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QUANTIFICATION ANALYSIS OF DEAMMONIATION LATEX EFFLUENT SLUDGE

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RINGKASAN: *Kajian ini memfokuskan analisis kuantifikasi terhadap unsur-unsur di dalam enapcemar effluen susu getah ternyahammonia yang dicairkan menerusi spektroskop penyerak tenaga (EDS). Pengurangan di dalam peratus berat dan peratus berat atom ditemui dalam unsur karbon (C) tetapi terdapat peningkatan bagi unsur oksigen bagi kedua-dua peratusan tersebut. Bentuk morfologi bakteria (Basillus sp.) yang digunakan sebagai inokulum di dalam kajian ini, seperti yang dilihat di bawah mikroskop imbasan elektron (SEM) adalah berbentuk rod pendek. Perlekatan dan penembusan bakteria tersebut di atas enapcemar effluen susu getah ternyahammonia yang dicairkan turut diperolehi di bawah SEM. Kecekapan sistem rawatan skala pandu yang berasaskan kaedah pengudaraan tambahan dipertingkatkan menerusi kaedah imbuhan-bio iaitu penambahan bakteria eksogenus yang spesifik untuk meningkatkan lagi penurunan bahan organik dalam effluen susu getah ternyahammonia ini. Keputusan menunjukkan peratus penyingkiran permintaan oksigen biokimia (BOD_3), permintaan oksigen kimia (COD) dan pepejal terampai (SS) mencapai 91.8 ± 0.1, 89.7 ± 0.1 dan 88.6 ± 0.4 pada masa tahanan hidraul 24 jam (HRT) dan kepekatan inokulum ialah 22 mg/l.*

ABSTRACT: The study was done to quantify elements in diluted deammoniation latex effluent sludge through EDS (energy dispersive spectroscopy). A reduction in percentage weight and percentage atomic weight was observed for the carbon (C) element, however an increase of oxygen (O) at both percentages was seen. It also found that the specific exogenous bacteria (inoculum), *Bacillus sp.* was a short rod shape as seen under TEM and it attached and penetrate on the diluted deammoniation latex effluent sludge surface as seen under scanning electron microscope (SEM). The effectiveness of using specific exogenous bacteria to enhance the reduction of the organic and inorganic pollutants was done through the pilot scale latex effluent treatment by extended aeration and bioaugmentation. The results showed BOD_3, COD and SS were removed up to 91.8%, 89.7% and 88.6 ± 0.4 at 24 h HRT and 22 mg/l inoculum.

KEYWORDS: Extended aeration, scanning electron microscope, transmission electron microscope, energy dispersive spectroscopy, inoculum, bioaugmentation.

INTRODUCTION

Wastewater treatment by an activated sludge process is based on the growth of microbial populations, particularly bacteria, in flocculated form (known as biological floc) (Jorand *et al.*, 1995). Activated sludge is a heterogeneous mixture of particles, microorganisms, colloids, organic polymers and cations (Forster, 1976; Li and Ganczarzyck, 1990). Yeoh (1993) reported that the success of an activated sludge system in wastewater treatment depends predominantly on the complete utilisation of assimilable substrate as well as the flocculation of discrete microbial cells into readily settleable flocs.

Current treatment technologies such as bioremediation can be used independently to reduce the organic or inorganic wastes either in wastewater, soil or groundwater contamination (Alexander, 1994). Glaser (1994) stated that the application of mineral nutrients to enhance the activity of oil or petroleum hydrocarbon degrading microorganisms, indigenous to contaminated environments (i.e. enhanced biological treatment), has been used for the past 10 to 15 years. This application has also been supported by Chirwa and Wang (1995), in their findings using a continuous-flow bioreactor containing *Bacillus sp* on glass beads to remove chromium from wastewater. Within a 24-hour liquid detention time, *Bacillus sp* was able to completely remove chromate concentrations of up to 200 mg/l by aerobic respiratory activity.

Latex effluent has been shown to contain high levels of COD, BOD_3 and suspended solids (Lee Rubber Industry, Personal Communication). Kadir *et al.* (1996) successfully reduced the odour and brought down the BOD_3, COD and SS levels of a rubber processing industry to permissible levels set by the Department of Environment by using the inoculum specific for hydrocarbon. This reduction was achieved within a month after the application of the inoculum.

The objective of this study is to quantify an element in diluted deammoniation latex effluent sludge through EDS from the pilot scale latex effluent treatment by extended aeration and bioaugmentation.

MATERIALS AND METHODS

The treatment system

Aerobic pilot scale systems were custom made using fibre glass materials. The system comprised a 0.5 m diameter and 1.2 m width/length cylindrical tank separated into two parts which are the equalization tank (EQT) (0.7 m long) and extended aeration tank (EAT) (0.5 m long) (Figure 1). Samples were aerated in EAT for 24 h while both ends are capped with a 0.1 m cover, and a hopper type clarifier with dimensions 0.45 m diameter and 0.6 m high was used. The retention time for the clarifier was about 2-3 hours.

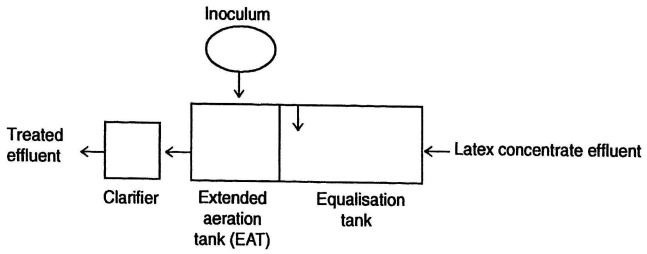

Figure 1. *Schematic diagram of the bioaugmented reactor*

Sampling and wastewater compositions

Latex effluent samples were collected from a local company from their raw deammoniation latex effluent (B) before entering the rubber trap as indicated in Figure 2. Deammoniation latex effluent was a mixture of two processing steps, that is the initial latex washing process and the deammoniation process of skim latex. The samples were diluted eight times prior to use. BOD_3, COD and SS values were predetermined using the APHA method (1992). Table 1 shows the parameters tested before and after treatment.

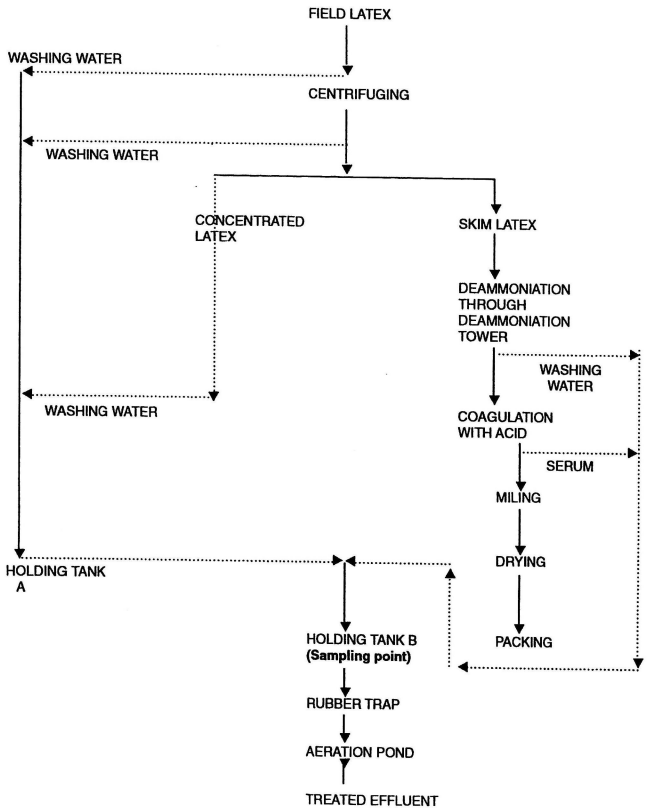

Figure 2. *Latex processing flowchart*

Table 1: Parameters tested before and after treatment

Parameter	Raw (Before) mg/l	Treated effluent (After) mg/l	% Efficiency
BOD	679 ± 1	55.4 ± 0.4	91.8 ± 0.1
COD	1359 ± 1	139.9 ± 0.1	89.7 ± 0.1
Suspended solids	249 ± 1	28.2 ± 1.2	88.6 ± 0.4

Inoculum

The heterogeneous culture of *Bacillus sp* (Baugh, 1996) is commercially available and was used in this study. The inoculum was stored in the refrigerator at 4°C until ready for use. The concentrated inoculum was diluted with water to 22 mg/l (w/v) prior to application.

Treatment process

Thirty litres of raw deammoniation latex effluent of known BOD_3, COD and SS concentrations were allowed to homogenize in a standard FRP (fibre reinforced plastic) tank. The sample was pumped into the EAT using a masterflex pump (Model no. 7568-10) at a flow rate of 1 litre per hour. The EAT chamber was aerated for 24 h. Air was supplied using air diffuser (Model no: SA 130 EX. Lot no. : 905, National air pump) at a rate of 1.5-3.0 mg/l dissolved oxygen. Two sets of fine bubble spargers were used to aerate the extended aeration tank. pH was constantly monitored using Orion Research, Model SA 210 pH meter.

There was no recycled sludge and the system was operated for a month in order to achieve the required mixed liqour suspended solids (MLSS) of 3000-3500 mg/l. A constant concentration of MLSS was maintained by estimating MLSS concentration daily and withdrawing calculated amount of sludge when required. Experiments were performed at an average daily temperature of 29 ± 1°C. No oxygen was supplied to the equalization tank.

The diluted inoculum (22 mg/l) was introduced into the EAT to enhance the loading reduction of the tested parameters. An inoculum concentration of 22 mg/l was used based on the initial optimum level for the treatment as claimed by the bacteria suppliers. The diluted inoculum, in a ten-litre aspirator bottle was placed above the EAT. The drips of inoculum was controlled by a tap and set at six second interval per drip (1 ml) for each experiment. The slow addition of the inoculum at 1 ml/6 s was meant to control the growth of the bacteria, since rapid bacterial growth can cause the sludge to be toxic due to the long retention time.

Our results correlated with findings by John *et al.* (1976), who stated that the utilisation of rubber effluent as a growth media for single cell protein is very promising. Further reports by Wubah (1994) stated the ability of several bacterial strains isolated from the sludge and lagoon water to degrade the major organic pollutants under laboratory conditions.

The effectiveness of the inoculum has successfully been seen in treating effluent from SMR (Standard Malaysia Rubber) processing factories (Kadir *et al.*, 1996). The result after six months application of the inoculum to the existing ponding system showed a reduction of 98.1% BOD_3, 98.4% COD and 84.0% SS (Kadir *et al.*, 1996).

The results are also congruent to the findings by Diercks *et al.* (1996), who evaluated ways to improve system efficiency using the addition of thermophilic, cultured microorganisms, directional aeration and effluent recycling to the lagoon in a kraft mill. Their results demonstrated both BOD_3 and TSS removal across the lagoon-based system by more than 85%.

CONCLUSION

Specific exogenous bacteria have the capability to enhance the reduction of deammoniation latex effluent, based on their adaptability to growth and ability to oxidise the latex effluent waste. Reduction in percent weight and percent atomic weight was found in carbon (C) element but there was an increase in oxygen (O) for both percentages.

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REFERENCES

Alexander, M. (1994). *Biodegradation and Bioremediation.* San Diego: Academic Press.

APHA (1992). Standard method for examination of water and wastewater, 18th (ed). *American Public Health Association,* Washington, D.C.

Baugh, C.L. (1996). Custom Biologic Increment, Florida, USA

Buffle J., De Vitre R., Perret D. and Leppard G.G. (1989) *Physico-chemical characteristics of a colloidal iron phosphate species formed at the oxic-anoxic interface of a eutrophic lake. Geochim. Cosmochim. Acta* **53** : pp 399-408.

Chirwa E.M.N. and Wang Y.T. (1995) Chromium detoxification by fixed film bioreactors. In: *Proceedings of 50th. Ind. Waste Conf.* Purdue Univ., West Lafayette, Ind., pp 535.

Diercks R., Dunigan M. and Christiansen J. (1996). Optimizing BOD_5 removal under adverse operating conditions in a kraft mill. In: Proceedings of the International Environ. Conf. TAPPI. pp 1/139.

Forster C.F. (1976) Bioflocculation in the activated sludge process. J. Wat. Sc. Tech **A(2)** : pp 119-125.

Glaser, J.A. (1994). Bioremediation. New York, Mc Graw-Hill. Inc.

John C.K., Ponniah C.D., Lee H. and Chin P.S. (1976). Environmental research at RRIM: The role of RRIM in controlling effluent problems in rubber industry. In: *Proceedings of Protecting Our Environment at the Institute Kimia Malaysia,* Kuala Lumpur, 11-13 March 1976.

Jorand F., F. Zantarian., F. Thomas., J.C. Block., J.Y. Bottero., G. Villemin., V. Urbain and J. Manem. (1995). Chemical and structural (2D) linkage between bacteria within activated sludge flocs. *J. Water Res.* **29(7)** : pp 1639-1647.

Kadir, M.O., Norulaini, N.A., H. Darus and Hua, C.K. (1989). Zero discharge treatment of rubber waste effluents using a combination of aeration and bioremediation. In press, USM, Penang.

Leppard G.G., De Vitre R., Perret D. and Buffle J. (1989). Colloidal iron oxyhydroxy phosphate: the sizing and morphology of an amorphous species in relation to partitioning phenomena. *J. Sci. Total Environ.* **87/88** : pp 345-354.

Leppard G.G., Burnison B.K. and Buffle J. (1990). Tranmission electron microscopy of the natural organic matter of surface waters. *Analyt. Chim. Acta.* **232** : pp 107-121.

Li, D.H., and Ganczarczyk, J.J., (1990). Structure of activated sludge flocs. *J. Biotechnol. Bioengng.* **35** : pp 57-65.

Perret D., Leppard G.G., Muller M., Belzile N., De Vitre R. and Buffle J. (1991). Electron microscopy of aquatic colloids: non pertubing preparation of specimens in the field. *J. Water Res.* **25** : pp 1333-1343

Wubah D.A., Hale D.D. and Rogers J.E. (1994). In: Bioremediation in freshwater and marine systems. Mc Graw Hill inc., New York, pp 281-294.

Yeoh, B.G., Chee, K.S., Phang, S.M., Zaid, I., Azni, I. And Maketab, M. (1993). In: Biological Removal of Heavymetals. Waste Management in Malaysia: Current Status and Prospect for Bioremediation. Kuala Lumpur: Ministry of Science, Technology and the Environment.