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JILID 1

DEVELOPMENT OF BATIK WASTEWATER TREATMENT FOR COTTAGE INDUSTRY

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ABSTRACT

Batik industries produce a variety of waste liquors from the cleaning, processing and dyeing of the fabric. Disposal of batik wastewater of pH ranges 4 to 13 could cause an environmental problem due to the high content of dissolved solid and toxic compound as well as the color body. Standard wastewater treatment analysis was applied to characterize the wastewater. A bench scale of treatment was established using a new coagulant known as KN1. KN1 is a plant based coagulant and most suitable pH for the coagulation process ranging from 5 to 5.9. The results obtained shows that batik wastewater could be treated using this method, followed by removal of color and an inorganic matter using activated carbon. A pilot plant will be designed based on the bench study with stringent requirements such as simple, low cost and users friendly for small batik industries.

Key words: KN1, adsorption, activated carbon, wastewater, coagulation, and flocculation.

INTRODUCTION

Generally, batik industries are home-based and family operated which scattered around our country, especially in East Coast state. In Terengganu, batik industries are one of the major earning sources for villagers. Most of them are sub-vendor to established company around Malaysia. Batik industries produced about 5 m^3 per day or around 150 m^3 per month (3). According to the Environmental Quality Act 1974, First Schedule, Environmental Quality (Sewage and Industrial Effluents) Regulation 1978, from Regulation 3 states that this regulation should not apply to any discharges from processing, manufacturing, washing or servicing of any other products or good that produce effluent less than 60 cubic meters (13,000 gallons) per day. Even though small scale of batik industries excluded of this regulation, numbers of this industry could produce substantial amount of wastewater. However, Environmental Quality Act 1974, under Environmental Quality (Scheduled Wastes) Regulations 1989 of Act 127 stated that any waste falling within the categories of waste listed in the First Schedule is referred as a scheduled wastes included dye or any coloring matter produce from any batik industry (1).

Batik using dyes as the main compound to colour the fabric. Besides azo-group and amines as its main functional group, dyes also contain several impurities such as heavy metals and solvent. Some of the heavy metals contain in the dyes such as nickel, chromium, cobalt, copper, zinc and etc. The colour is the first contaminants to be recognized because it is visible to the human eye. Strong colour is the most notorious part, which were depending on the type of dyestuff used. The colour used are varies from red, brown, blue, purple and black due to their intensified and dark varieties. These colours can change daily, or even several times a day because the dyestuff used in the dyeing processes changes frequently due to customers' requirements. Dyes are highly stable molecules, made to resist degradation by light, chemical, biological and other exposures. Commercial dyes contain a mixture of complex constituents (6).

At present, none of the methods used to decolorize of textile wastewater such as ozonation, chlorination, photo-catalytic, biological method are being apply to solve batik wastewater problem (5). Therefore, a new approach of treating batik wastewater is introduced in this study by using plant-based coagulant, known as KN1. KN1 has been founded has similar properties and characteristics of commercial grade coagulant. According to Kuo (1992) plant based coagulant not only posses the advantages of oxidation and coagulation process but also can increase the amount of oxygen in water (4).

A treatment plant will be designed based on the bench scale with stringent requirement to meet the terms with Standard B of Environmental Quality Act. Besides that, the cost, area required and maintenance of the treatment plant will be considered in the design. The main objective in this research is to develop plant based coagulant.

MATERIALS AND METHODS

Sample preparation Batik wastewater samples used in this work were obtained from cottage industries around Kuala Terengganu and labeled according to the companies. pH of the wastewater was varying from 4.5 to 11.5 and remain unchanged. Absolute concentration of the dye in the effluent were unknown, therefore dye degradation rates were determined using turbidity meter ranged from 20 to 200 FTU. All COD values were obtained by closed reflux colorimetric method using HACH 8000 method. Other parameters determined during the studies were: pH, Total Solid (TS), Volatile Suspended Solid (VSS), Suspended Solid and BOD_5 were carried out using standard wastewater analysis based on USEPA and APHA methods (7). Total amount of oil and grease as well as heavy metals content in sludge and water samples also determined. The heavy metals analysis was carried out using Hewlett Packard Inductively Couple Plasma – ICP-OES (2). Characteristics of batik wastewater and soil from the analysis such as biological oxygen demand (BOD), chemical oxygen demand (COD), suspended solid (SS), acidity or alkalinity are shown by Figures 1, 2, 3, 4, 5 and 6 respectively.

Coagulant preparation. In this study, coagulant (KN1) was obtained by extracting 20 g of a plant with 200 ml of distilled water and pH of KN1 varies from 5 to 5.9. HCl or NaOH was added to KN1 solution to get the suitable pH of the coagulant solution.

GAC preparation. Local manufacturer supplied the coconut shell based activated carbon used. The quality and properties of GAC were determined by its adsorption power and porosity. Methylene blue decolorizing power and iodine number was used to indicate the adsorption power while BET measurement was used to check the porosity and surface area of the GAC. GAC with 8x12 mm mesh size was selected due to it suitability and the adsorption. Activated carbon with 1100 m^2/g surface area, 160 mg/l methylene blue number and 1150 mg/g iodine number was used in this study.

Batik wastewater treatment. Treatment was conducted using KN1 as a coagulant and 2.0 M HCl as an acid medium to ensure the coagulant and flocculation process occurred. In this study, the ratio of KN1 and HCl are the crucial factor compared with optimizing the pH of the wastewater as shown by Table 1. The solution was stirred using a glass rod for 5 minutes to settle down. The sediment was filtered through selected filter fabric and the supernatant was passed through the GAC column before it was discharged. Performance of the treatment was determined by the analysis of COD, BOD and other parameters.

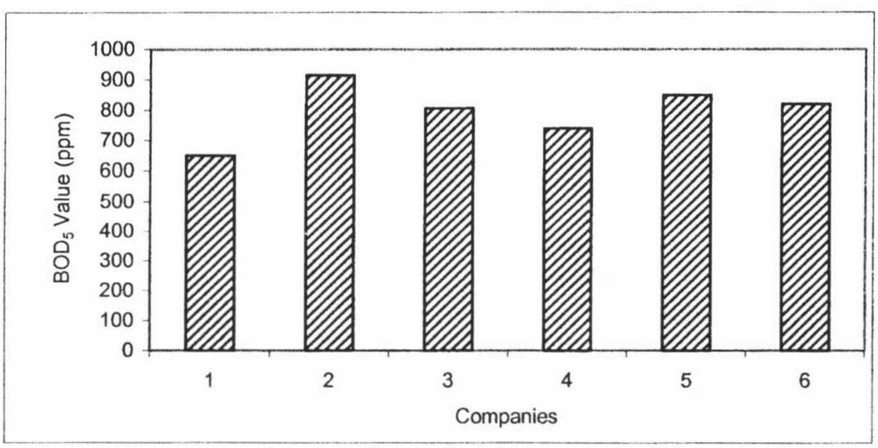

Figure 1. BOD value for batik wastewater from different companies.

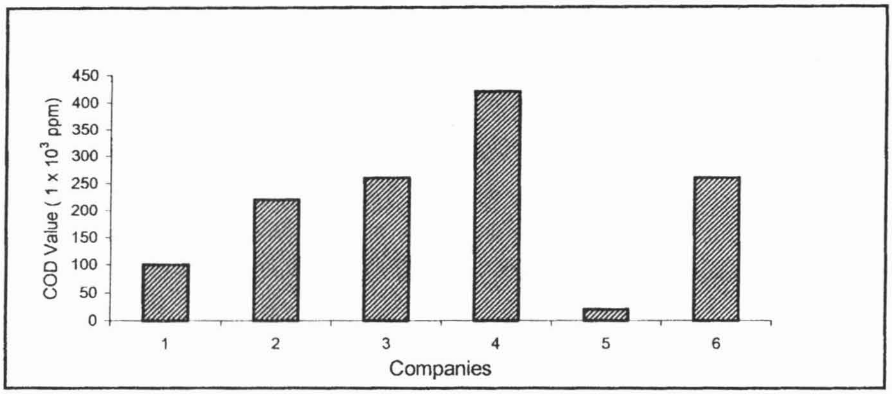

Figure 2. COD value for batik wastewater taken from different companies.

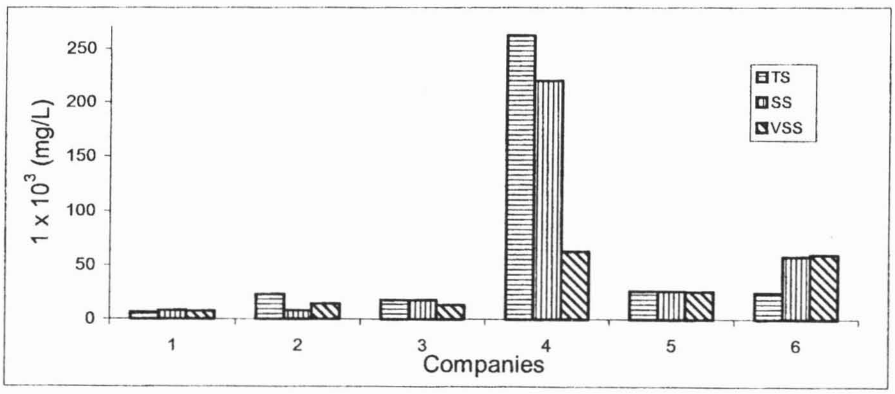

Figure 3. TS, VSS, SS and pH values from different companies.

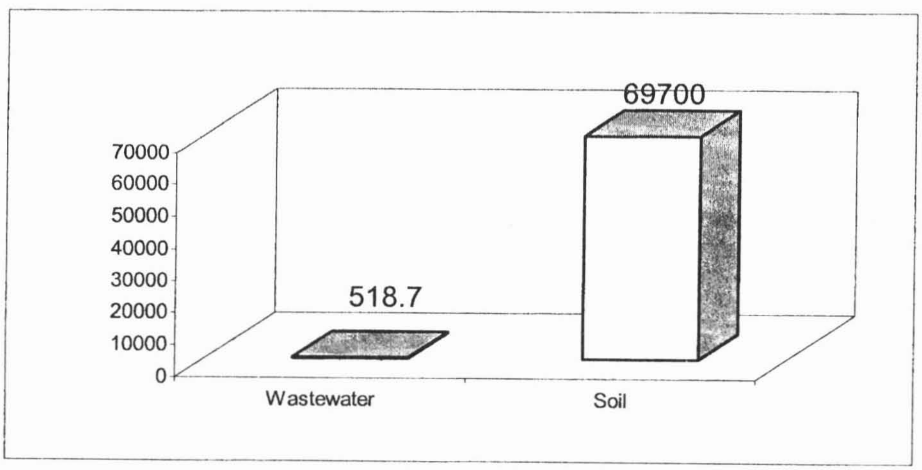

Figure 4. Oil and grease constituents in wastewater and soil sample

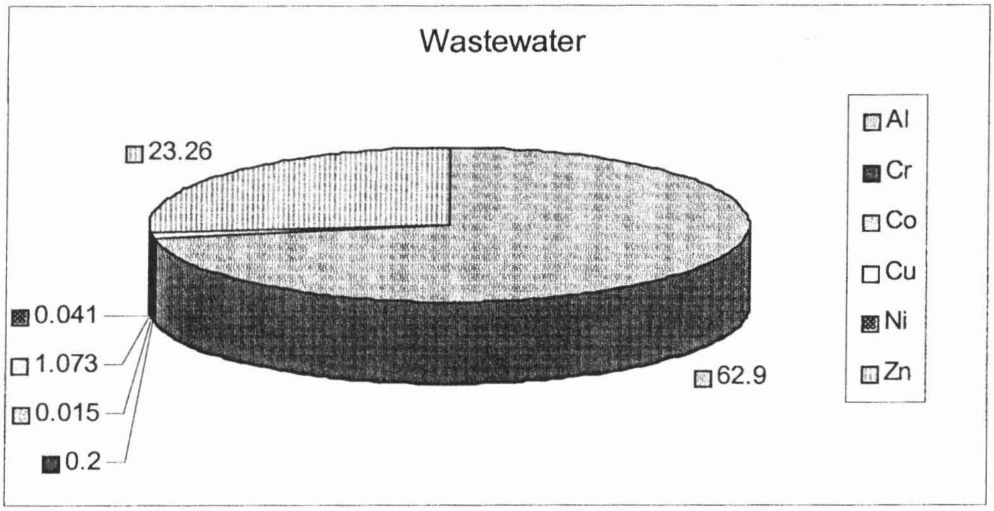

Figure 5. Heavy metals constituents in wastewater and soil.

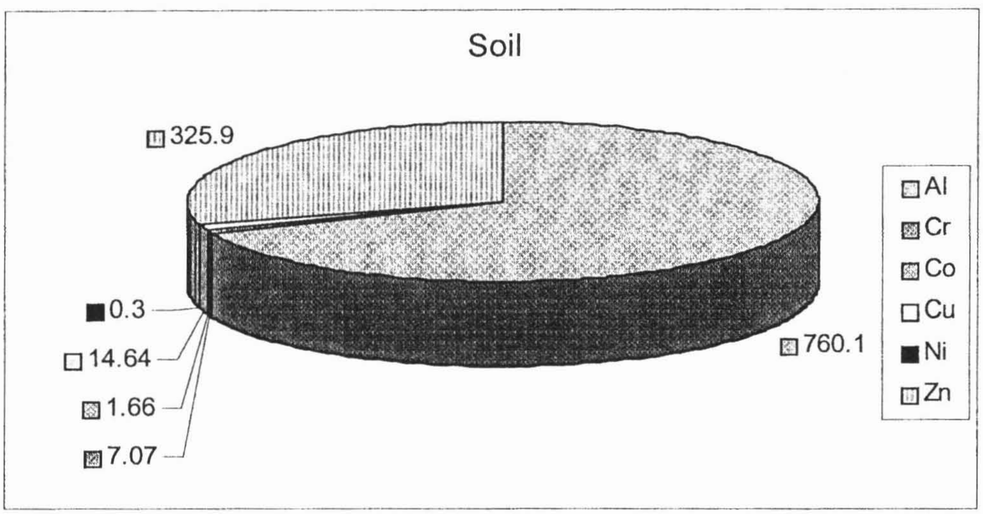

Figure 6. Heavy metals constituents in soil

RESULT AND DISCUSSION

Table 1 shows the recommended volume of KN1 to HCl at specified pH ranges of 30 ml of batik wastewater. Figure 7 indicates the COD value of the samples after and before treating with KN1 with the recommended ratio as shown in Table 1. The average reduction of COD value is about 53.57 % of individual samples compare with the COD reduction of blended wastewater, which is 54.5%. Blended wastewater samples show better reduction for COD since the concentration of colloidal particles for the blended sample is higher than individual samples. Destabilization of colloidal particles by KN1 is more effective at high colloidal concentration, i.e. blended samples. This might be due to insufficient contact opportunities between the colloids in diluted solutions. Other factors that affecting the result might be amount of the dosage and concentration of the KN1. Minimum concentration of KN1 used was only 10 % (weight/volume) while the higher volume used is 10 ml to 10 ml of HCl for treating every 30 ml of individual or blended sample.

KN1 was proven effective in the color removal of batik wastewater. Table 2 shows that the turbidity of the wastewater was reduced from 1425 FTU to only 56 FTU after the treatment process, hence 96% of the color was removed. Therefore, role of the GAC is easier since large amount of the color was removed. The remaining of colloidal particles, which represent turbidity of the wastewater, had removed after passed through the media filter and GAC column. Furthermore, removal of colloidal particles reduced the total dissolved solid (TDS), suspended solid (SS) and volatile suspended solid (VSS) content in the wastewater. The reduction of TDS, SS and VSS as shown by Table 2 are 83.5%, 99.5% and 99.4% respectively.

Table 1. The recommended volume of KN1 to HCl for 30 ml sample of batik wastewater

pH range	KN1 (ml)	HCl (ml)
<3	*** not applicable	
4-5	8	12
6-7	6	14
8-9	8	12
10-11	10	10
11-12	10	10
>13	*** not applicable	

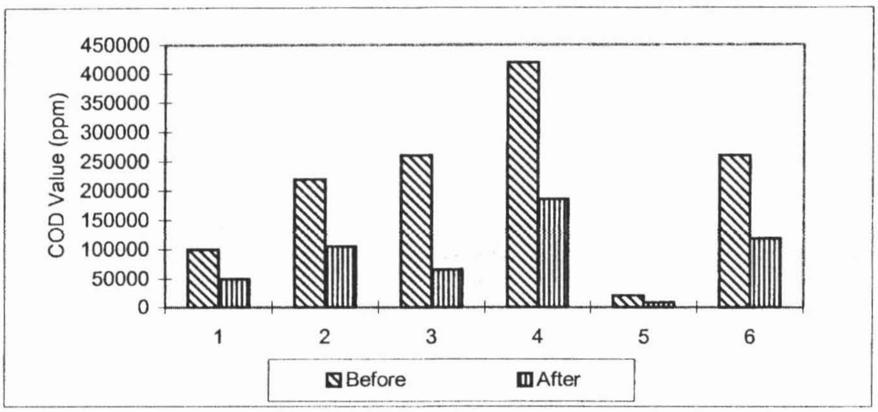

Figure 7: COD value before and after the treatment for different companies.

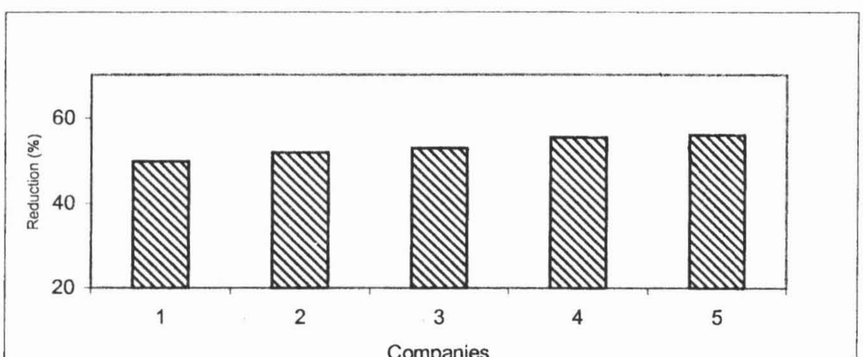

Figure 8: Percentage reduction of COD after the treatment for different companies.

Table 2: The percentage reduction of blended batik wastewater samples before and after treatment using KN1

Wastewater (mix)	COD Value (mg/l)	BOD_5 Value (mg/l)	Turbidity (FTU)	TDS (mg/l)	TSS (mg/l)	VSS (mg/l)
Before Treatment	3235.2	870	1425	11274	2022.5	1637.5
After Treatment	1472	427	56	56	10	10
Reduction (%)	54.5	50.1	96	83.5	99.5	99.4

CONCLUSION

Volume of the coagulant depends on the pH value of the wastewater. Volume of KN1 ranging from 6 to 10 ml for wastewater with pH 4 to 13 respectively. Average COD and BOD reduction are 53.13 % and 50.1 % respectively after treated with KN1. Quality of wastewater could be drained safely to the environment after polishing with GAC.

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REFERENCES

1. Act 127, 2000. Environmental Quality Act and Regulation. *Law of Malaysia*, MDC Publisher Printers Sdn Bhd pp 60 and pp 167.

2. Boumans, P.W.J.M. *Inductively coupled plasma-emission spectroscopy-Part 1*. John Wiley & Sons. New York. pp 584.

3. Jusoh. M. Z., pers. Comm., 2002.

4. Kuo. W. G.1992. Decolourizing Dye Wastewater with Fenton's Reagent. *Water Research*. Vol. 26, No. 7, pp. 881-886.

5. Namboodri C.G, Perkins W.S and Walsh W.K .1994. *Decolourizing Dyes with Chlorine and Ozone*: Part 1. Journal of American Dyestuff. pp 17-22

6. Robert J.D, Grainer J.L, O'Neal, I-Wen Wu .1994. *Photocatalytic decolorizaton of wastewater dyes*. Journal of Water Environmental Research Vol. 66(1). pp 18-36

7. *Standard Methods For The Examination of Water and Wastewater*. 14th Edition. Revised 1985. APHA, AWWA, WPCF.