

A Comparative Analysis of the Performances of Four Different In-Ground Lagoons Anaerobic Digesters in the Treatment of Palm Oil Mill Effluent (POME)

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Abstract : Production of biogas from POME requires anaerobic digestion (AD), thus, anaerobic digester performance in biogas plants is crucial. As POME from different sources have varying characteristics due to different process flows in mills, there is no ideal treatment parameters for POME. Hence, different treatment plants alter different parameters in anaerobic digestion to achieve desired biogas production levels and to meet POME waste discharge limits. The objective of this study is to evaluate the performance of mesophilic anaerobic digestion in four different biogas plants in Malaysia. Aspects of POME pre-treatment efficiency, analysis of treated POME and AD's bottom sludge characteristics, including several parameters like chemical oxygen demand (COD), biological oxygen demand (BOD), total solid (TS) removal in the effluent, pH and temperature changes, total biogas produced, the composition of biogas including methane (CH₄), carbon dioxide (CO₂), hydrogen sulfide (H₂S) and oxygen (O₂) were investigated. The effect of organic loading rate (OLR) and hydraulic retention time (HRT) on anaerobic digester performance is also evaluated. In pre-treatment, it is observed that BGP B has the lowest average outlet temperature of 40.41 °C. All BGP shows a high-temperature fluctuation (36 to 49 °C) and good pH readings (minimum 6.7), leaving the pre-treatment facility before entering the AD. COD removal of POME is considered good, with an average of 78% and maximum removal of 85%. BGP C has the lowest average COD and TS content in treated POME, 13,313 mg/L, and 12,048 mg/L, respectively. However, it is observed that the treated POME leaving all ADs, still contains high-quality organic substances (COD between 12,000 to 19,000 mg/L) that might be able to digest further to produce more biogas. The biogas produced in all four BGPs varies due to different COD loads. BGP B has the highest amount of biogas produced, 378,874.7 Nm³/month, while BGP D has the lowest biogas production of 272,378.5 Nm³/month. Furthermore, the composition of biogas produced in all plants is well within literature values (CH₄ between 55 to 65% and CO₂ between 32 to 36%).

Keywords : palm oil mill effluent, in-ground lagoon anaerobic digester, anaerobic digestion, biogas

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