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By-products of palm oil mill effluent treatment plant – A step towards sustainability

K. Gobi, V.M. Vadivelu *

School of Chemical Engineering, Universiti Sains Malaysia, Engineering Campus, 14300 Nibong Tebal, Penang, Malaysia

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ABSTRACT

The current wastewater treatment system for palm oil mill effluent (POME) regularly fails to treat the effluent efficiently. The growing demand for palm oil has caused a substantial increase in the generation of POME. To meet the discharge limit proposed by the Department of the Environment, the POME must be treated effectively before being released into the receiving water bodies. The open pond system is presently being used to treat the POME because the open pond system is cheap and less maintenance is required. However, the failure of this technique in the current scenario has spurred the research into new technologies to explore their applicability in treating POME. Although the discovery of new technologies is commendable, the financial infeasibility of these new treatment techniques has stagnated their progress. In this work, a role for the by-products of the treatment systems in implementing the new technologies with return of investment has been revealed. A thorough review of the characteristics and recent trends for producing polyhydroxyalkanoate (PHA), a by-product, is also discussed in this work. Moreover, the opportunities available to further enhance the production of PHA in POME wastewater have been addressed and are presented in this work. Production of biohydrogen, another by-product, is also discussed in this review. In a nutshell, the enhancement of PHA production coupled with biohydrogen production as a by-product may provide a new dimension to the POME treatment plant by generating revenue. Production of PHA and biohydrogen from POME contributes significantly towards the cause of sustainability.

Contents

* Corresponding author. Tel.: +60 459 964 60; fax: +60 459 410 13.
E-mail address: chvel@eng.usm.my (V.M. Vadivelu).

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1. Introduction

An industrial wastewater treatment plant is generally considered a money depletion zone in a business operation. Little investment would therefore be made in the wastewater treatment plant. As a result, the wastewater is either insufficiently treated or not treated at all. If this trend continues, the environment will be severely polluted, and access to clean water will be limited in the future. An increase in the volume of industrial wastewater has been reported in developing countries [1]. The increase in the volume of industrial wastewater in developing countries can be related to the growth of the population. Population growth causes the demand for end products to increase. Similar developments can be expected for palm oil derivative products. An increase in the demand for end products causes the production rate to increase and concomitantly increases the amount of wastewater released into water bodies. Fig. 1 shows the projected world population growth for developing countries and industrialised countries. An exponential increase in world population is expected in developing countries in another 30 years.

Developing countries such as Malaysia, Indonesia, Nigeria and Thailand are the major force in supplying palm oil to the world [3]. Fig. 2 shows the palm oil producers in the world. In particular, the oil palm industry is the fourth largest contributor to the Malaysian economy, contributing approximately RM 53 billion of the Gross National Income of Malaysia [4]. This industry has grown in tandem with the nation's growth. The production of palm oil contributes approximately 39% of the total palm oil production in the world, and 44% of the palm oil is exported around the world [5]. Essentially, the palm oil demand grows because palm oil is cheap and has high oxidative stability. Biodiesel production from palm oil has recently escalated the demand for palm oil further. With the growing demand for palm oil, the plantation area of oil palm trees has reached approximately 5 million hectares in Malaysia [6]. The crude palm oil (CPO) production was 18.8 million tonnes in 2012. Under the Tenth Malaysian Program, the palm oil is expected to contribute approximately RM 69.3 billion through exportation [7].

In tandem with the increase in demand for palm oil, CPO production rate has escalated approximately 171% in the span of 20 years in Malaysia (as shown in Fig. 3). Higher CPO production has increased the amount of waste released from the oil extraction process, and this waste has a critical need to be addressed. Empty fruit bunches, press fibre, palm kernel endocarp, palm kernel press cake and liquid effluent (palm oil mill effluent (POME)) are the wastes generated through processing to produce CPO [9]. These wastes cause detrimental effects to environmental quality if they are left untreated. Among those wastes, POME makes up the largest portion. For every 1 t of CPO, approximately 5–7.5 t of water are necessary. More than 50% of this water that is used in the production of CPO will end up as liquid waste [10]. POME characteristics as determined by different researchers are presented in Table 1. Table 1 shows that POME is evidently an agent causing severe pollution (high chemical oxygen demand (COD) and the presence of oil and grease). The critical need to treat the POME has sparked the interest among researchers to find new

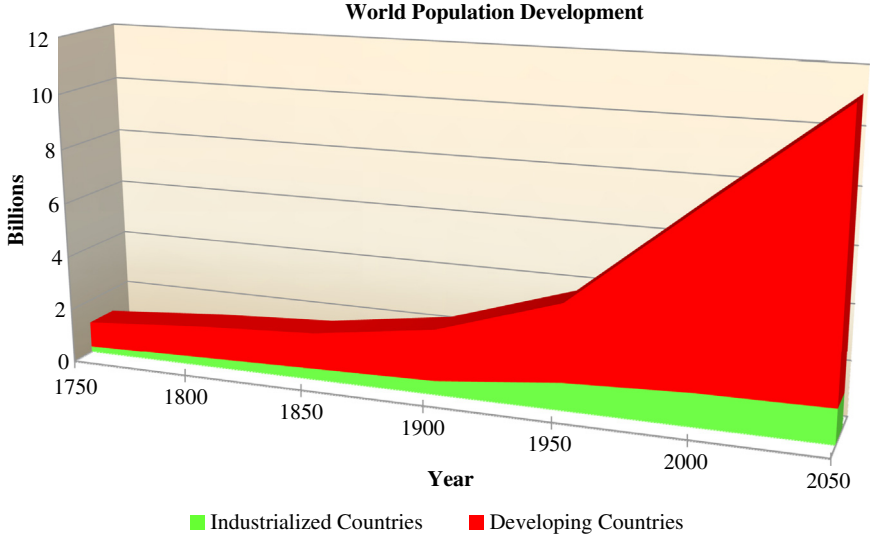

Fig. 1. Projected population of the world [2].