Optimization of mixing in a Chinese dome digester for tropical regions

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Keynote Speaker

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Short Biography
Abiodun Jegede is a Postdoctoral Researcher at the Engineering Science Department and Fellow at Oxford Martin School, University of Oxford, United Kingdom. He holds a BTech in Physics from Federal University of Technology Akure, Nigeria, MSc in Renewable Energy Engineering from Heriot Watt University, Edinburgh, United Kingdom and PhD in Environmental Technology from Wageningen University, The Netherlands. His major research interests are in anaerobic digestion, hydrolysis and biorefinery. He has supervised many undergraduate students in this field and renewable energy in general. Abiodun has won many research grants and awards as well as published many journal articles and he is a reviewer for two environmental and waste management journals. He is an associate member of the Institution of Chemical Engineers (IChemE) and an active committee member of the Thames Valley group of the same body in United Kingdom.

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Abstract:
The growing demand for energy because of population growth and depletion of natural resources has led to the growing demand for anaerobic digestion technology in rural areas of many developing countries. Biogas, a major product of the anaerobic digestion process, is a renewable, clean and efficient source of energy which can be used as a substitute for fuels such as firewood, charcoal and cattle dung commonly used by rural dwellers. The domestic digester is a type of anaerobic digester usually applied in a single decentralized system mostly in rural areas of developing countries and can serve as energy solution to meet their cooking needs. Among all household digesters, the Chinese dome digester (CDD) is the most popular and most implemented reactor because of its reliability, low maintenance requirement and long lifespan.

Mixing in the CDD depends on the change of slurry level in the digester and extension chamber during gas use and could be regarded as intermittent natural mixing. Mixing is an important process in anaerobic digestion for establishing contact between micro-organisms and feed for homogenization of temperature in the digester and preventing settling and floating layers. However, mixing is limited in the CDD and is therefore operated at long hydraulic retention times (> 40 days) and low influent total solid (TS) concentrations (≤ 7%) when compared to forced mixed reactors (intermittently or continuously), leading to a large reactor volume and high installation cost. In this study, mixing was optimized in the CDD without the inclusion of moveable parts with lower water dilution (high influent TS, 15%) at reduced hydraulic retention times 30 and 40 days respectively.

An optimized CDD with self-agitating mechanism, with the inclusion of two baffles, was investigated at a pilot scale (digester volume = 500L) and compared with the conventional CDD (as blank) at 15% influent TS concentration at two HRTs (30 and 40 days). The reactors were operated at ambient temperature between 27-33°C. The optimized digester showed better digestion efficiency and process stability while the blank digester was unstable throughout the study period. The optimized CDD has a self-mixing cycle of two minutes using the produced gas without a moving part and can be operated at high influent TS (15%) concentration. This implies that a smaller reactor volume could be achieved at high loading rate and reduced HRT (< 40 days) with eventual reduction in reactor cost.