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A New Flocculant-Coagulant with Potential Use for Industrial Wastewater Treatment

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Abstract. This research is focusing on preparation of flocculants from waste Activated Bleaching Earth (wABE) for treatment of wastewater from different sources. The flocculants were prepared by digestion method using HCl or H_2SO_4 and NaOH. Samples of industrial wastewater including food and beverages, paper mill (Soaking & End Process) and Palm Oil Mill Effluent (POME) were used to determine the flocculation activity. Results showed that treatment of Food and beverages wastewater with HCl-flocculant dosage of 6.5% (v/v) showed COD and turbidity removal of up to 71.5% and 70.8% respectively. Wastewater from soaking of paper mill and end process paper mill showed a bit lower percentage of COD removal of about 40-50%. However, the turbidity and Total Suspended Solid (TSS) of end process paper mill were high (91.67% and 95.77%) respectively. The highest Chemical Oxygen Demand (COD), turbidity and total suspended solid (TSS) removal was obtained when POME were treated with 2%(v/v) H_2SO_4-flocculant where the COD, turbidity and TSS removals were 81.15%, 82.54% and 89.91% respectively. The results indicated that the new flocculant-coagulant has potential application for treatment of different industrial wastewaters.

Keywords: Waste Activated Bleaching Earth (wABE); Flocculation; Wastewater treatment; Flocculant-Coagulant Agent.

1. Introduction

Coagulation and flocculation is one of the methods used to treat industrial wastewater. Besides, this flocculation is a process to remove suspended particles by aggregating small particles into larger-size flocs. This process was broadly used to remove particles in wastewater [1]. In recent years, various flocculant catagories have been developed including inorganic flocculants, organic flocculants and composite flocculants. In addition, flocculation is very important in industrial process to separate solid-liquid waste during primary purification [2]. The wastewater is usually difficult to degrade and have high turbidity and toxicity [3]. This separation step is important to ensure that the wastewater being treated and comply with the Department of Environment (DOE) regulation before release to river or sea. In this research we are preparing new acid based flocculant-coagulant agent from Waste Activated Bleaching Earth (wABE) to treat industrial wastewater. wABE have been used as absorption agent to treat contaminant from wastewater and also

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remove poison and dye from crude oil industry [4], [5]. wABE usually be found as waste bleaching agent in Palm Oil Industry. The wABE is flammable and will release organic waste which is poisonous to environment [6]. By reusing wABE as flocculant-coagulant agent will solve environmental problem greatly.

2. Materials and Method

2.1. Flocculant-coagulant Preparation

Samples of wABE were obtained from Wilmar Edible Oil Sdn. Bhd, Penang, Malaysia and Felda Iffco Sdn. Bhd., Klang, Malaysia. wABE samples were first treated with hexane to extract the remaining oil. The deolied wABE was then used for preparation of flocculant. A volume of 300mL of 5M acid (HCl/H_2SO_4) or alkali (NaOH) was used to extract metals and nonmetals from 200g of waste activaled bleching earth (wABE) in 2 L glass beaker. The mixture was stirred at 1000rpm for 30 minutes before added slowly with 1700 mL distilled water. The solution was stirred at the same speed for another 30 minutes before allowed to settle. The upper portion (liquid) was transferred to a 500mL Duran's bottle and used as acid/alkali flocculant for treatment of different wastewater samples. The efficiency of the flocculant-coagulant was determined based on their ability to reduce chemical oxygen demand (COD), turbidity and total suspended solid (TSS) of different wastewater samples.

2.2. Analysis

The specific analysis of metals and non-metals in the acid/alkali flocculant was made by using "Inductively coupled plasma mass spectrometry" (ICP-MS) carried out at the analysis laboratory Faculty of Science and Technology, UKM. COD, turbidity, TSS, and pH measurements were made by using standard techniques. Turbidity meter model "Portable Microprocessor Turbidity Meter" (Hanna Instrument, Japan) was used to measure the turbidity of the samples before and after flocculation treatment. The COD was measured using HANNA COD method based on the closed dichromate-reflux colorimetric method. The kit used was High Range (0 to 15000 mg/L (ppm)) HI93754C-25.

3. Results and Discussion

3.1. Flocculant-coagulant Preparation

The treatment of de-oiled wABE with acid and alkali, led to the dissolution of metals/non metals from wABE in the form of respective salts as it is shown in the Table 1. It has been reported that acid can be used to dissolve the metals from the montmorillonite clay to create porosity for adsorption purposes (Jasra et al. 1995). It is obvious that acid might possess dissolved metals/non metals from montmorillonite clay in the form of respective salts. This study is in agreement with the previous reports regarding dissolution of metals from clay to create porosity but presenting a different application to utilize the dissolved metals/non metals for the treatment of wastewater. It was also assumed that the dissolution of metal/non metal from the wABE might have created some active sites on the particles of wABE which were helpful in the flocculation/coagulation process of suspended solids in wastewater.

3.2. Flocculation-coagulation experiments using different industrial wastewater

Paper mill waste from soaking process has high total suspended solids which are non-filterable residue and the chemical demand oxygen in this waste is high (34600 mg/L).. Soaking paper mill showed best result for turbidity removal with all above 99.90% but the COD and TSS removal were less than 50% when 10% (v/v) flocculant was used.

Samples of wastewater of end process of paper mill were treated using 1 and 2 % of flocculant. The flocculant showed faster flocculation comparing to soaking process waste water. The time for treatment was less than 15 min and the results exhibited that by using this flocculant (2%), the removal of COD, TSS and turbidity were 52%, 95.77 % and 91.67% respectively.

Palm oil mill effluent (POME) is a potential pollutant with high chemical oxygen demand (COD) and biochemical oxygen demand (BOD). It is considered as a hazardous effluent if disposed off without treatment. Many methods have been reported in the literature to treat the POME before disposing it off.

These methods include the coagulation using chemicals, inorganic/organic polymers and electrical inputs [7], [8]. POME is also treated anaerobically to reduce the COD and BOD before its disposal [9].

Table 1: Metal analysis of HCl-flocculant and H_2SO_4-flocculant by ICP-MS

Metal analysis of Ac-flocculant & Alk-flocculant by ICP-MS (ppm)					
Analyte	HCl-flocculant	H_2SO_4-Flocculant	Alk-flocculant	Precipitation by mixing HAc-floc and Alk-floc	Precipitation by mixing SAc-floc and Alk-floc
Silicon	17.630	117.36	42 87.4629	66.85%	96.92%
Aluminium	457.507	954.91	11.960	90.8%	98.41%
Iron	294.0461	1484.7	10.687	98.91%	99.02%
Magnesium	9 70.2230	1170.1	2.471	66%	99.42%,

Table 2: COD removal, TSS removal and Turbidity removal from different wastewater after flocculation using flocculant prepared using HCl

Wastewater	**Dosage (%)**	**COD removal (%)**	**Turbidity removal (%)**	**TSS removal (%)**
Food & beverages	1	64.6	69.78	-
	5	35	70.53	-
	6.5	71.5	70.80	-
	10	63.74	70.82	-
Paper mill (soaking)	2	<20	<20	<50
	10	42.14	42.14	99.09
Paper mill (end process)	1	34.78	86.11	93.08
	2	52.17	91.67	95.8
Palm Oil Mill Effluent	1	60.22	69.46	79.99
	2	63.79	72.76	85.55
	5	76.69	75.68	87.64
	10	81.15	80.54	89.91

Results show that the percentage of TSS removal after being treated with 10% (v/v) flocculant was 89.91% while the COD and turbidity removal were 81.15% and 80.54 respectively. Details studies on treatment of POME ware carried out using different dosage of H_2SO_4-flocculant. The results shows that high percentage of COD, turbidity and TSS removal can be achieved using 2% (v/v) flocculant (Fig. 1).

4. Conclusion

Palm oil mill effluent can be treated by using wABE to reduce the COD, turbidity and other related polluting parameters. This study looks supportive to utilize the same technique for the treatment of other types of wastewater or down streaming of industrial fluids. Further studies are in progress to explore the advantages and disadvantages of the prepared coagulant/flocculant.

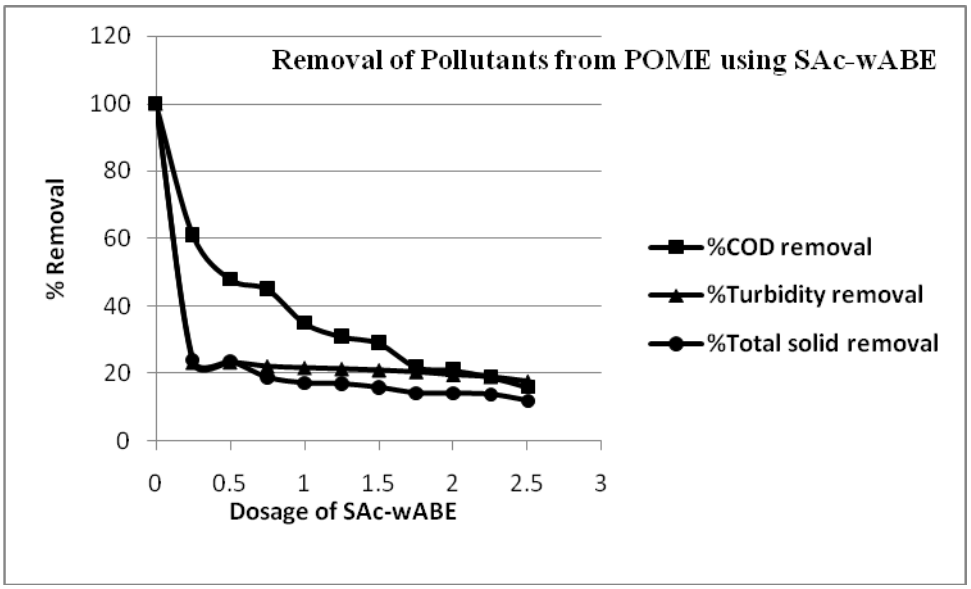

Fig. 1: Removal of COD, turbidity and total suspended solids from POME with flocculant prepared using H_2SO_4

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