TERTIARY TREATMENT OF PALM OIL MILL EFFLUENT (POME) USING HYDROGEN PEROXIDE PHOTOLYSIS METHOD

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A project report submitted in partial fulfilment of the requirements for the award of the degree of Master of Engineering (Civil – Environmental Management)

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NOVEMBER 2008

ACKNOWLEDGEMENT

First and foremost, praise to Allah, the most Graceful and Merciful for His bless for giving me an excellent health to ensure best performance during completing my work especially on this report. He also has given me such a big patience to cope with my works and finally completed this report in a given time.

I would like to express our sincere and gratitude and appreciation to my supervisor Dr. Azmi Aris for his valuables ideas, concern, help, dedication, suggestion, guidance, and especially his support either moral or physical to help me in completing this report. All of his effort and willingness had managed me to give the very best in this report.

Special appreciation to my father Abdullah Ibrahim, my lovely mother, Hasnah Mohd Yatim who sacrificed much for this current effort.

Special thanks to all the lab assistants, including Pn. Ros, En. Yusuf, En. Suhaimi and En. Ramlee for helping me in collection of samples, giving me guideline on how to operate the instrument and given me information to complete this report. Last but not least, biggest complement goes to my entire friend for their direct and indirect help, support and understanding throughout the work.

ABSTARCT

Palm oil mill effluent (POME) is in the form of highly concentrated dark brown colloidal suspension. Despite of being treated using biological treatment, the wastewater is still coloured and indicates the remaining of significant concentrations of organics in the effluent discharge. Hence, tertiary treatment is required to further improve the quality of the effluent. Hydrogen peroxide photolysis (UV/H_2O_2) is one of the advanced oxidation process (AOP) that can be an option to treat the biologically treated POME (BT-POME). Experiments were conducted to investigate the removal of colour and COD in order to assess the effectiveness and feasibility of (UV/H_2O_2) catalytic system for tertiary treatment of POME. The operating parameters such as hydrogen peroxide dosage, pH value and initial BT-POME concentrations were evaluated. The removal process could be fitted by the zeroth order for COD and second order kinetics for colour. The efficiency of colour and COD removal ranged from 7.3%-61.3% and 7.4%-61.1% respectively. Examination of the effect showed the maximum removal could be achieved under optimal conditions of H_2O_2 dosage of 250 mg/L and pH of 7.5. In general, the three factors mentioned earlier affect the performance of the process and discussed in the report. Further study is needed to improve the performance of UV/H_2O_2 process in treating BT-POME.

ABSTRAK

Air sisa berwarna daripada kilang kelapa sawit ialah dalam bentuk bahan lekit berwarna coklat gelap. Walaupun telah dirawat secara biologi, air sisa kelapa sawit masih mengandungi warna dan bahan organik yang tinggi. Oleh itu, rawatan tahap ketiga diperlukan untuk meningkatkan mutu effluen. 'Hydrogen peroxide photolysis' adalah satu dari proses oksida lanjutan yang boleh menjadi pilihan untuk merawat air sisa berwarna daripada kilang kelapa sawit. Ujian telah dijalankan untuk mengkaji penyingkiran warna dan COD dengan tujuan menilai keberkesanan dan kebolehlaksanaan proses'UV/H_2O_2'. Faktor dos hydrogen peroksida, nilai pH dan kepekatan awal air sisa ke atas keberkesanan proses olahan dinilai. Proses pengurangan boleh dikategorikan sebagai 'zeroth order' untuk COD dan 'second order' untuk warna. Berdasarkan ketiga-tiga faktor yang telah dinilai, pengurangan warna adalah dalam 7.3% - 61.3% dan COD 7.4% - 61.1%. Penyingkiran terbaik dapat dicapai berdasarkan tahap optimum sebanyak 250 mg/L untuk dos hydrogen peroksida dan pH 7.5. Secara umumnya ketiga-tiga faktor mempengaruhi keberkesanan proses 'UV/H_2O_2'. Pengaruh ini telah diperjelaskan di dalam laporan ini. Daripada keputusan ujikaji ini boleh disimpulkan bahawa proses 'UV/H_2O_2' memerlukan kajian selanjutnya supaya kegunaannya dapat diaplikasikan dalam rawatan air sisa kelapa sawit.

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CHAPTER 1

INTRODUCTION

1.1 Background

The Malaysian oil palm industry has recorded an impressive performance as one of the largest producer and exporter of palm oil in the world (Ahmad et al., 2003). Recently, the production of crude palm oil for 2006 stood at 15.9 million tones in 2006 from 15.0 million tons the previous year and exports increased by 2.36 million tons (MPOB, 2007).

However, the palm oil industries also cause some environmental concerns. The industry generates the most biomass from the oil extraction process such as mesocrap, fiber, shell, empty fruit bunch (EFB) and palm oil mill effluent (POME). It is estimated that more than 50 million tones of biomass was generated from the palm oil industry in the year 2005 (Yacob et al., 2006). The wet process of palm oil milling consumes a large amount of process water. The final POME is generated from hydrocyclone washing and cleaning up processes in the mill (Hassan et al., 2004). Zinatizadeh et al. (2006) reported, during palm oil mill extraction, about 1.5 tonnes of palm oil mill effluent is produced per tonne of fresh fruit brunch (FFB) processed by the mill. Wu et al. (2007) estimated that for 1 tonne of crude palm oil

produced 5 to 7.5 tonnes water are required and more than 50% of the water will end up as effluent.

Several innovative treatment technologies have been explored and applied by palm oil mill to treat POME. Biological approach is the most popular treatment method to treat the effluent as POME has high organic and mineral content which can be broken down by microorganisms. Currently, the majority of palm oil mills have adopted conventional biological treatments of anaerobic or facultative digestion which need large treatment area, long treatment periods and high cost for maintenance. However, not all of the palm oil mill is satisfying the Malaysian Department of Environment (DOE) requirements. In order to regulate the discharge of effluent from the crude palm oil industry as well as to exercise other environmental control under the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Order, 1977 and the Environment Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977 were promulgated under the Environmental Quality Act, 1974 (DOE, 1999 and Ahmad et al., 2003).

1.2 Aim of Study

The aim of the study is to develop an effective tertiary process in treating biological treated palm oil mill effluent (BT-POME).

1.3 Objectives of Study

The objectives of this study were:

1. To evaluate the feasibility of hydrogen peroxide photolysis (UV/H_2O_2) method in removal of organics and colour from biologically treated POME
2. To determine the effect of the H_2O_2 dosing, pH and initial BT-POME concentration on the effectiveness of the process.

1.4 Scope of Study

This study consists of a series of lab scale experiment which utilize hydrogen peroxide photolysis (UV/H_2O_2) method in treating biologically treated POME. The biologically treated POME was obtained from a nearby palm oil mill. The efficiency of the system was assessed based on colour and COD removal.

1.5 Problems Statement

The biological treatment employed by the palm oil mill industry currently is able to meet the standard discharge limit by the Malaysian Department of the Environment. However, despite of being treated the wastewater is still coloured and contains high biochemical oxygen demand (BOD), chemical oxygen demand (COD), oil and grease, total solids as well as suspended solids and it can certainly cause

considerable environmental problems (Wu et al., 2007). Hence, tertiary treat is required to further improve the quality of the effluent. Hydrogen peroxide photolysis (UV/H_2O_2) is one of the advanced oxidation processes (AOPs) that can be an option to treat the biologically treated POME (BT-POME). These studies explore the feasibility of UV/H_2O_2 process in polishing the treated POME.

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