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DEVELOPMENT OF LATEX-BASED AS NEW COAGULANT FOR INDUSTRIAL COOLANT WASTEWATER TREATMENT

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ABSTRACT

In recent years, polymer application has become more important in wastewater treatment due to easier sludge disposal, reduction in cost for chemical consumption and increase pollutant removal efficiencies. It can be used either as coagulant or coagulant aid to destabilize and aggregate colloidal particles. In this study, industrial coolant wastewater was treated with latex-based material as a new coagulant. Latex is a liquid particle of rubber in an aqueous serum containing various kinds of organic and inorganic substances. It can be coagulated by adding acetic acid (1 %) or formic acid (0.5 %). Composition of latex varies depending upon botanical species and influenced by biological and climate. Characteristic of the industrial coolant wastewater was determined before and after the treatment. It was found that COD of the wastewater was reduced to 99.9 percent and comply the Environmental Standard to be discharged to the monsoon drain after polishing with commercial grade of activated carbon and dilution process.

Keywords : polymer, coagulant, coagulant aid, latex, COD

INTRODUCTION

Number of industries are increasing in Malaysia. Those industries discharge wastewater that is complex in nature and highly toxic. It is important to treat the wastewater to protect public health and environment. The aims of wastewater treatment are to reduce the total organism content and remove bacteria and viruses as well as chemicals and suspended matter that are harmful to health, to reduce to a low level those chemicals that might interfere with the normal domestic industrial uses of water and any corrosive properties of water and protect the pipe distribution systems.

Government had introduced a waste minimization concept for industrials sector. There are 4 categories involved in the strategy: source reduction, recycling, incineration/treatment and secure land disposal. Wastewater treatment can be divided into physical treatment such as pretreatment, clarification, flocculation, flotation, gravity separators and filters adsorptions. Chemical treatment normally referred to neutralization, oxidation-reduction, coagulation and chemical precipitation, ion exchange and membrane processes whereas biological treatments are trickling filters, activated sludge, oxidation ponds, anaerobic digestion and ultimate disposal methods (baring to sea, burial, deep well injection, incineration).

In this study, KS1 which is latex-based material was employed to treat the coolant wastewater from lens industry. Latex is a homogenous colloidal dispersion in water of polymeric particles, mostly 100-300 μ m in size. It can be stabilize by using surface active agent e.g. anionic soaps and nonionic surfactant. Average molecular weight 200000-300000 with the primary high molecular weight polymer in NRL (natural rubber latex) is polyisoprene. Latex can be divided into fresh and concentrate latex. The characteristic of the natural rubber is shown in Table 1 (1).

It is found that the particles of the diluted latex are in Brownian movement when determined under a microscope. They carry a negative electric charge which causes them to repel one another. If the electric charge is sufficiently reduced, the particles will able to come together and coagulation will occur. Acids are most frequently used, especially formic and acetic acids.

The main objective of this research is to investigate the feasibility of treating coolant wastewater by developing latex-based material as a new coagulant for chemical coagulation. In this study hydrochloric acid was used to coagulate the mixture of KS1 and wastewater.

Table 1. Typical Fresh Latex Composition. (1)

Components	%
Total Solids Content	41.5
Dry Rubber Content	36.0
Amino Acids and N-Bases	0.30
Neutral lipids	1.0
Proteins	1.60
Phospholipids	0.60
Inositols-Carbohydrates	1.5
Salts (mainly K,P and Mg)	0.50
Water	58.5

Coagulation is widely used in water and wastewater treatment. Shut'ko (1986) investigated the treatment of industrial wastewater from petroleum refineries by using aluminium containing coagulants. They found that aluminium containing coagulants were effective for the treatment of the petroleum refining wastewater, particularly for effluents with high salt concentration. A laboratory scale coagulation of pulp and paper mill effluents using alum and chlorinated copper was carried out by Soetopo (1984). In their study, it was reported that significant reduction of suspended solids, BOD, COD and color were obtained.

Colloidal dispersion can be divided into two major classes according to their mode of stabilization: hydrophilic colloids which gain stability by solvation of the interface, where the term solvation includes all degrees of interaction from mere physical wetting to the formation of adherent thick layers of oriented water molecules, which may display highly viscous or gelled properties; and hydrophobic colloids which are stabilized by an electrostatic repulsion between particles, arising from ions that are either adsorbed onto or dissolved out of the surface of the solid. Destabilization of particle is essential in order to bring them in contact and aggregate. Chemical coagulants can destabilize the colloidal particles by four distinct mechanisms; double layer compression, charge neutralization; enmeshment in a precipitate and interparticle bridging.

Several chemical have been conventionally used as coagulants in water and wastewater treatment, such as ferric chloride, ferrous sulphate, aluminium chloride, aluminium sulphate and hydrated lime. Different coagulants effect different degrees of destabilization. The higher the balance of the counter-ion, the more is its destabilizing effect and the less is the dose needed for coagulation. Using Al(111), particle destabilization is believed to be brought about by Al(111) polymers which are kinetic intermediates in the eventual precipitation of a metal hydroxide precipitate. These polymers are adsorbed on colloidal particles. The amount of polymer adsorbed and consequently the dosage of Al(111) coagulant necessary to accomplish destabilization of colloidal particles can depend on the concentration of colloids. (O'Melia, 1972)

If pH is below the isoelectric point of the metal hydroxide, positively charged polymers will prevail and adsorption of these positive polymers can destabilize negatively charged colloids by charge neutralization. Above the isoelectric point, anionic polymers will predominate, where particle destabilization may take place through adsorption and bridge formation. At high doses of Al(111), a sufficient degree of oversaturation occurs to produce a rapid precipitation of a large quantity of aluminium hydroxide, enmeshing the colloidal particles in what has been termed a sweep floc and also when Fe(111) salts were used as coagulants, monomeric and polymeric ferric species are formed, the formation of which is highly pH dependent. (5)

MATERIALS AND METHODS

Spent coolant as an effluent from a lens industry was used as a sample in this study. The optimum ratio for KS1, wastewater and acid were determined by jar tests. The settleability of the wastewater was tested in accordance with the procedure outlined in the Standard Methods (APHA, 1985). The objective of the jar test was to determine the optimum dose and pH value at which a coagulant should be introduced. Samples of supernatant were collected and pH, turbidity and COD of the supernatant were measured. The same steps at different doses of the coagulant were repeated. The supernatant was neutralized with calcium oxide and then filtered before treated with activated carbon (1100 m²/g specific surface area) for adsorption process. The solid produced by coagulation process than pressed to remove liquid before disposed.

RESULTS AND DISCUSSION

The optimum ratio for coolant wastewater, KS1 and hydrochloric acid were determined by varying the volume of KS1 and acid used for a constant volume of coolant wastewater. The supernatant of the selected ratio were tested for chemical oxygen demand (COD) to determine the lowest COD reduction. Molarity of hydrochloric acid was varied to investigate the COD reduction. Figure 1 shows that the best ratio for hydrochloric acid, KS1 and wastewater respectively is 65:35:100.

Figures 2, 3, 4, 5 and 6 respectively, show the characteristic of coolant wastewater before and after treatment. Figure 2 shows the reduction COD for different dilution started from 3 times to 12 times with the value of 487 mg/liter to 73 mg/liter respectively. Addition of hydrochloric acid to the new coagulant, KS1 and wastewater mixture produced light yellowish supernatant. The acid components trapped the oily contaminants, coalesced and separated from the supernatant. Anion polymer portion from KS1 attracted remaining oils and larger charge cations. Figure 3 shows that TSS of the coolant wastewater was effectively reduced from 1745 ppm to 70 ppm after 12 times dilution process. From figures 4, and 5 the reduction of oil & grease and sulphide after 12 times dilution are 99.9% and 99.5% respectively. Heavy metals ion (cation) in remaining solution were trapped and agglomerate with KS1 to form solid waste as shown by Figure 6 for 12 times dilution.

The pH of supernatant was between 1-2 and calcium oxide was used to neutralized the sample until it reached pH between 6.5-7.5. The supernatant was filtered due to precipitation of calcium chloride and then treated with activated carbon for adsorption process. At this stage the value of COD was reduced to the range of 4000 –2000 ppm which lie above the limit permitted by DOE (Department of Environmental). The supernatant was diluted 12 times with water and resulted COD with 80 ppm.

CONCLUSION

The optimum ratio volume of new coagulant (KS1) and acid required for successful coagulation was found to be 35 ml and 65 ml respectively for every 100 ml of coolant wastewater at pH 7. From the chemical treatment, it was observed that KS1 can be developed as new coagulant to treat coolant wastewater. 99.9 percent COD was reduced as well as 96 percent suspended solid was removed after 12 times dilution process as a final stage of treatment.

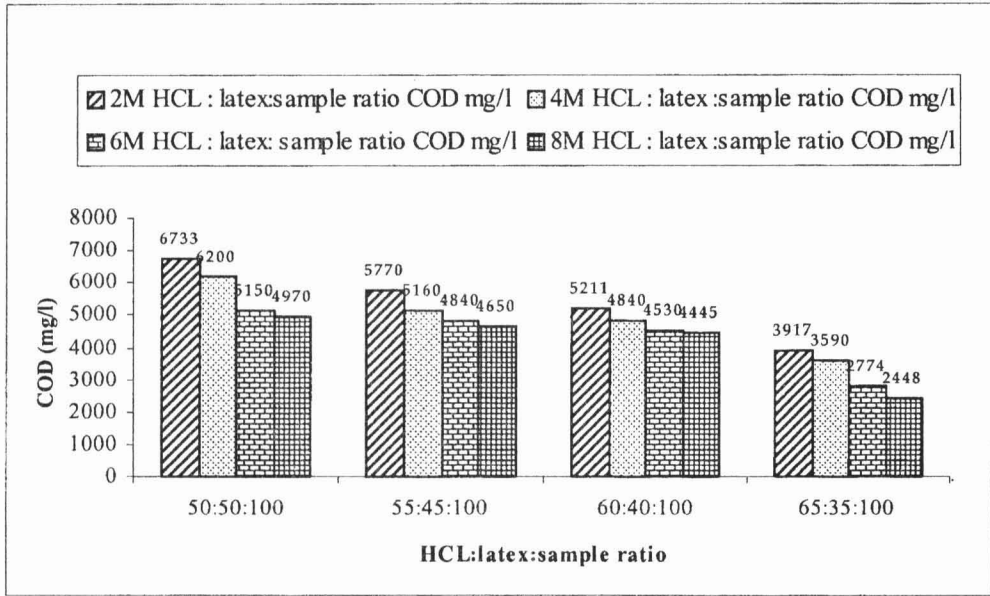


Figure 1. Changes in COD concentration of the coolant wastewater

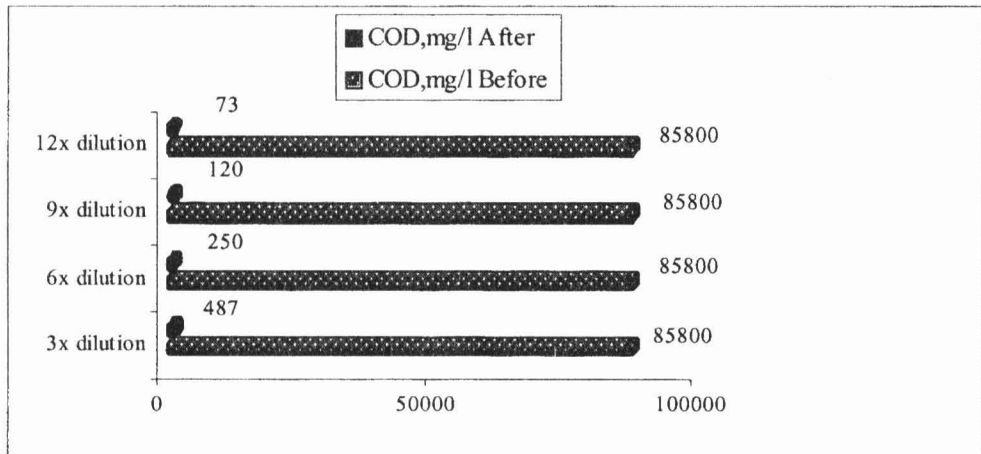


Figure 2. Changes in COD concentration of the coolant wastewater.

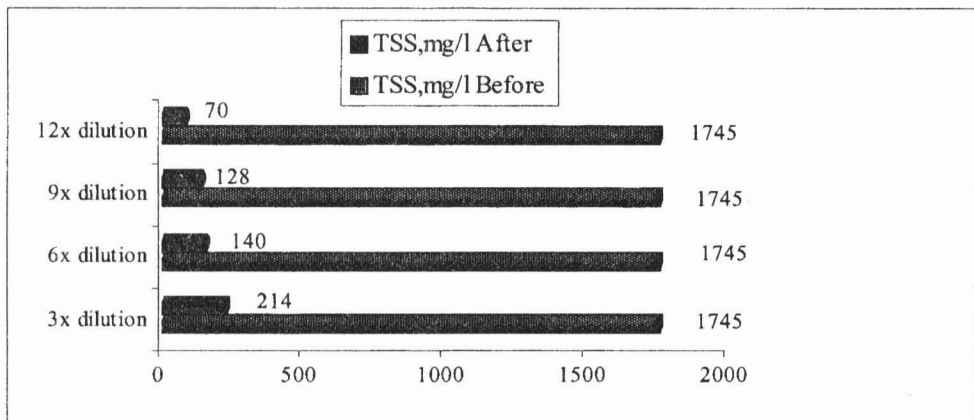


Figure 3. Changes in TSS concentration of the coolant wastewater.

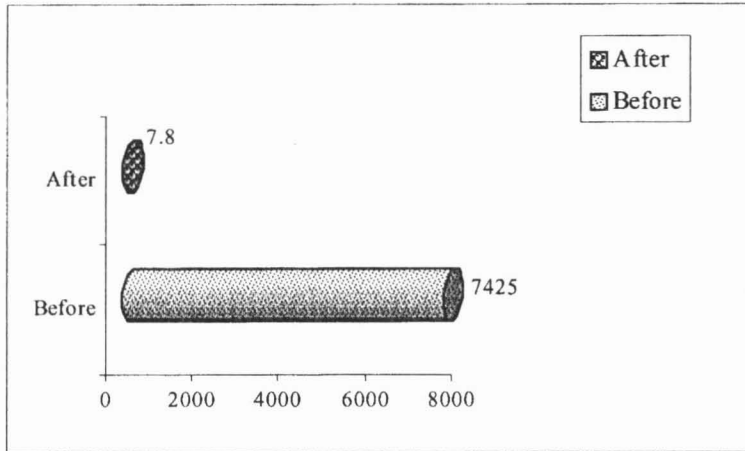


Figure 4. Changes in oil & grease concentration of the coolant wastewater.

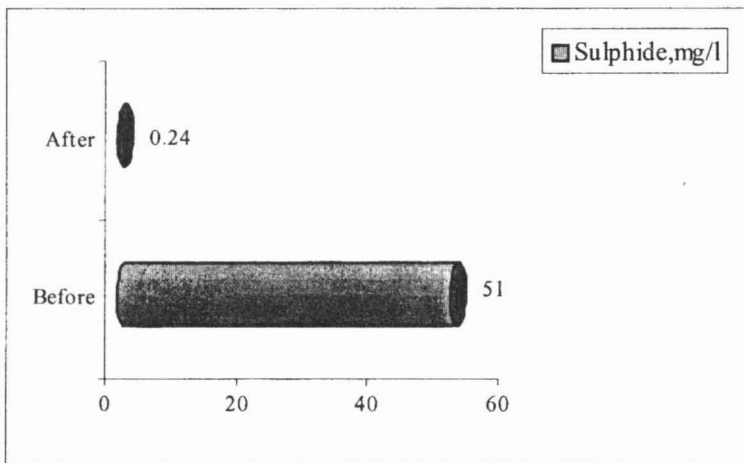


Figure 5. Changes in sulphide concentration of the coolant wastewater.

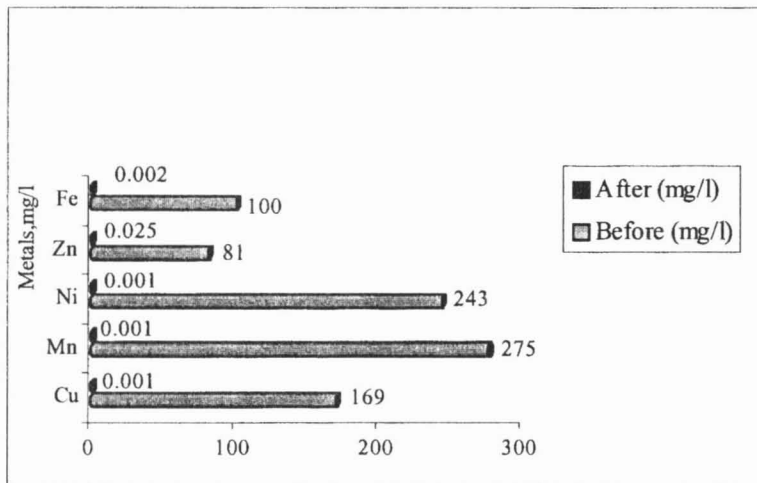


Figure 6. Changes in metals concentration of the coolant wastewater after 12 times dilution.

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REFERENCES

1. Jean Le Bras, Introduction to Rubber . Mac Laren and sons LTD London page 36-72
2. Lin S. H. and Lin C.M. (1993) Coagulation-flocculation by ferric chloride of some organic compounds in aqueous solution. *Water Research* 27(3), 433
3. Livke V. A., Ostrovka V. I. and Gendruseva N. P. (1989) Tertiary coagulation treatment of aniline dye industry wastewater. *Soviet J. Water Chem. Technol.* 11(2), 115
4. Nemerow N. L. (1978). *Industrial Water Pollution: Origins, Characteristics and Treatment*, 2nd Edn. Addison-Wesley Publishing Company
5. O' Melia C. R. (1972). Coagulation and flocculation. In *Physicochemical Processes For Water Quality Control*, ed. W. J. Weber. Wiley Interscience, New York
6. Shut'ko A. P (1986) Treatment of industrial wastewater from petroleum refineries by using aluminium containing coagulants. *Neftepererab. Neftekhim* 8, 5
7. Tanimoto K. and Yamagishi K. (1997) Powdered chemical agents for treatment of wastewater from processing of meat and fish and the treatment process. *Jpn. Kokai Tokkyo Koho A2(14)*, 5
8. Tebai L. and Hadjivassilis I. (1992) Soft drinks industry wastewater treatment. *Water science Technol.* 25(1),45
9. Yamagushi H. (1997) Coagulation treatment of industrial wastewaters from silicone water manufacturing. *Jpn. Kokai Tokkyo Koho A2 (4)*, 7