International Journal of GEOMATE, Oct., 2016, Vol. 11, Issue 26, pp. 2684-2687
Geotec., Const. Mat. & Env., ISSN: 2186-2982(Print), 2186-2990(Online), Japan

EFFECTIVENESS OF JACKFRUIT SEED STARCH AS COAGULANT AID IN LANDFILL LEACHATE TREATMENT PROCESS

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ABSTRACT: Aluminium sulphate (alum), ferric chloride and polyaluminium chloride (PAC) are the most common coagulants being used for leachate coagulation-flocculation treatment. However, the impact of these residual's coagulants have sparked huge concern ceaselessly. Therefore, development of natural coagulant as an alternative coagulant for treatment process has been given full attentions. In this attempt jackfruit seed starch (JSS) which produce by extraction method was used as coagulant aid with PAC. The removal efficiency was determined using jar test method. The removal of leachate pollutants was compared between PAC coagulant with and without JSS. Interestingly the JSS coagulant aid has succeed to reduce the dosage of PAC from 900 mg/L to 600 mg/L by increasing the removal of COD, colour and ammonical nitrogen (NH_3-N) up to 33.6%, 93.6%, and 13.1 % respectively. While the removal for turbidity and suspended solid (SS) were maintained at 94% and 92 % respectively. The addition of JSS has succeeded to reduce 33.3% the usage amount of PAC in treatment process of landfill leachate. The result proved that JSS was effective to be used as coagulant aid landfill leachate treatment.

Keywords: Landfill Leachate, Natural Coagulant, Jackfruit Seed and Starch.

1. INTRODUCTION

Leachate is highly contaminated liquid that defined as the aqueous effluent generated through precipitation, degradation and percolating process of landfill storage (waste) within period time [1]. Leachates usually contain large amounts of organic and inorganic matter [2], which are toxic to living organisms and ecosystems. Generally the physical-chemical treatment is effective method for old and stabilized leachate. One of common physical-chemical method that used was coagulation-flocculation.

Coagulation-flocculation is a relatively simple physical–chemical technique that may be employed successfully for the treatment of stabilized and old landfill leachate [3]. Nevertheless the performances of the treatment are varies and depending on the type of process parameter implemented.

Jackfruit (Artocarpus heterophyllus Lam.) is an important naturalized plant of Southeast Asia which rich with starch sources. There are various natural based coagulants or flocculants has been explored in water and wastewater treatment applications. Jackfruit seed starch has not been considered and exploited as a potential source of starch. However, only a few published articles are available on this material. Thus this paper is focused on landfill leachate treatment using JSS as coagulant in Kuala Sepetang Landfill Sites. The efficiency of removal of organic matter and ammonia in leachate were investigated by comparing between powder and dilution of JSS using jar test.

2. METHODOLOGY

2.1 Leachate Sampling and Characterization

The leachate samples were collected from a Kuala Sepetang Landfill Sites,Taiping, Perak. The characteristics of raw leachate collected are shown in Table 1.

2.2 Preparation of Jackfruit Seed Starch (JSS)

Preparation of JSS is used from a modified method of Tulyathan, Mukprasit and Sajjaanantakul [4,5]. Method of isolation of JSS is based on modified method of Bobbio, Dash, and Rodrigues [6]. Slurries of JSS was prepared in 0.05 M sodium hydroxide (NaOH) solution and constantly stirred for 6 h. The slurries were centrifuged for 20 min at 4°C. The supernatant was drained and the upper brown sediment was scraped and followed by a second extraction with a 0.05 M NaOH solution. The remaining sediment was mixed with distilled water and filtered by a sieve (0.15 mm mesh size) to eliminate fibers. The filtrate was neutralized with 0.1 M hydrochloric acid (HCl) to pH 7.0 and the slurries were centrifuged for 20 min at 4°C. The supernatant was drained and the upper brown sediment was scraped and the remaining was washed with distilled water and centrifuged for 20 min at 4°C. The starch cake was dried at 50°C for 12 h.

2.3 Jar Test

Coagulation test was performed by using jar test equipment (SW6 Stuart Bibby Scientific Limited, UK). 3M NaOH and 3M HCl were used to adjust the pH sample. 500 ml of leachate samples were filled into six beakers and agitated simultaneously with combination of rapid mixing speed of 200 rpm in 3 min and 40 rpm in 30 minutes for slow mixing, and settling time was 60 minutes.

3. RESULTS AND DISCUSSION

3.1 Characteristics of Raw Leachate

Characteristics of leachate at Kuala Sepetang landfill was summarized in Table 1. The obtained pH (8.16) agrees with the other studies conducted for stabilized leachate characteristics in Malaysia [7, 8]. However, according to BOD5/COD ratio below, the leachate showed higher biodegradability than expected.. Although the age of the leachate is already more than 10 years. The value obtained indicates that the leachate are partially stabilized leachate (0.1< BOD5/COD<0.3) This probably happened because the landfill is still under operating and producing young leachate which is mixed together with old leachate and this may effects the biodegradability of the leachate itself. Therefore, biological degradation is still occurring in the leachate [8].

Table 1 Characteristics of Kuala Sepetang raw leachate

No	Parameters	Value
1	pH	8.16
2	Turbidity(NTU)	106
3	Colour (Pt Co)	4588
4	Suspended Solid (mg/L)	187
5	Ammonia-N (mg/L)	264
6	BOD_5 (mg/L)	100
7	COD (mg/L)	898
8	BOD_5/COD	0.11
9	pH	8.16

3.2 Removal Rate

In this study, the optimum dosage of PAC was investigated at the optimum pH (pH5). The percentage removal of COD, colour, turbidity, SS and NH_3-N the dosage range were tested from 400mg/L until 1100 mg/L. Table 2 shows the optimum percentage removal of pollutants. Based on the result obtained, the optimum dosage for pollutants removal was 900 mg/L. This optimum dosage was successfully removing 13.9% of COD, 93.5% of colour, 90.3% of turbidity, 95.6% of SS and 9.7% of NH_3-N.

This result displayed high removal of efficiency of contaminants which conforming that stabilized leachates are rich with organic matters [9] such as humic substance (measured as COD intensity) and fulvic like fraction [7, 10]. The removal of substance can be explained by the charge neutralization mechanism in coagulation-flocculation process. Basically, the amount of coagulant added depends on the magnitude of electrical charge surrounding the colloidal particles (zeta potential) in samples. Since the charge of PAC (Al^{3+}) is positive, the negative charges of particles in leachate are neutralized by the addition of PAC during coagulation flocculation process [11]. Furthermore, as the landfill getting older, more organic matter with negatively charged particles exists in the leachate.

Table 2 PAC-leachate coagulation performance at selective coagulation

Parameter	Removal (%)	Supernatant concentration (mg/L)	Standard*
Chemical oxygen demand (COD)	13.9	720.0	400
Colour (Pt Co)	93.5	323.0	100 ADMI
Turbidity (NTU)	90.3	9.0	-
Suspended solids (SS)	95.6	8.2	50.0
Ammoniacal-nitrogen (NH_3-N)	9.7	2170.0	5.0

* Malaysian Environment Quality Regulations 2009

Figure 1 shows the effect of JSS dosage as coagulant aid on the removal of COD, colour, turbidity, SS and NH_3-N by using PAC (900 mg/L, pH 5) as coagulant in leachate treatment. The percentage removal of COD, colour, turbidity, SS and NH3-N the dosage range were tested from 500mg/L until 3000 mg/L. Table 3 shows the optimum percentage removal of JSS dosage as coagulant aid at optimum dosage of PAC (900 mg/L, pH 5). Based on the result obtained, the optimum dosage for pollutants removal was 500 mg/L for colour, turbidity and suspended solid removal. While the optimum dosage COD and NH_3-N removal were 1000 mg/L and1500 mg/L respectively. This optimum dosage was successfully removing 31.6% of COD, 93.3% of colour, 92.3% of turbidity, 94.5% of SS and 13.1% of NH_3-N.

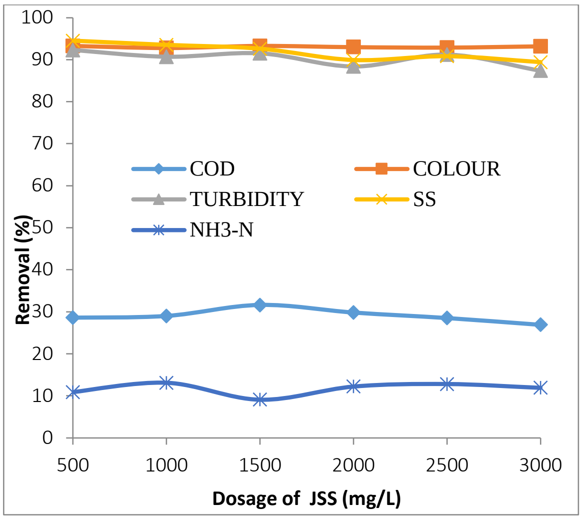

Fig. 1 Effect of JSS dosage as coagulant aid on the removal of COD, colour, turbidity, SS and NH_3-N by using PAC (900 mg/L, pH 5) as coagulant in leachate treatment.

The implementation of JSS as coagulant aid with PAC displayed improvement for the pollutants removal compared to PAC without JSS. The removal of COD turbidity, SS and NH_3-N has increased to 31.6%, 92.3%, 94.5% and 13.1 % respectively. The removal of substance can be explained by the bridging mechanism in coagulation-flocculation process. Basically, the flocculation process promoted the agglomeration of flocs with the polluted particles. The addition of JSS has increased the agglomeration within the flocs and the size of floc formation. The agglomerations of the flocs provide strong attraction to the suspended particles and increased the floc size for settlement. Thus the addition of JSS with PAC (900mg/L at pH 5) has improved removal of the pollutants.

Figure 2 shows the effect of PAC dosage as coagulant on the removal of COD, colour, turbidity, SS and NH_3-N at optimal dosage of JSS (500 mg/L) as coagulant aid leachate treatment. The percentage removal of COD, colour, turbidity, suspended solid and NH_3-N the dosage range were tested from 300mg/L until 1000 mg/L. Table 4 shows the optimum percentage removal of PAC dosage as at optimum dosage of JSS. Based on the result obtained, the optimum dosage for PAC was 600 mg/L for COD, color and NH_3-N removal. While the optimum dosage for turbidity and suspended solid removal was 500 mg/L. This optimum dosage was successfully removing 33.5% of COD, 93.6% of colour, 92.3% of turbidity, 94.5% SS and 14.1% NH_3-N.

Table 3 PAC- JSS leachate coagulation performance at selective coagulation.

Parameter	Removal (%)	Supernatant concentration (mg/L)	Standard*
Chemical oxygen demand (COD)	31.6	636.0	400
Colour (Pt Co)	93.3	335.0	100 ADMI
Turbidity (NTU)	92.3	10.3	-
Suspended solids (SS)	94.5	12	50.0
Ammonical-nitrogen (NH_3-N)	13.1	2780.0	5.0

* Malaysian Environment Quality Regulations 2009

The effect of optimal dosage of JSS as coagulant aid at optimal dosage PAC displayed good improvement for the pollutants removal. The removal of COD, colour and ammonical nitrogen has increased to 33.6%, 93.6%, and 13.1 % respectively. While the optimum dosage for turbidity and suspended solid removal were remain the same. This proved that the addition of JSS as coagulant as coagulant aid has succeeded to reduce 33.3% the usage amount of PAC in treatment process of landfill leachate.

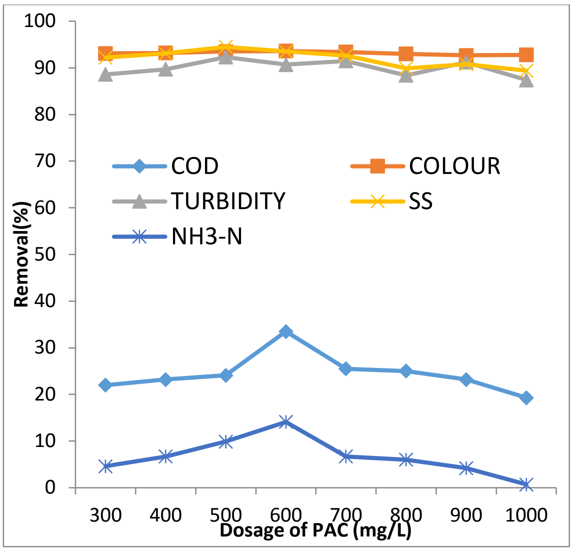

Fig. 2 Effect of PAC dosage as coagulant on the removal of COD, colour, turbidity, SS and NH_3-N by using JSS (500 mg/L) as coagulant aid in leachate treatment.

4. CONCLUSION

The performance of JSS with PAC coagulant was further optimized. The results shows the dosage optimization of PAC at optimal dosage of JSS was achieved 600mg/L. The addition of JSS has succeeded to reduce 33.3% the usage amount of PAC in treatment process of landfill leachate. Therefore, this study suggests that starch from the jackfruit seed has a potential to be used as coagulant aid in removing organic matter and ammonia present in the landfill leachate.

Table 4 The optimal dosage of PAC- JSS removal performance**.**

Parameter	Removal (%)	Supernatant concentration (mg/L)	Standard*
Chemical oxygen demand (COD)	33.5	580.0	400
Colour (Pt Co)	93.6	318.0	100 ADMI
Turbidity (NTU)	92.3	10.3	-
Suspended solids (SS)	94.5	12	50.0
Ammoniacal-nitrogen (NH_3-N)	14.1	2430.0	5.0

*Malaysian Environment Quality Regulations 2009

5. ACKNOWLEDGEMENTS

The writers would like to express their heartiest thanks to Universiti Sains Malaysia for the financial support funded under the RUI USM grant (1001/PAWAM/814166).

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International Journal of GEOMATE, Oct., 2016, Vol. 11, Issue 26, pp. 2684-2687.
MS No. 5138 received on June 23, 2015 and reviewed under GEOMATE publication policies.

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