Effect of operating temperature in the anaerobic degradation of palm oil mill effluent: Process performance, microbial community, and biokinetic evaluation

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Abstract
This research paper presents the thermophilic anaerobic digestion (TAD) of palm oil mill effluent (POME), which is an extension of a previously conducted mesophilic anaerobic digestion (MAD) study. An anaerobic suspended growth closed bioreactor was operated at various hydraulic retention times (HRT) between 24 and 8 days. The effect of operating temperature on the performance, microbial identification, and biokinetic coefficients was evaluated. Performance was quantified by the production of biogas and the chemical oxygen demand (COD) reduction efficiency. Biogas production in TAD (64.56 L/day) was higher than MAD (46.76 L/day). A higher COD reduction efficiency was also achieved in TAD (90.90%) compared to MAD (89.66%). Other than that, more species of methanogenic bacteria were also identified in TAD through 16S rDNA. Furthermore, the modified Monod model implemented in the biokinetic evaluation revealed that higher values of maximum substrate utilization rate ($r_{x,max}$) and maximum specific biomass growth rate (μ_{max}) contributed to the better performance in TAD. The high $r_{x,max}$ value explains the higher COD reduction efficiency obtained in TAD. The critical retention time (θC)θC) in TAD is also higher than MAD, making it less prone to the washout of active microbes when operating near low retention times. Additionally, TAD also achieved higher methane yield ($YCH4$YCH4) as opposed to MAD. The extension study concluded that the TAD of POME demonstrated improved performance in terms of biogas production and COD reduction when evaluated against the previously conducted MAD.

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