Development of a nonlinear response surface model to predict the volume of biogas yield of a fixed dome digester charged with cow manure.

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Abstract

Waste-to-energy conversion is contributing significantly in enhancing the economic growth and health quality in society. One of the technologies that utilized waste-to-energy transformation is biomass technology. The study focused on the development of a nonlinear multiple regression (response surface) model to predict the biogas production with input parameters being relative pH of slurry, slurry temperature, and product of ambient temperature and relative global irradiance using an underground fixed dome digester fed with cow dung by continuous method. The fixed dome digester was fabricated with high-density polyethylene (HDPE) PVC plastic. The data acquisition system comprised of temperature sensors, pH transducer, pyranometer, biogas analyzer, a gas flow meter, and dataloggers. The results depicted that the hydraulic retention period for the anaerobic digestion was 50 days and the cumulative volume of biogas produced was 39.41 m^3 while the reactor volume was 2.15 m^3. It was determined that the measured daily biogas yield and the predicted values during the hydraulic retention period demonstrated no significant difference with a determination coefficient of 0.945 and a root mean square error of 0.023. The findings from the study can lead to the conclusion that the nonlinear surface response model can predict the biogas yield with high accuracy based on the acceptable values of both the root mean square error and determination coefficient.

Keywords: fixed dome biodigester, waste-to-energy conversion, nonlinear multiple regression model, determination coefficient, root mean error