BIOGRAPHICAL SKETCH

Juliet Ohemeng-Ntiamoah grew up in Accra, Ghana. She obtained her B.S. in Environmental Science from Kwame Nkrumah University of Science and Technology, Ghana, in August 2012. She is the recipient of several awards and scholarships including the highly competitive American Association of University Women (AAUW) 2015/2016 International Doctoral Fellowship. Her research focuses on optimizing renewable energy recovery from organic waste via a bioengineered process known as anaerobic (co) digestion. She enjoys reading novels by contemporary African writers, with Americanah being her favorite novel.

EDUCATION

B.Sc. Environmental Science 2012
Kwame Nkrumah University of Science and Technology, Ghana.

Ph.D., Civil and Environmental Engineering 2020
Tennessee Technological University, USA. (*expected*)

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College of Engineering

TENNESSEE TECH

The Department of

Civil and Environmental Engineering

Announces the Dissertation Defense

of

Juliet Ohemeng-Ntiamoah

In Partial Fulfillment of the Requirements

For the degree of

Doctor of Philosophy

Friday, February 21, 2020

2:30pm-5:00pm

Held in

Prescott Hall, Room 225

Tennessee Tech University

FIELD OF STUDY

Civil and Environment Engineering

DISSERTATION TOPIC

Anaerobic Co-digestion of Waste Activated Sludge with Food waste and Fats, Oils and Grease: Effects on Digester Performance and Microbial Community Structure and Activity

EXAMINING COMMITTEE

Dr. Tania Datta (Chair), CEE

Dr. Lenly Weathers, CEE

Dr. Alfred Kalyanapu, CEE

Dr. John Gunderson, BIO

Dr. Donald Walker, BIO

ABSTRACT

Anaerobic digestion is commonly employed by water resource recovery facilities (WRRFs) to transform wastewater residuals into methane. The mono-digestion of wastewater residuals typically yields low methane, making it economically unattractive for recovery and reuse. One possible way to address this challenge is the implementation of anaerobic co-digestion. Co-digestion involves the addition of more than one energy-rich organic substrates. However, the complex substrate characteristics can affect the microbial communities underlying the process, resulting in inhibition. This study elucidates the effects of co-digestion of waste activated sludge (WAS) with various proportions and loadings of food waste (FW) and fats, oils and grease (FOG) on digester performance and microbial community structure and activity, in an effort to avert inhibition. We hypothesized that not only will the co-substrates significantly enhance methane yield and change the microbial community, but a stepwise incremental feeding strategy of the co-substrate will avert process inhibition.

Long-term lab-scale bioreactors revealed that the co-digestion of 75% FW with WAS increased methane yield by 70-fold when compared to mono-digestion of WAS. However, only a 16.5-fold increase in methane yield was observed during the co-digestion of 50% FOG with WAS, beyond which inhibition occurred. Stepwise increment of FW enabled the microbial communities to adapt to higher loading of FW and avert inhibition. The co-substrates changed the microbial community structure and activity, while inhibitory conditions enriched fermentative *Firmicutes* at the expense of syntrophic fatty acid oxidizers and methanogens. There was high activity of *Methanosaeta* in contrast to high dominance of *Methanolinea* in the archaeal community structure. Overall, this study showed that stepwise increment of FW can avert inhibition in co-digestion systems. It also informs that co-digetion optimization strategies need to be targetted at the active microbial community. Finally, the operational strategies and microbial knowledge gained in this work can help WRRFs implement resilient co-digestion systems for enhanced methane yield towards energy neutrality.