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Deep Depreciation Rates of Aqueous Gypsum Composting Plant in Soil Containing Montmorillonite Nano silicon

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Abstract: *Background and objective: The research objective is to investigate the deep change rate of leachate quality parameters in soil containing nano-clay in the Agh Ghala composting plant. Methodology: The impact of clay presence on removal of leachate pollution was investigated. A pipe with a diameter of 10 cm and a length of 30 cm was filled with clay of composting plant. Then, an outlet valve was placed every 10 cm from the height of the soil. Type of soil and nano-clay percentage was expressed. Then, leachate was entered at a specific concentration and the results for the parameters TSS, TDS, BOD, COD, EC, pH in different columns were investigated to plot the recline rate. Results: Based on the analysis carried out in the first treatment of one percentage nano-clay, an efficiency of 62% was obtained. The second treatment of nano-clay had an efficiency percentage of 70% to 74%. The results of third treatment of one percentage nano-clay had removal efficiency of about 83%. Based on the results of the analysis in the first treatment of 5% nano-clay sample, the removal efficiency was about 74%, and it was 93% in the second treatment of 5% nano-clay. The results of the analysis of the third treatment of 5% nano-clay indicated a removal efficiency of about 98%. Conclusion: The results show the high impact of Montmorillonite mineral zeolite, which removal efficiency of 98% was obtained in leachate pollutant index parameters of the composting plant.*

Keywords: *Leachate, Agh Ghala, Composite, Nano-Clay, Montmorillonite Introduction*

INTRODUCTION

Collection, treatment, and disposal of solid wastes are one of the main problems, which urban planners face in many developing countries. Unfortunately, wastes are poured into streams in some of our cities or deposited unhealthy in slopes and other places which are contrary to the standards of protection and conservation of surface water and groundwater resources. It is very hazardous in terms of environment health, especially in cases in which the landfill is sandy soils, or they are deposited near the rivers, or in areas where underground water is used to provide drinking water for humans or livestock. As a result of decomposition and degradation of urban wastes, a series of physical, chemical and biological changes occurs, leading to production of leachate and landfill gases (Rostamdel et al., 2014; Shatighani, 2012). The leachate is water which is in contact with the wastes and can include high concentrations of COD, BOD, nutrients, heavy metals and rare organic elements. In general, 100 ml of waste leachate contains about 100 billion coliform, which can contaminate large amounts of water.

Moreover, many urban, industrial and agricultural wastes can enter various types of chemicals, some of which include toxic substances such as arsenic, lead, cadmium, chromium, cyanide, mercury, chemical fertilizers and pesticides, radioactive materials, bacteria, viruses and eggs of parasites, fats, acids, bases, and chemical salts (Sanayi et al., 2012). The best way to control and prevent pollution caused by the release of leachate is to prevent its releasing to groundwater. Leakage control in wetlands is not practically feasible (Rostamdel et al., 2014; Shatighani, 2012). The main objective of this research is to investigate the rate of deep change in leachate quality parameters in the soil containing nano-clay in the Agh Ghala composting plant. In this research, the effect of the presence of clay on the removal of leachate pollution of deep changes rate of leachate quality parameters was examined. Montmorillonite, as a nano-particle forming the main phase in bentonite with dimensions of about 10 angstroms and with having unique properties such as inflammability in polar environments, high specific surface, surface electrical properties and cation exchange capacity, has various applications in industry and research.

Some of these applications include using it as a base for catalytic, filler and absorbent reactions, which various applications have been reported for each of these cases in the papers. Interesting studies have also been conducted on the use of montmorillonite as the carrier of drug in the body and the controlled release of the drug (Movahedian & Ebrahimi, 2003). One of the unique properties of bentonite is its inflammability in polar environments. This phenomenon has resulted in using it in oil upstream industries, including the construction of drilling mud, which this inflammability property is in fact due to the presence of montmorillonite in bentonite. The use of montmorillonite as cohesive, filler, absorbent, and catalyst has made bentonite to be widely-used soil (Kazemian & Faghihian, 2008; Ohadi & Amiri, 2012). The objective of this paper is to investigate the effect of Montmorillonite nano-clay on reduction of leachate pollutants in the composting plant. In this paper, we try to investigate the rate of leachate pollutants reduction in several soil columns.

Methodology

This research is an experimental-based fundamental and applied research carried out on samples taken from waste leachates of Agh Ghala Compositing Plant landfill. A pipe was filled with landfill clay and pilot was prepared. This pipe has a definite diameter and height and the leachate passed through it. Then, the results for TSS, TDS, BOD, COD, EC, pH, and pH parameters in different columns were investigated to plot the reduction rate. Limitations of this study included the unavailability of waste leachate and the difficulty of accessing them, constraints in facilities and equipment needed to make pilot research, and time constraints. The variables included the clay texture in different columns, the number of parameters, and the number of experiments, which included 3 times of sampling. In this study, independent variables included soil, nano-clay, soil-nano-clay; sewage as well as soil depth in the column and the dependent variables included TSS, TDS, BOD, COD, EC and pH.

In making the pilot sample, the following items should be considered:

1. Soil amount which should be 3 kg
2. Pilot length which is 70 cm and the pilot diameter which is 10 cm
3. Pilot columns which are 30 cm, the first column is empty and the next column has 30 cm clay and 5 cm sand at the end.
4. The 30 cm column of clay was divided into 3 parts and each part and 3 outlet valves. Were placed in each part

5. Two nano-clay treatments were used, which included 5% and 1% nano-clay treatments and normal soil was the control.
6. Leachate treatment included 50% leachate and 50% water.
7. At each time, the parameters mentioned in the sample were measured before entering the pilot, and then repeated at each time of outlet valves.

Absorption isotherm

It is a mathematical relation (empirical or analytic), which expresses the equilibrium value of the substance (usually gas) absorbed either chemically or physically on the surface of a given solid by gas pressure changes at a constant temperature (Hashemi, 2013). Finally, by calculating the initial value of BOD, the removed value, residual value, and their logarithms, Freundlich and Langmuir isotherms were plotted.

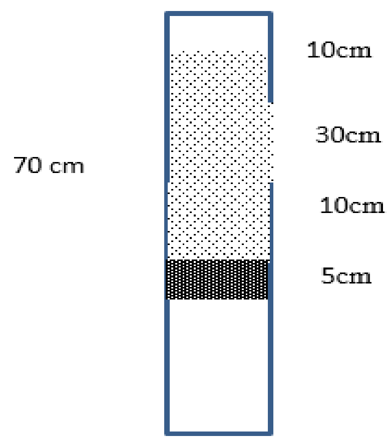

Figure 1: experimented pilot

In this section, leachate sample of Agh Ghala compositing plant was taken and transferred to laboratory for filtering operation. First, the leachate was analyzed which the following results were obtained.

Table 1: chemical and physical parameters of raw leachate

Parameter	value	unit
pH	6/4	---
BOD	12350	Mg/l
COD	37250	Mg/l
TSS	11180	Mg/l
TDS	45100	Mg/l
EC	89700	Mg/l

In the next stage, two treatments of soil (ordinary soil as control and nano-clay soil) with percentages of 5 and one percentage were used.

Table 2-: type of absorbents used in the research

type of absorbent	Column height in pilot (cm)	Naming during the research
Soil (control)	10	A1
	20	A2
	30	A3

Nano-clay (one percentage)	10	B1
	20	B2
	30	B3
Nano-clay (5 percentage)	10	C1
	20	C2
	30	C3

Leachate analysis after passing through absorbent sample
Treated leachate including raw leachate and water (50% water and 50% leachate) was passed through samples and sampling was performed from outlet valve to be prepared for analysis.

Control sample

In this study, 30 cm of normal soil as a control was placed inside the pilot and three outlet valves were placed at the end of each column for sampling. Then, the samples were analyzed and the result was as follows.

Results

First, leachate of compositing plant was passed through 10, 20 and 30 cm columns. Then, the value of pollutants was analyzed.

Table 3: Results of control soil samples

Parameter	Control soil		
	Results of 10 cm column sample (Mg/l) A1	Results of 20 cm column sample (Mg/l)A2	Results of 30 cm column sample (Mg/l)A3
BOD	14780	12350	11227
COD	29430	24580	22350
TSS	8830	7380	6710
TDS	35630	29760	27050
EC	70850	59200	53800
pH	6/9	7/0	7/2

Results of one percentage nano-clay sample

In this study, 30 cm of one percentage nano-clay soil was placed inside the pilot and three outlet valves were placed at the end of each column for sampling. Then, the samples were analyzed and the result was as follows.

Table 4: results of one percentage nano-clay sample

Parameter	One percentage non-clay		
	Results of 10 cm column sample (Mg/l) B1	Results of 20 cm column sample (Mg/l)B2	Results of 30 cm column sample (Mg/l)B3
BOD	7110	5800	3930
COD	14150	11175	6700
TSS	4250	3242	2125
TDS	17130	12180	7670
EC	34100	24220	17000
pH	7/2	7/2	7/3

Results of 5% nano-clay sample

In this study, 30 cm of 5% nano-clay soil was placed inside the pilot and three outlet valves were placed at the end of each column for sampling. Then, the samples were analyzed and the result was as follows.

Table 5: results of 5% nano-clay sample

Parameter	Results of 10 cm column sample	Results of 20 cm column sample	Results of 30 cm column sample

	(Mg/l) C1	(Mg/l)C2	(Mg/l)C3
BOD	4865	1403	225
COD	9685	2496	410
TSS	2900	771	257
TDS	11720	3520	812
EC	23320	6820	1435
pH	7/1	7/4	7/5

Plotting the linear form of Langmuir-Freundlich isotherms for the absorbent studied
In order to investigate and predict the absorption isotherm behavior in the removal of BOD, the linear form of isotherms should be plotted. Laboratory data for plotting isotherms for 1 and 5% nano-clay absorbent and control soil are shown in table 6.

Table 6: Discontinuous laboratory data for plotting absorption isotherms by control and 5% and one percentage nano-clay soil for BOD

C_0 (mg l^{-1})	Absorbent	Ce (mg l^{-1})	q_e (mg g^{-1})	C_e/q_e	Log (q_e)	Log (C_e)
18710	Control soil	14782	3928	3/76	3/59	4/17
18710	Control soil	12350	6360	1/94	3/80	4/09
18710	Control soil	11227	7483	1/50	3/87	4/05
18710	One percentage nano-clay	7111	11599	0/61	4/06	3/85
18710	One percentage nano-clay	5801	12909	0/45	4/11	3/76
18710	One percentage nano-clay	3930	14780	0/27	4/17	3/59
18710	5% nano-clay	4865	13845	0/35	4/14	3/69
18710	5% nano-clay	1403	17307	0/08	4/24	3/15
18710	5% nano-clay	225	18485	0/01	4/27	2/35

Diagrams 1 and 2 illustrate the linear form of absorption isotherms (Langmuir, Freundlich) for nano-clay absorbent in removing BOD from the leachate of Agh Ghala composting plant.

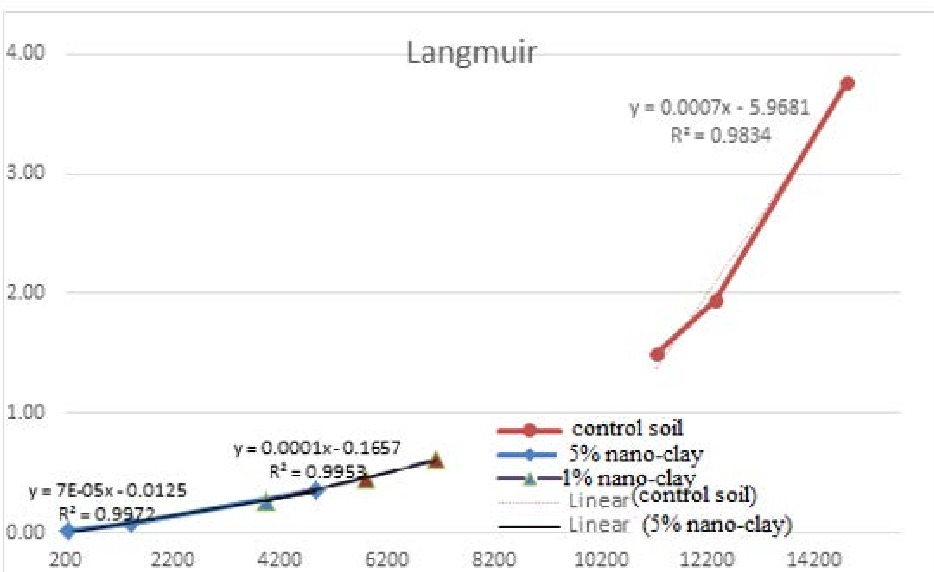

Diagram 1: plotting linear form of Langmuir isotherm for 5% and 1% nano-clay and control soil for BOD

Diagram 2 illustrates the BOD removal in the control soil, 1% nano-clay 1 and 5% nano-clay in Langmuir isotherm. The removal rate of BOD in 1% nano-clay with a correlation coefficient of 0.995 indicates the removal with good efficiency in this nano-clay.
Moreover, the removal of BOD in 5% nano-clay with a correlation coefficient of 0.997 indicates good removal efficiency in this nano-clay. It is natural that the rate of this coefficient to be more in 5% nano-clay than that in one percentage nano-clay.

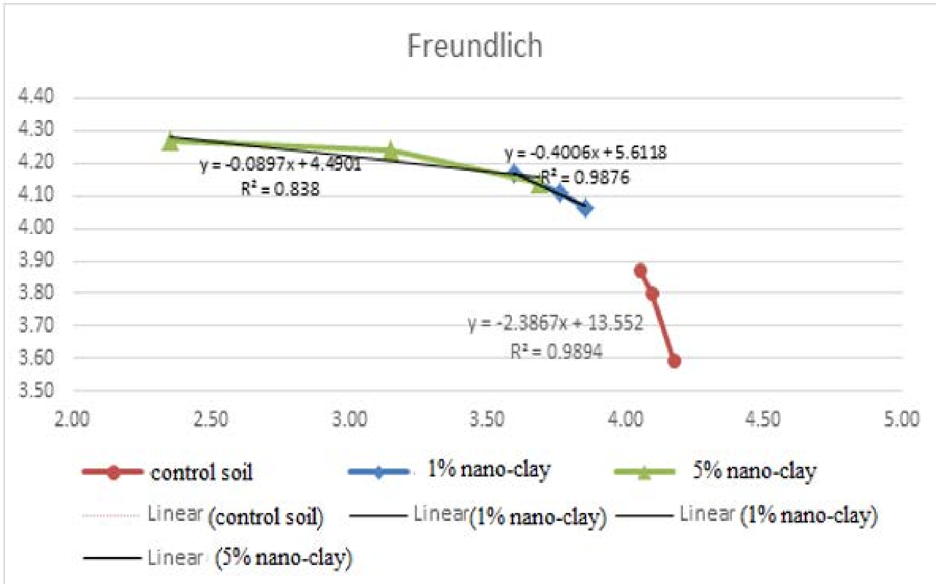

Diagram 2: plotting the linear form of Freundlich isotherm for control soil, 1% nano-clay and 5% nano-clay for BOD

Diagram 2 illustrates the BOD removal in the control soil, one percent nano-clay, and 5 percent nano-clay in the Freundlich isotherm. One percentage nano-clay shows the correlation coefficient of 0.987 and 5% nano-clay shows the correlation coefficient of 0.838, indicating good efficiency in this nano-clay. As this coefficient is abnormally is lower in 5% nano-clay than that in 1% nano-clay, Langmuir isotherm should be considered as a base.

Discussion

Control soil

As the results showed, in the first treatment of control soil sample, the removal efficiency in 10 cm column was 21% and the value of the parameters decreased slightly. In the second stage and sampling with control soil and a 20 cm column, we had removal efficiency of 34%. This reflects the effect of soil layers. The results of the analysis of the third column of control soil which was 30-cm layer showed that the removal efficiency was about 40%, which was generally not acceptable for using, while our goal was not to use this soil and this soil was used as control for comparison with other samples.

One percentage nano-clay

According to the analysis performed, we had an efficiency of 62% in the first treatment of one percentage nano-clay sample and 10-cm column and the value of parameters declined significantly. In the second stage and sampling with one percentage nano-clay and 20-cm column, we had an efficiency of 70-74%. The pH level increased as expected. This efficiency was good and acceptable for us given the height of the column. The results of the analysis of the third column of nano-clay at a height of 30 cm showed a removal efficiency of about 83%.

Five percentage nano-clay

According to the analysis performed, we had an efficiency of 74% in the first treatment of 5% nano-clay sample and 10-cm column and the value of parameters declined significantly, while this rate of removal was seen in the 20-cm column in one percentage nano-clay. In the second stage and sampling with 5% nano-clay and 20-cm column, we had an efficiency of about 93%, which this level of removal is acceptable and good. The pH level increased as expected. This efficiency was good and acceptable for us given the height of the column and reached to equilibrium. The results of the analysis of the third column of 5% nano-clay at a height of 30 cm showed a removal efficiency of about 98% and rest of the analyzed parameters declined significantly.

Conclusion

We examined the effect of soil on the quality of leachate in this research. It was found that montmorillonite nano-clay could significantly reduce the removal efficiency by 98% in pollutant index parameters.

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