1. Introduction

Palm oil industry is at present, the largest agro-based industry in Malaysia. It accounts for 49.5% of world production and 64.5% of world exports in 1998. In that year alone, Malaysia produced 7 425 000 tonnes of palm oil for worldwide export (Industrial Processes & The Environment Handbook No.3, 1999), which was approximately 618 750 tonnes per month. In May 2001, the amount of crude palm oil production increased, hitting a high of 985 063 tonnes (Palm Oil Link, 2001).

Given this huge amount of palm oil production, the quantity of resources needed and the quantity of wastes produced are therefore expected to be great. A typical palm oil mill releases liquid effluent, known as palm oil mill effluent (POME), gaseous emissions from boilers and incinerators, solid waste materials and by-products that include empty fruit bunches (EFB), potash ash, palm kernel, fibre and shells. These wastes, if not disposed of properly, will have great impacts on the surrounding environment.

Wastewater that is not treated properly will lead to water pollution. Inappropriate handling and disposal of solid wastes from boilers, incinerators, and sludge separators will cause environmental degradation such as air pollution, noise pollution and odour emission.

Compared to gaseous emissions and solid waste production, water and wastewater management in crude palm oil mills has long been a topic of research and discussion. This is due to the large amount of water needed for palm oil mill extraction and the indiscriminate discharge of untreated or partially treated POME into public watercourses.

During the processing of fresh fruit bunches (FFB), water is the most needed resource. To process one tonne of FFB, typically 1.5 m^3 of water is used (Industrial Processes & The Environment Handbook No.3, 1999). Out of this amount, 50% will be released as palm oil mill effluent (POME) and the rest of the water is lost as steam and boiler blowdown, wash waters and leakage.

Based on the statistical value of total crude palm oil production in May 2001, the production of 985 063 tonnes of crude palm oil means a total of 1 477 595 m^3 of water was used, and 738 797 m^3 was released as POME, in that month alone. Without proper treatment, this wastewater will pollute watercourses receiving it.

The current treatment technology of POME typically consists of biological aerobic and anaerobic digestion. Biologically treated effluent is disposed of via land application system, thus providing essential nutrients for growing plants. This method may be a good choice for disposal of treated effluent. However, considering the rate of daily wastewater production, for example, approximately 26 m^3 per day for an average palm oil mill with an operating capacity of 35 tonnes FFB per day, it is doubtful that the surrounding plantations receiving it could efficiently absorb all the treated effluent.

Another new technology under research is the zero waste evaporation technology. By evaporating the POME, water can be recovered while the residual solid content can be utilized as fertilizer. Though this method reclaims about 80% of water from POME, a major drawback is the high energy requirement (Ma, 1996).

Since the ultimate goal of wastewater management is towards zero discharge, the best wastewater treatment scheme is inevitably a treatment that allows 100% reuse and recycling of wastewater. If one considers the volume of water needed by the crude palm oil milling industry, the practice of releasing treated wastewater without further reuse in-house is a wasteful exercise.

Another alternative to minimize fresh water and energy consumption is to reuse wastewater directly from the final treatment pond. This could be as feed water for boiler or hydrocyclone. However, if this is the solution, a higher quality of treated water is required especially when it is to be used as boiler feed. The current treatment system of anaerobic followed by aerobic degradation is not capable of producing such high quality of treated effluent.

A possible technological solution to produce higher quality effluent is through the use of membrane technology at the tertiary treatment stage. Membrane treatment is capable of providing a highly efficient treatment, requires minimal energy, and does not introduce any additives to the waste stream.

There are many membrane process applications on water and wastewater treatment that has proven to be efficient. Membrane technology covers a large spectrum of separation techniques, ranging from reverse osmosis to microfiltration. Among the various membrane processing technologies, ultrafiltration offers an attractive option for wastewater treatment. It is a low pressure-driven membrane process retaining most effectively macromolecules sized within 0.001 – 0.02 μm. Although the biologically treated POME is already low in biodegradable organic contents, it still possesses significant amount of persistent cellulosic materials and oily residues that usually occur in the form of macromolecules. With membrane ultrafiltration, these molecules could be separated from the waste stream thus producing a higher quality effluent.

In this research project, a study has been carried out to examine the feasibility of using membrane ultrafiltration for the final treatment of POME extracted from the aerobic treatment pond. The general objectives are to

I) Evaluate the effectiveness of membrane ultrafiltration of treated POME and

II) Investigate the possibilities of water reuse and water recycling of the membrane-filtered treated POME.

This dissertation report is organized into seven chapters. Chapter 2 consists of findings from literature survey. This includes the current crude palm oil milling process, treatment technologies of palm oil mill effluent, an overview of membrane technology in particular ultrafiltration, and previous studies on the use of ultrafiltration for palm oil mill effluent treatment. Chapter 3 discusses in more detail the research objectives followed by methodology and working procedures of experimental studies done during the study. Results obtained from the experimental studies and discussions of findings are presented in Chapter 4. Conclusions based on results and discussions are given in Chapter 5. Future recommendations for further research on this topic can be found in Chapter 6. Chapter 7 lists all the relevant references used in this project.