Computational Model of Methane Production in a Small-Scale Biodigestor

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Where there is organic waste, there is an opportunity to produce energy. An anaerobic digestor is a system which converts organic materials into fuel using naturally occurring processes. Anaerobic bacteria, organisms which thrive in a low to zero oxygen environment, transform organic materials into a fuel called biogas. Biogas is a combination of gases, mostly consisting of carbon dioxide (CO_2) and methane (CH_4). Harvesters are particularly interested in CH_4 concentration, as it the combustible component. A small scale biodigester (anaerobic digestor) was built and installed at the Jackson County Green Energy Park (JCEP) by students of Western Carolina University's College of Engineering and Technology. The intention of this research is to create a mathematical model which predicts the amount of methane produced over time. The use of modeling is beneficial to understanding the factors which contribute to the production of biogas and CH_4. A computational model was created with an exponential decay function, and an ordinary differential equation. MATLAB software was used to organize and construct it. The final model is a piecewise continuous system which describes the decay of organic material over multiple 6-day periods. CH_4 production is proportional to organic material consumption. Using the model, it was found that the system creates approximately 32.2 cubic meters of methane over a 24-day period, when fed 140 grams of organic material every 6th day. This model can also be used to predict CH_4 production of any proposed biodigester. If the design requires a specific biogas quantity to meet energy needs, the model can aid in scaling the design. Anerobic digestion and biogas production is a complex process, with many variables effecting CH_4 production. As data is collected from the prototype, the model can be updated to incorporate additional factors and offer a more useful and accurate description of the system.