Optimization of Biogas Production Conditions Using Batch Scale Thermophilic Anaerobic Digester

Aron Munywoki Kali [I14/36859/2010]

Email: aronkali89@gmail.com

Supervisors

1) Prof. Geoffrey N. Kamau
2) Dr. Joseph Mwaniki

Overdependence on oil from foreign countries has affected the Kenyan economy and the national energy security. An alarming demand and consumption rate of fossil fuels has become an issue of concern not only in Kenya but also many countries across Africa. There are countless uncertainties associated with environmental risks. The government must look beyond fossil fuels to realize long term economic growth and energy security. Nairobi Water and Sewerage Company (NW&S Co.) look forward to treating municipal wastes anaerobically to produce biogas, a renewable and nearly the best alternative energy source.

This research focused on the optimum anaerobic digestion conditions that maximize biogas production in batch scale using a thermophilic anaerobic digester. Moreover, an effective heating and mixing mechanisms for the reactor were investigated. In addition, organic loading rate and characteristics of feed wastewater (BOD, COD, pH, TS) were undertaken. Measurements on biogas production rate in the thermophilic anaerobic digester, maximum gas yield and biogas quality were carried out.

The samples (sludge and wastewater) were collected from the anaerobic ponds and the inlet channel, respectively at Ruai Wastewater Treatment Plant. The feed was preheated prior to introduction into the reactor to allow the microbes to acclimatize. The reactor was fed at a controlled organic loading rate of 0.5 L/min. The reactor contained substrate to inoculums in the ratio 3:1. Temperature was controlled using a thermostated heating coil. The reactor contents were mechanically mixed by regular manual shaking of the reactor. Digestion was carried out in a batch scale system under thermophilic and anaerobic conditions for a period of 20 days.

The final average volume of biogas produced was 1.225×10^{-2} m^3. Average production rate of biogas was 3.53×10^{-4} m^3/day. Average percentage composition of biogas produced by thermophilic digester was 66.6 vol. % CH_4, 30.4 vol. % CO_2 and other trace gases were assumed to take 3% by volume.

Finally, it is recommended that further studies to be undertaken to improve the reactor design particularly the mixing mechanism of the reactor contents. Hopefully, the findings of this research will play a key role in guiding NW&S Co. in its effort to transform wastes to energy.