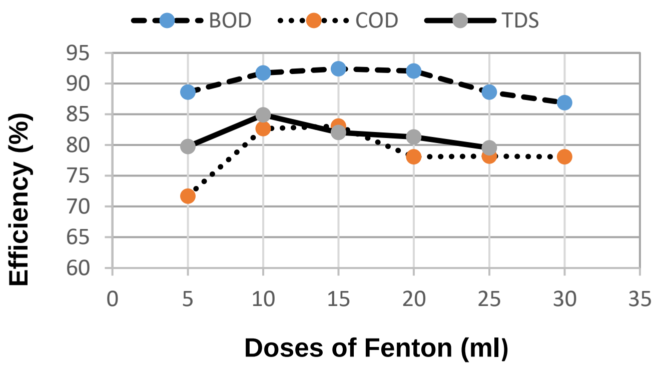

Figure 6 Effect of concentration of Fenton on the treating of BOD, COD and TDS in leachate

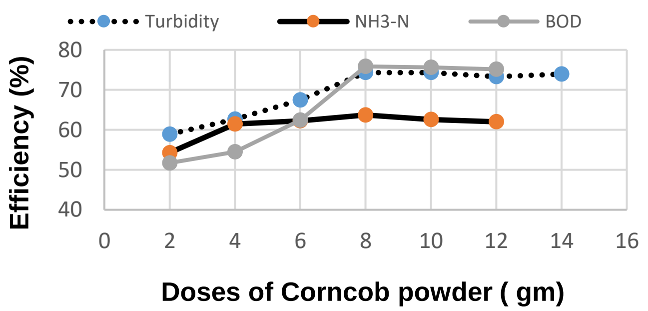

Figure 7 Effect of concentration of Corncob powder on the treating of Turbidity and NH_3-N in leachate

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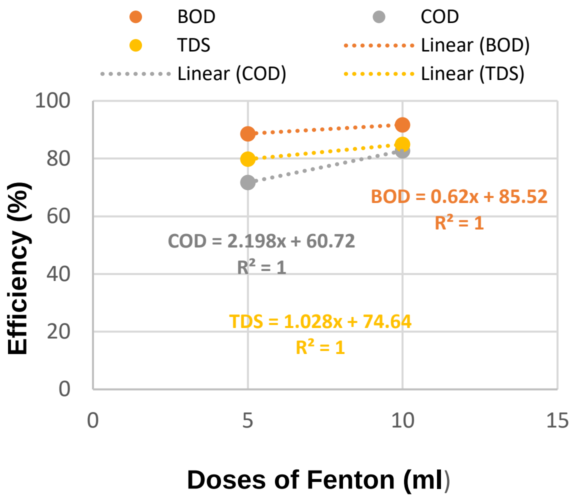

Figure 6(a) Regression analyses for treating BOD, COD and TDS from leachate using Fenton at various doses until the optimum.

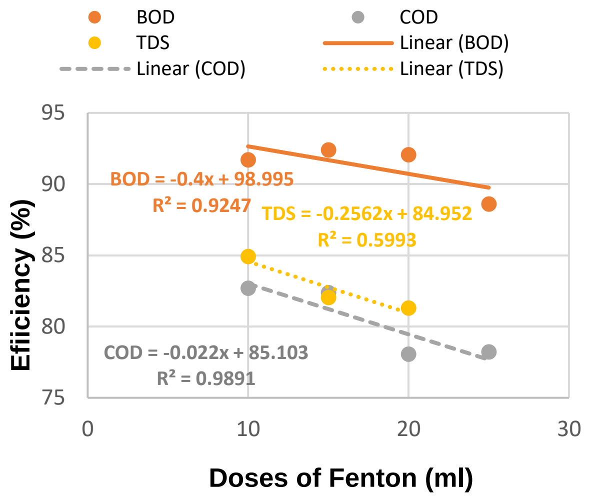

Figure 6(b) Regression analyses for treating BOD, COD and TDS from leachate using Fenton at various doses after the optimum.

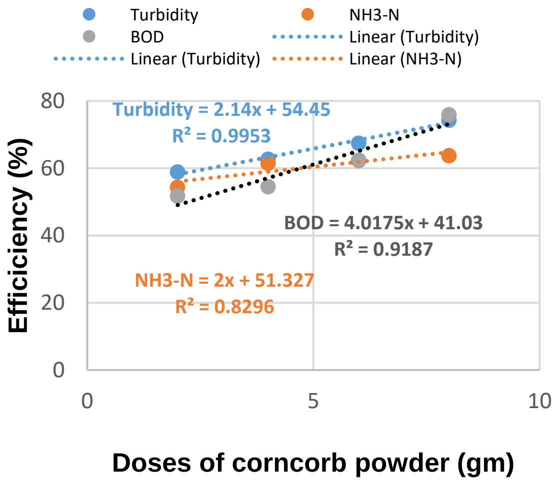

Figure 7(a) Regression analyses for treating Turbidity, NH_3-N and BOD from leachate using Corncob powder at various doses until the optimum

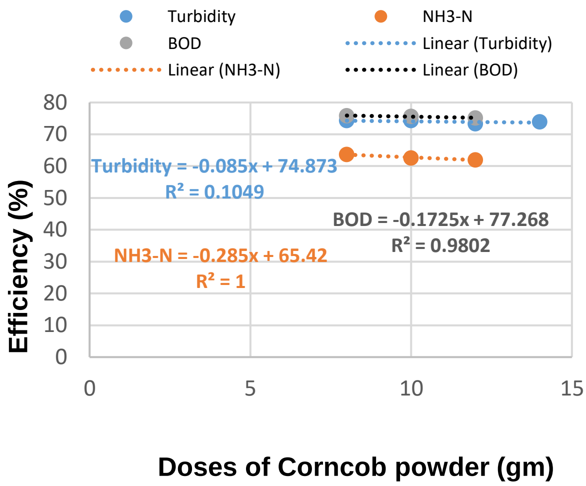

Figure 7(b) Regression analyses for treating Turbidity, NH_3-N and BOD from leachate using Corncob powder at various doses after the optimum

Effect of pH on the Optimum Dosage of Fenton reagent

The fact that oxidation is strongly encouraged by pH levels in the acidic range is a crucial aspect of the Fenton process (Yang Deng et al. 2006). In this study, it was observed that in Fenton oxidation pH level gradually decreased with the increase of Fenton doses. So pH adjustment for Fenton based treatment is essential. Although Fe^{3+} is least soluble at pH 8.0, from (Stumm et al. 1994) and (Rivas et al. 2004), it was found that pH-5.5 was most effective for Fenton oxidation of a leachate. It has been observed that at pH-6 Fenton is most effective to reduce 5 pollutant parameter of leachate. Table 2 and figure 8 shows the behaviour of Fenton at a dose of 10ml/100ml for various pH values.

Table 2 Results of leachate treatment with various pH at optimum concentration using Fenton reagent

Leachate parameters	Untreated leachate (initial reading)	Treated of leachate with various pH at optimum concentration of Fenton reagent					
		pH4	pH5	pH6	pH7	pH8	pH9
BOD_5	290 mg/l	30.5	27	22	26	24.15	33
COD	1920 mg/l	555.7	505.2	330.5	410	345.75	352.20
TDS	5540 mg/l	1115	945.75	825	877.45	1020	1132
Turbidity	292 NTU	90.5	85.17	75.15	80.45	88.15	89.25
NH_3-N	350 mg/l	95	92	88	91	89	97

Figure 8 reveals that Fenton reagent was found to have the greatest ability to remove pollutants when used at the recommended dosage of 10ml/100mL at pH 6, while pH 4 had the least amount of success. At pH 6 Fenton reagent have an ability for treating efficiency 92.41, 83.78, 85.1, 74.26, 74.85 of BOD_5, COD, TDS, Turbidity and NH_3-N. Similar result was also found by (Kang et al. 2000) at the pH level of 4-6. Finally, it can be concluded that the results of the current study are consistent with mentioned above of the researchers.sss

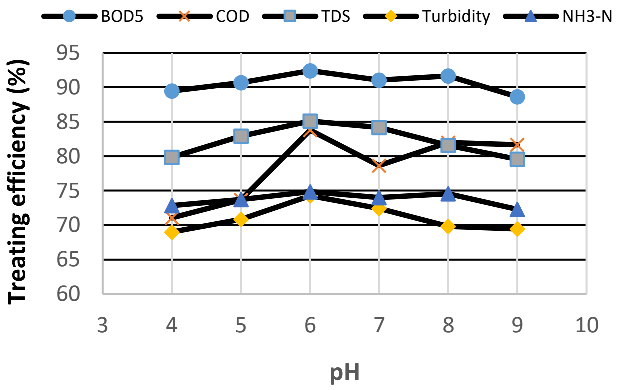

Figure 8 Effect of pH on treating of different parameters in the leachate using Fenton at 10ml/100 ml

Regression Coefficient for Optimum pH Values

Figure 8 illustrates how pH levels between 4 and 9 affect the removal of relevant pollutants using Fenton at the recommended dosage of 10ml/100 ml. It's interesting to note that the regression coefficient (R^2) for changing pH conditions was strongly linear and changed before and after the pH dosage that worked best. According to the experimental findings, the regression coefficient for removing BOD_5,COD and TDS up to the optimal pH level was 0.9596,0.9211,0.0981 respectively figure (8a), but after that point, it was found to be 0.7121,0.9719,0.0339, respectively figure (8b). On the other hand, pH adjustment is not essential for using Corncob powder as coagulant. Sometimes Corncob powder may increase pH level in small amount.

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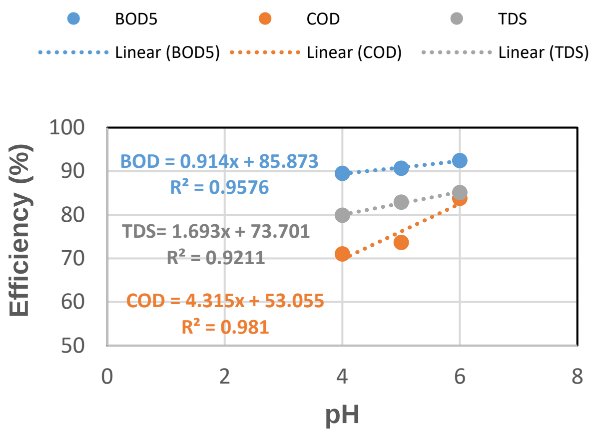

Figure 8(a) Regression coefficient for pH range 4-6 for treating BOD, COD and TDS using Fenton until optimum pH

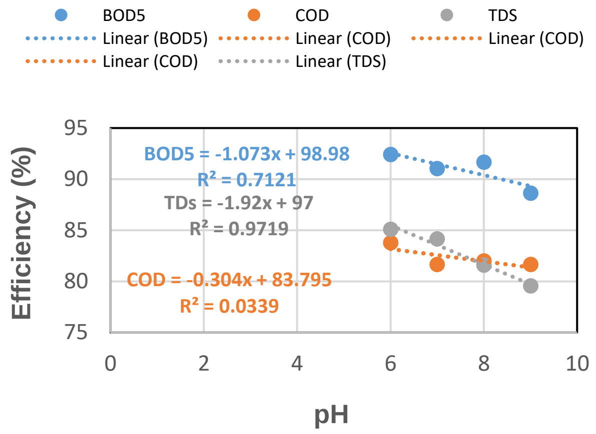

Figure 8(b) Regression coefficient for pH range 4-6 for treating BOD, COD and TDS using Fenton after optimum pH

Optimum Results of Leachate Treatment

Table 3 Leachate treatment efficiency by using of Fenton reagent and Corncob powder

Treating material	Optimum conditions	Efficiency (%)				
		BOD_5	COD	TDS	Turbidity	NH_3-N
Fenton reagent	10 ml/100 ml At pH 6	92.41	83.78	85.1	74.26	74.85
Corncob powder	8 gm/100ml	75.86	---	53.79	74.31	63.71

The optimum results were achieved by using Fenton reagent (10ml/100ml at pH 6) and Corncob powder (8gm/100ml) are evident in table 3 and figure 9. It is an interesting note that Fenton based leachate treatment has a higher efficiency than Corncob powder in almost all parameters. But Fenton based treatment, it is essential for adjustment of pH in the leachate. Similar results were also found by (B. Xie et al. 2010) at pH level 5. However pH adjustment also depends on initial leachate condition. From (Kang et al. 2000), it was found that operating pH ranged from 2.0 to 9.0 for Fenton oxidation, and also found that both overall COD removal efficiency peaked between pH 3.0–6.0. In these current study, it was found that at when pH level is at 6, Fenton reagent gains higher pollutant removal efficiency. On the other side, Corncob powder is a natural coagulant and in this study, it was observed that it is capable to reduce near almost 75% of BOD and it has also greater removal efficiency of turbidity comparison with Fenton. By using

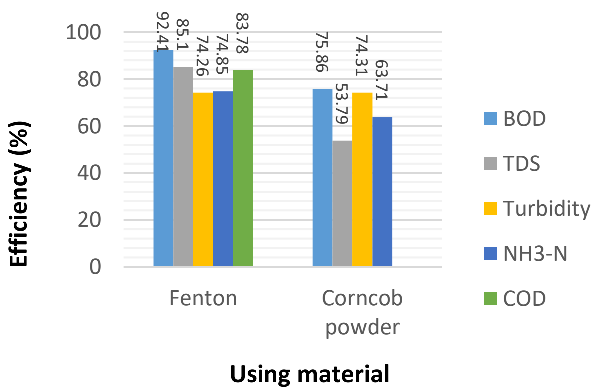

Figure 9 Optimum results of leachate treatment by Fenton and Corncob powder at optimum conditions

Corncob powder almost similar result was found by (M. Vinodh Kumar et al. 2018). It is also noted that pH adjustment is not essential for Corncob powder based treatment. pH does not affect its work efficiency. Finally it can be concluded that the results of the current study are consistent with the findings stated by (Kang et al. 2000; M. Vinodh Kumar et al, 2018).

CONCLUSIONS

Based on experimental results, Leachate treatment technique was evaluated and leachate treatment efficiency was compared with conventional Fenton system and *Zea mays* powder (Corncob). For best performance Fenton reagent needs 10ml/100ml and Corncob powder needs 8gm/100ml of raw leachate treatment. According to this study Fenton system has much efficiency than Corncob powder. However Fenton system is a mixture of two strong chemical like Ferrous Sulphate and Hydrogen Peroxide but Corncob powder is a natural coagulant and it is low cost locally available waste materials. As per this consideration it has a quite good efficiency to reduce pollutant parameters of leachate. According to this study, corncob powder can reduce these 5 pollutant parameters by more than 50%. So it can be stated that for primary treatment purpose of leachate Corncob powder can be the best option.

In addition, regression coefficients may be used to express how well Fenton system and Corncob powder perform at removing pollutants from leachate at various concentrations and pH levels. These conditions may be changed before and after they reach their optimum doses.

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REFERENCES

Ahn, D. H.-C.-S. (2002). Use of Coagulation and Zeolite to Enhance the Biological Treatment Efficiency of High Ammonia Leachate. *J. of Environmental Science and Health. A: Toxic/Hazardous Substances & Environmental Engineering*, 37(2): 163-173.

Amokarane, A. C. (1997). *water research*, 31 (11): 2775-2782.

Azmi, N. B. (2015). “Stabilized landfill leachate treatment by sugarcane bagasse derived activated carbon for removal of color, COD and NH3-N–optimization of preparation conditions by RSM”. *Journal of Environmental Chemical Engineering*, 1287-1294.

B. Xie, Z. L. (2010). Treatment of mature landfill leachate by biofilters and Fenton oxidation. *waste management*, 2108-21012.

Bohdziewicz, J. M. (2001). Application of Pressure-Driven Membrane Techniques to Biological Treatment of Leachate. *Process Biochemistry*, 36(7):641-646.

Chiang, L. C. (2001). *Environmental Engineering Science*, 18(6): 369-378.

Cho, S. H. (2002). Photocatalytic degradation of the landfil leachate containing refractory matters and nitrogen compound. *Appl. Cata. B:Environ. 39*, 125–133.

Huang, C. D. (1993). Advanced chemical oxidation: its present role and potential future in hazardous waste treatment. *Waste Management*, 13 (5–7), 361–377.

John Edward Riester, J. (1994). Landfill Leachate Production and Gas Generation Numerical Model. *A Dissertation Submitted to the Faculty of Old Dominion University in Partial Fulfillment of the Requirements for the Degree of the Doctor of Philosophy*.

Kang, Y. H. (2000). Effects of reaction condition on the oxidation efficiency in the fenton process. *Water Resources*, 34, 2786–2790.

Lin, S. a. (2000). Treatment of Landfill Leachate by Combined Electro-Fenton Oxidation and Sequencing Batch Reactor Method. *Water Research* , 34(17): 4243-4249.

Lopez, A. P. (2004). . Fenton's pretreatment of mature landfill leachate. *Chemosphere 54*, 1005–1010.

Loudidou, M. X. (2000). Comparison of Two Biological Treatment Process Using Growth Biomass for Sanitary Landfill Leachate Treatment. *J. of Envi. pollution* , n 13 (2): 273-281.

M. Vinodh Kumar, S. S. (2018). Leachate Treatment from Municipal Solid Waste Landfill by Using Natural Coagulant of Zea Mays. *IJSRST*, 2395-6011 .

Marttinen, S. K. (2002). Screening of Physical–Chemical Methods for Removal of Organic Material, Nitrogen and Toxicity from Low Strength Landfill Leachates. *Chemosphere*, 46 (6): 851–858.

Morawe, B. R. (1995). Activated Carbon Column Performance Studies of Biologically Treated Landfill Leachate. *Chemical Engg. and Processing*, 34(3):299-303.

Ozturk, I. A. (2003). Advanced Physico-Chemical Treatment Experiences on Young Municipal Landfill Leachates. *Waste Management*, 23 (5) :441-446.

Pignatello, J. (1992). Dark and photoassisted Fe3+-catalyzed degradation of chlorophenoxy herbicides by hydrogen-peroxide. *Environ. Sci. Technol*, 26 (5), 944–951.

Rafizul, I. M. (2009). *Characterization of Leachate Generated from MSW in Sanitary Landfill Lysimeter.* S. Margherita Di Pula, Cagliari, Italy: Twelfth International Waste Management and Landfill Symposium.

Rivas et, a. (2004). Stabilized Leachates: Sequential Coagulation-Flocculation + Chemical Oxidation process. *Journal of Hazardous materials B*, 116:95-102.

SES. (1994). The UV/ Oxidation Handbook. *Solarchem Environmental Systems Markham, Ont., Canada*.

Steensen, M. (1997). Chemical Oxidation for the Treatment of Leachate-Process Comparison and Results From Full Scale Plants. *Water Science and Technology*, 35(4): 249-256.

Stumm, W. M. (1994). *Aquatic Chemistry.* New York: third ed. Wiley Interscience.

Teel, A. W. (2002). Degradation of carbon tetrachloride by modified Fenton reagents. *J. Hazard. Mater. 94,*, 179-189.

Trebouet, D. S. (2001). Satbilized Landfill Leachate Treatment by Combined Physicochemical-Nanofiltration Processes. *Water Research*, 35(12) :2935-2942.

Wang, F. S.-D. (2003). Application of advanced oxidation methods for landfill leachate treatment. *J. Environ. Eng. Sci. 2*, 413–427.

Wang, Z. Z. (2002). Landfill Leachate Treatment by a Coagulation–Photooxidation Process. Journal of Hazardous Materials. B95, 153–159.

Watts, R. B. (1999). Role of reductants in the enhanced desorption and transformation of chloroaliphatic compounds by modified Fenton's reactions. *Environ. Sci. Technol. 33*, 3432-3437.

Yang Deng, J. D. (2006). Treatment of landfill leachate by the Fenton process. *water research*, 3683–3694.