A Waste of Energy

Anaerobic digestion process regimes for energy recovery from waste

With increased focus on climate change mitigation, the re-use of waste as a resource and new technological approaches which lower capital costs, Anaerobic Digestion has in recent years received increased attention among governments. Anaerobic digestion is a well-established sustainable technology that is widely used in agricultural and municipal waste treatment, enabling the highly efficient recovery of energy from industrial waste streams.

This technology plays a decisive role in the ongoing campaign against climate change, with Europe and Asia, respectively having the highest numbers of large and small-scale anaerobic digesters. However as Anaerobic Digestion is gaining more economic interest there is need to optimize the process, especially for small scale Anaerobic Digestion systems. Currently there about 265 Anaerobic Digestion plants in the United Kingdom and in the last five years the United Kingdom's Anaerobic Digestion industry has seen a 622 percent growth outside of the water sector. Graduate researcher Michael Fagbohungbe has been working with several organic substrates such as: spent grain, crude glycerol, horse manure, cattle manure, grass silage, primary sludge and citrus peel waste; in order to gain a better understanding of this method.

The project was aimed at enhancing the performance of small-scale anaerobic digestion. Anaerobic digestion is the breakdown of decomposable material by groups of bacterial cells in the absence of oxygen to produce gas in which approximately 70 percent is methane. The technology decreases the amount of degradable organic waste to land; reduce carbon emissions to the atmosphere; provide an alternative source of energy and a nutrient rich digestate. The digestate is rich in organic fertiliser and this replaces the energy intensive production of inorganic nitrogen and exploration of limited phosphorous resource. In an attempt to study the possibilities of

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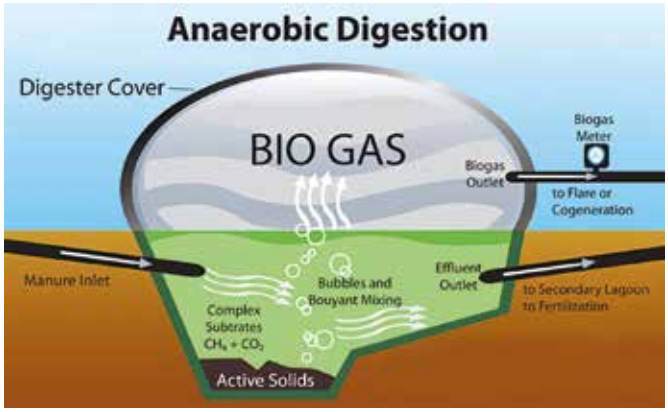
enhancing small-scale anaerobic digestion, the project investigated the potential of optimizing anaerobic digestion through high solid digestion and substrate induced inhibition (SII). The study of different inocula, changes in environmental conditions, adsorption of inhibitors and reactor



modification and integration have been explored. The rationale behind high solid digestion is to increase the amount of organic substrate that may be added in an attempt to increase methane production. However, high solid anaerobic digestion has been reported to reduce water usage by 5-20 percent depending on the total solid content of the feedstock, enhance digestate handling and reduce reactor size. On the other hand, the application of high solid anaerobic digestion reduces methane production because of poor transportation of metabolites and nutrients to the bacterial sites. At the moment, a laboratory based anaerobic digestion system has been developed to investigate the process based solutions and alleviate these constraints; this line of investigation is still on-going. An integrated anaerobic digestion system which combines high solid and low solid digesters was developed to increase diffusion of metabolites and nutrients, reduce biomass washout and increase methane production.

The inhibition of the microbial activity can reduce methane production, and for commercial anaerobic digestion systems, this will reduce the efficiency of waste management and energy production, there by impacting on revenue. The occurrence of SII in anaerobic digestion is directly or indirectly associated with the organic substrate. Direct source of SII is caused by the constituent of the organic substrate while indirect source of SII is as a result of the metabolic intermediate produced during the anaerobic digestion of some organic substrate.

An example of a direct source of SII is the citrus peel waste which was the main substrate used for the research study. Citrus peel waste contains an essential oil which is rich in limonene and this compound is inhibitory to microbial activity. For limonene, the investigation focussed on ways to reduce the impact of the chemical on microorganisms by exploring the selection of more robust inocula and the addition of different biochar material. This was carried out using laboratory scale digesters; digested sewage sludge was found to be the most robust of all the inocula tested during the study. With regards to the addition of biochar material, it enhanced the colonisation of the bacterial cells and reduced the inhibition caused by limonene compound by 75 percent.

As a result of this project a laboratory scale anaerobic digestion system with the potential of optimizing high solid anaerobic digestion application with less SII will be developed. In addition, a process flow for offering anaerobic digestion consultancy and monitoring services would have been developed, thus maximizing Stopford's plan to become an anaerobic digestion technology provider.

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