Workshop on anaerobic digestion of solid waste: summary of findings

Joint workshop between IEA Bioenergy Tasks 36 and 37, Stockholm, 8th May 2013.

Note on Tasks: Task 36 examines the integration of energy into solid waste management, which generally covers combustion technologies. Task 37 investigates anaerobic digestion (AD), which covers all aspects of anaerobic digestion.

Aim of workshop: This workshop was designed to update Task 36 on relevant developments on anaerobic digestion and to investigate the areas where there are synergies in the two areas, where the work of Task 37 might overlap with the work of Task 36 and where there could be useful joint projects.

Programme for Workshop

The presentations at the workshop are listed below. All of these are available from the IEA Bioenergy Task 36 web site (http://www.ieabioenergytask36.org/index.htm), except for Professor Svensson's. For more information on his work, please contact Professor Svensson directly at bo.svensson@liu.se

Strategies for collection of organic waste in Stockholm	Johanna Nilsson
Biogas production in Sweden – role of nutrient composition and effects on microbial composition, degradation capacity and rheology	Professor Bosse Svensson
Biogas from organic residues and outlook to heterofermentative alcohol production	Günther Bochmann
Update on Joint Task 36/37 report on international practices on the source separation of organics	Kathryn Warren & David Baxter
Valorgas project – Collection and AD of Food Waste	Sonia Heaven
WRAP Organics Programme	Nina Sweet
Trends influencing energy recovery from waste	Pat Howes

Findings

Presentations at the meeting clearly showed that anaerobic digestion of organic waste from the municipal waste stream is an important and growing technology, particularly when co-digested with food waste (for example from restaurants and catering). Clear evidence was

provided to demonstrate that it is a carbon and energy efficient solution for the right types of organic waste and compliments recycling. **Source separation** has been demonstrated as an important step in being successful with AD. However, the economics are not so clear and it is not clear whether AD would be commercially competitive in some cases without Government support.

Additionally, there are still issues that need to be addressed and some of these impinge on other aspects of waste management. For example:

- For AD the major feedstocks of interest are **food waste and the organic fraction of municipal solid waste**. These feedstocks are either collected separately from source or separated using some form of post collection separation such as mechanical and biological treatment (MBT). The presentation by Günther Bochman shows the types of digestion plant available; Sonia Heaven presented the work of the VALORGAS project on the different options for food waste collection in Europe.

- AD of waste is very cost sensitive. Swedish work (see Nilson's presentation) has shown that for **source separation** the major **cost** is the collection cost, particularly in areas where these is no space for a second food waste bid and collective solutions are necessary. Methodologies are available for collective solutions, but they are expensive and this cost needs to be addressed.

- The other major cost in the AD of solid waste is the cost of co-digestion feedstocks that increase the yield of biogas. The substrate digested is an important influence on the overall cost.

- Source separation has been shown to work in Sweden, but education on what goes into the waste is important. Elsewhere (e.g. Austria) there have been problems with source separation of green waste.

- Many plants use source separated waste, but **mechanical biological treatment** (MBT) is also a route to AD of waste. How can we achieve good performance from MBT processed waste in anaerobic digestion? And if we cannot produce good digestate, is AD the right solution for waste not sorted at source?

- AD is a solution for the organic waste stream, but it is not the only solution. We need to understand performance in comparison with other solutions. This is not just energy and carbon balance, but cost, risk, engineering performance and return on investment. There is evidence that there are higher carbon savings using source separated AD for energy rather than EfW for this waste stream, but the use of the nutrients in the residue as fertiliser is important to this analysis.

- There is a large variation in the composition of the organic fraction of Municipal solid waste, over the year and within areas. Work is ongoing on sub-division of the organic fraction into a fine fraction that is digested and a coarse fraction that is composted.

- The price for substrates that can improve the yield of AD (e.g. brewer's spent grain) has increased recently. Targets for AD of food waste and the organic fraction of MSW may result in an increase in the price of such co-digestion feedstocks.

- Professor Bo Svenson has examined optimisation of biogas production in order to achieve the demonstrated theoretical maximums. Using DNA sequencing techniques, he has shown that the microbial populations mediating the process change according to substrate, clearly demonstrating that different substrates are going to be sensitive to different conditions. It also explains why if a digester has been developed for one substrate, substituting another substrate should not be done without consideration of the consequences. Work on AD has demonstrated problems with some substrates, and, although these are being overcome, it does show that process engineering must fit the substrate or the digestion process may be inefficient.

- **Obtaining good yields from AD is all about optimisation**. Optimisation of pre-treatment, of process engineering, of co-digestion, etc.

- Swedish work has demonstrated that **taking food waste out of MSW decreases the residual waste by 8% and increases the calorific value of the residual waste by around 6%**. Ash is increased by 7% and fossil carbon by 4%. Chlorine and metal content (by weight) may also change.

These findings mean that for AD of solid waste we should think in terms of a process chain, not just one step: from start (source separation) to end products. Anaerobic digestion needs to be integrated with local waste management systems, rather than being mandated at regional or national levels.

Barriers to the successful use of AD of solid organic waste

The main barriers identified to the successful use of AD of solid organic waste are:

Use of the digestate: if this is not of marketable grade should it be burnt? What impact does this have on energy recovery in combustion systems?

There remain difficulties in process chain drivers. Policy is particularly important: government regulators need to take a positive role. The commercial sector responds to immediate market and solutions; without stable and positive government support they may not respond.

Conclusions

- Source separation is important to AD of waste and one of the major costs is the collection system

- Substrates can make a major difference to the economics – but local conditions are also important.

- There is evidence that source separation to AD is energy and carbon efficient but the use of nutrients in the residue is important to this finding. If the residue cannot be used and is burnt in EfW or buried in landfill this important advantage is lost.

- Microbiology is complex and important in influencing the yields. In particular inhibition can make a big difference to performance. Trace elements (e.g. Co, Ni,

Se) are a key, but so is understanding exactly what is happening within the digester. Methodologies are now available to rapidly identify the microbial population. Can these be developed into a tool for understanding (or predicting) problems in the digester?

- Quality control is important.

Questions that remain

What will energy from waste look like in the future? If organic wastes are taken out of the waste stream, how is the composition of residual waste changed? How does the renewable content change? What differences will source separation make to recovery of energy from the residue? Is the Swedish work quote above typical, or are there differences between countries?

Is AD an enduring trend? Is it simply stimulated by current Government policies? Is it cost competitive? What are the financial figures? Are other drivers more important? Are there regions where the other drivers predominate? Is the work on sensitivities to cost reported above something that needs to be considered?

Is there an alternative to biogas production for biodegradable content of waste? There are technology drivers for biofuels production; and in the future for bio-based materials. How does AD compare with these alternatives?

What about MBT & AD? Is this the right way forward? How does the quality of the digestate affect the economics of the process?