Removal of Color, Suspended Solids, COD and Ammonia from Partially Stabilize Landfill Leachate by Using Iron Chloride through Coagulation Process

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***Abstract*—Sufficient treatment of leachate is vital before it is discharged into receiving water bodies. MLS leachate is characterized as partially stabilized leachate. Therefore, coagulation is a fair treatment to degrade pollutants in MLS leachate. The aim of this study was to evaluate the optimum coagulation conditions of dose and pH of iron chloride for MLS leachate by using jar test. The influence of iron chloride dose, resulted in percentage removal of SS (97% at 1500 mg/L), color (95% at 1500 mg/L), COD (66% at 2000 mg/L) and NH3-N(13% at 3500 mg/L). While theaffect of pH, SS (94% at pH6), color(95% at pH6), COD(66% at pH 6) and NH3-N(56% at pH 6) were observed. Optimum dose and pH at 1500 mg/L and 6 were selected for SS, color and COD.Meanwhile,dose 3500 mg/L and pH 12 were selected for the optimum coagulation condition for NH3-N removal. Overall, treatment of the MLS leachate by the coagulation process with addition of IC was effective for SS, color and COD but weak in reducing NH3-N.**

***Index Terms*—Coagulation, iron chloride, leachate**

I. Introduction

Leachate is a byproduct of landfill operation. As water/liquid passes through solid waste, it will carry along the polluted matter and the solid waste liquid. Thus, leachate is considered as high strength wastewater.. Reduction of pollutant level in leachate is crucial, as it has the ability to contaminate natural water resources.

Various treatments that were originated from sewage and water have been used to treat leachate [1]. Leachate is difficult to handle due to variability of its characteristic. Most of the time combinations of various methods are used. Moreover, as landfill ages, the leachate characteristic changes, and the treatment methods also changes. At acidogenic phase, landfill will release large amount of volatile fatty acid content[2]. Leachate produced at acidogenic phase, can be characterized by high BOD (>10 000 mg/l), high ratios of BOD/COD (>0.7), acidic pH (5-6), high concentration of ammonia (500-1 000 mg/l), and high level of iron, manganese, zinc, calcium and magnesium. At this phase the landfill will produce a strong and unpleasant smell. The most suitable treatment at this phase is the biological method [3].

However,at themethanogenic phase, the organic fraction in leachate will be dominated by the non-biodegrable(refractory) compounds. It has low COD (< 4000 mg/l), basic (ph>7.5) and low biodegradability (BOD/COD <0.1)[4]. Odour is also reduced to being non-existent. However, ammoniacal nitrogen continues to be released at high levels in leachate. Inorganic substances such as iron, sodium, potassium, sulphate and chloride continue to dissolve from the landfill for many years to come. During this phase, chemical and physical treatments are best be used.

Coagulation is a conventional chemical and physical treatment process used in most water and wastewater treatment. It involves addition of coagulant into the polluted water under rapid mixing intensity. Addition of coagulant will destabilize the suspended particle, promote agglomeration of floc and finally the floc will settle at the bottom of reactor.

Numerous studies on the application of coagulant for partially stabilized leachate had been reported by various researchers for the pastyears [5-10]. However, no attempt has so far been made in application of Iron Chloride (IC) for Matang Landfill site (MLS). Each site of landfill will produce unique characteristics of leachate. Thus, the performance of IC on MLS will be different from other landfills. This article, evaluating the performance of IC in removing suspended solid (SS), color, chemical oxygen demand (COD) and ammonia (NH3-N) from partially stabilized MLS leachate.

II. Experimental Procedure

A. Leachate Sampling *and* C*haracterization*

Leachate samples were collected from MLS, located in at 4°49’20.08’N and 100°40’44.08’’ E near Taiping town in Perak, Malaysia. MLS is equipped with a leachate collection pond. The collection pond acted as a detention pond. Total landfill area of MLS is 12 ha. The landfill received about 300 tons of solid waste daily. Recycling was practiced at site mainly by scavenger. Then the remaining solid waste was dumped on site and covered by local soil.

Sampling procedure was conducted according to

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collection and preservation of samples Method [11]. All samples were collected and immediately transported to the Laboratory and stored in a cold room at 4^{o}C to minimize biological and chemical reactions. Prior to analysis, the samples were allowed to return to room temperature. All parameter s were measured according to APHA (2005) standard method[11].

B. Jar Test

Coagulation experiments were performed by using(SW6 Stuart, Bibby Scientific Limited, UK). Tests were carried out at room temperature. NaOH and HCL were used for pH adjustment. A coagulant was added into the reactor, and rapidly mixed (250 rpm) with 500 ml of leachate for 210 seconds. Then slowly mixed (50 rpm) for 50 minutes and lastly allowed to settle (60 minutes) before supernatant sample were collected by using syringe 3 cm below the surface of leachate for analysis of the responds of the parameter concentrations.

III. Result and Discussions

A. Leachate Characterization

Table II elucidated the characterization of leachate at range and average value of 16 parameters from MLS. All of heavy metal concentrations are below MEQA (1974) permissible limit except for cadmium. Higher than MEQA (1974) permissible limit were recorded for BOD_5, COD, SS, NH3-N and Oil &grease. Regarding to this matter, reduction of pollutant on MLS leachate is important. Based on BOD/COD ratio, MLS is categorized as partially stabilized leachate, so chemical and physical methods are suitable for MLS leachate treatment.

TABLE I: Charecteristics of Raw Leachate

No.	Parameters	Matang		MEQA (1974)*
		Value		
		Range	Average#	
1	Temperature (^{0}C)	27.3-37.4	30.3	40
2	pH	7.9-8.5	7.6	6.0-9.0
3	BOD5 (mg/L)	53-280	146	20
4	COD (mg/L)	470-1260	828	400
5	Suspended solids (mg/L)	194-1620	407	50
6	Ammonia-N (mg/L)	311-1620	868	5
7	Ferum (mg/L)	0-5.4	3.1	5
8	Turbidity(NTU)	15-289	112	-
9	BOD/COD	0.08-0.39	0.18	-
10	True color (ptCo)	885-6680	3199	-
11	DO (mg/L)	0.1-3.03	0.69	-
12	Oil and grease (mg/L)	2780-21350	7468	5
13	Cadmium (mg/L)	0.08-0.42	0.19	0.01
14	Nickel (mg/L)	0.02-0.42	0.16	0.2
15	Cuprum (mg/L)	0-0.23	0.13	0.2
16	Mangan (mg/L)	0-0.25	0.11	0.2

*MEQA: Malaysian Environmental Quality Act 1974.
6 samples taken from June- December 2012

B. Influence of Iron Chloride Dose

Amount of coagulant added into the sample is one of the key factors in determining the efficiency of the coagulation process. Doses of coagulant should be kept sufficient enough to perform at its required efficiency. Overdosing should be avoided, as re-stabilization of particle will occur. Fig. 1 shows the coagulation performance of MLS leachate treatment as a function of coagulant dosage.

Based on the data tabulated in Fig. 1, removal level was ranked as SS>Color>COD>NH3-N. Highest SS and color removal by IC was at dose 1500mg/L with 97% and 95% removal respectively. As for COD, highest removal was recorded at 2000 mg/L dose. While for NH3-N, highest removal obtained by the 3500 mg/L dose of IC. However, the removal of NH3-N is considered low for all range of dose tested.Comparing the removal of COD, NH3-N and color from partially stabilized leachate of Kulim Landfill Site, 30-70% were recorded respectively by Zainol et al., at dosed 4500 mg/L of polyalumium chloride[12].

Control sample was included to observe the difference between leachate with and without addition of IC. Fig. 1, suggested that, addition of ICwas able to remove the aforesaid parameters from MLS leachate. Better performance was recorded for SS, color and COD at dose 1000-2000 mg/L IC. However, reduction of SS, color and COD removal were recorded at a higher dose. Furthermore, a tremendous reduction of removal performance was recorded for color fromthe 2500 mg/L to the 3000 mg/L dose. On the other hand, for NH3-N, better removal was recorded at a simultaneous dose. Thus, the IC dose significantly affects the coagulation performance of the MLS leachate.

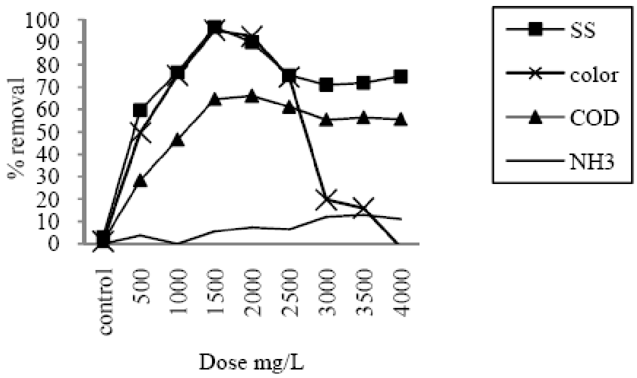

Fig. 2. Treatment of MLS leachate by varying dose of IC

C. Influence of pH

At optimum pH, the coagulant will produce the most effective hydrolysis species which is responsible for the removal of pollutant. According to Bratby, pH is one of the important factors during destabilization process[13]. Thus, selected optimum coagulation pH is crucial for coagulant used in this study.

The effects of pH on the reduction of responses were investigated (refer Fig. 2). Results indicate that for SS, color and COD removal, higher performance of IC was observed at pH 6. Since all of these 3 parameters (SS, color and COD) related to organic contents of leachate, same removal trends were recorded for all range of pH tested. However, the removal rate of SS and color by IC were at par for all range of pH tested. A study by Liu et.al, shows that optimum pH (COD=68% removal, color= 93% removal) for IC in treating leachate is at pH8 with 10 g/L dose[14]. While for this study, almost the same removal of COD (66%) and color(95%) at the optimum pH of 6was observed. In addition, 94% of color was recorded by Salina et al, for semi-aerobic leachate at pH 4 at 800 mg/L IC dose[6].

While for NH3-N, better performance was recorded at pH 12. Same removal of NH3-N was recorded by the control sample and leachate at the pH 12. The control sample is the MLS leachate without the adjustment of the pH. As proven, adjustment of the pH, does not significantly affect the NH3-N removal. However for color, SS and COD, adjustment of the pH significantly affect the performance of CI in treating leachate.

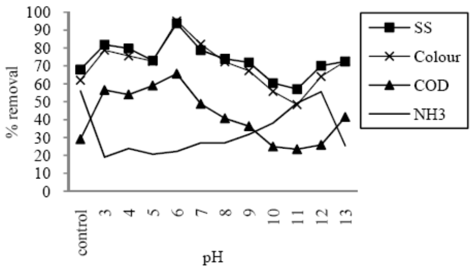

Fig. 2. Treatment of MLS leachate by varying pH of IC

IV. CONCLUSION

Coagulation of MLS leachate using IC has been studied. The outcome of the test revealed the ability of IC in degrading pollutant level in leachate. Almost the same removal trends were shown by SS, color and COD under the influence of dose and pH.Optimum dose for SS and color were at the dose of 1500 mg/L. However, for the COD,it was at 2000 mg/L dose of IC. The same optimum pH (pH 6) was recorded for SS, color and COD.NH3-N, shown difference removal trend comparing to other parameters tested. Higher removal of NH3-N, was recorded at a higher dose and pH.

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