Anaerobic Digestion at Loughborough University

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INTRODUCTION: Bioenergy for Sustainable Rural Living (BURD) is research partnership between 6 UK and 7 Indian Universities. The aim of this project is to develop best practise at a smaller community scale which makes use of hybrid and combinations of biofuels. The idea is to improve rural energy availability, equity of cost and to generate an economic stimulus from the desire to provide greater energy security and reduced environmental impact. Loughborough University part of the project is on how to apply village scale anaerobic digestion. Maize is one of the most commonly grown crops in the world. Here, we examine the effect of particle size and pre-treatment of maize (whole plant) on the anaerobic digestion process.

Methodology:

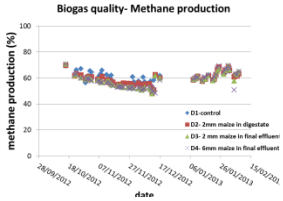
- Appropriate feeding stock identification- the main crops in UK and India are identified
- Maize is the most commonly grown crop in the world
- Examining the effect of particle size on gas production: 6 mm vs 2 mm
- Pre-treatment options- hydrolysis of feedstock in digestate or in the final effluent

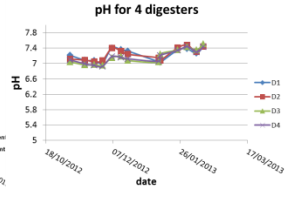
Experimental:

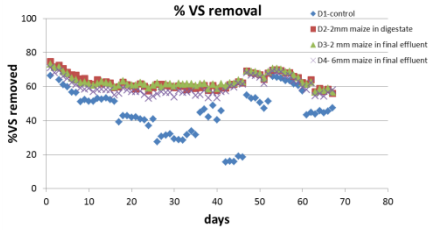
- 4 x 9l reaction vessels- sewage sludge and maize feedstock
- 22 days retention time
- Average rate of 3g VS/l/day, (min 1.35, max 3.25 g VS/l/day)
- Continuously stirred reactors (vertical stirring, see Figure)
- 37^{o}C hot room
- Substrate pre-treatment: soaked overnight in centrifuged digestate or the final effluent at 37^{o}C in shaker
- 5 days feeding-2 days no feeding cycle (no feeding during weekends)
- Digestate tested daily for TS/VS content, and stability (VFAs, alkalinity)
- Gas production continuously monitored; gas quality monitored daily

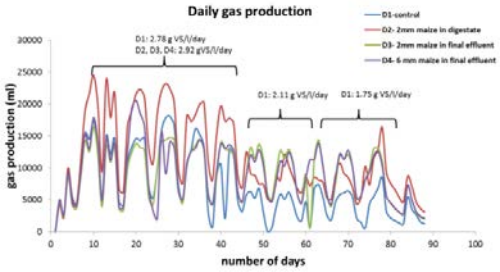
Results/Conclusions:

- Particle size (2 mm vs. 6 mm) didn't effect gas production
- Soaking maize in the digestate or the final effluent didn't have an effect on stability
- Average biogas production of 10 l/day was achieved in all reactors (see Figure)
- 60% methane in biogas
- Results shown are from the commissioning period demonstrating the consistency possible between duplicates. Average %VS removal and gas quality are shown from four reactors.
- %VS removal is a function of the loading rate.
- Changes in the loading rate were dependant on the total and volatile solids in sewage sludge, which varies seasonally
- Gas production figures show the impact of changes in organic load from 3 to 2.7 kg VS/m^3/day.
- In order to utilize anaerobic digestion for the use in rural Indian communities, maize will have to be mixed with a range of wastes. In rural UK communities co-digestion will improve the consistency of gas production. The future feedstock will be chosen based on its availability in field. The final design of the digesters will have to be robust and simple, in order to be used by non-specialists.









Loughborough is one of the largest Civil Engineering Departments in the UK with over 100 staff and 1000 students. It specialises in applied research and has worked for over 250 companies. Its current research portfolio includes 77 projects totalling over £20.3M. The 3000m^2 laboratory includes specialist hydraulic and analytical equipment for microbiology, soils and water to ISO standards. There is Zone 2 microbiology containment and temperature controlled laboratories for mesophilic and thermophilic digestion trials. There is also a pilot plant room for scale up studies.

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