ENERGY CROPS & BIOGAS: PATHWAYS TO SUCCESS

Summary of Topic 2 "Biomass processing Concepts, Storage, Pre- and Post-Treatment Technologies and Impacts

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The introductory presentation, "Results and bottlenecks of energy crop digestion plants – required process technology innovations" was made by Prof. Dr. Peter Weiland of the Federal Agricultural Research Centre (FAL), Germany.

An overview of the biogas plants with the prime focus on Germany where the ambitious programme in recent years has resulted in almost 3000 operating plants in 2005, compared to 100 in 1990. The total power generating capacity has reached 500 MW_e. The feedstock for >70% of plants is animal slurries and maize is feed to about 80% of plants, maize being fed most commonly via screw or piston systems at intervals of typically 12 hours, although feeding hourly can reduce the magnitude of shocks to the system. The trend in recent times has been to build large-scale plants, in the range 3000 to 5000 m^3, where the rate of dry feed is approximately 3 $kg/m^3/day$. Retention times range from 60-90 days in the majority of plants, the rather long times being a result of recycling which is taken into account in the retention time calculation.

The methane content was reported as 50-60%, but can be less than 50% in cases where air is used for H_2S control. Biogas with less than 50% methane can lead to ignition problems in gas engines. Methane formation is storage tanks accounts for approximately 10% of total yield and can reduce the environmental benefit it allowed to escape into the atmosphere.

The following potential problems with the use of energy crops were listed:

- non-optimum formation of organic acids
- mould formation during storage
- insufficient disintegration of energy crop solids
- mixing of silage and process water in external open tanks leads to lost CH_4
- direct feeding by screw/piston risks system blockages
- long retention times in digester
- scum formation and possible blockage of overflow pipe
- biogas accumulation in digestate
- short-circuit flow, particularly in one-step process
- biogenenic heat input by mono-fermentation of energy crops
- high sulphur content and associated air treatment reducing CH_4 concentration

It was also mentioned that reliable data on biogas yield from energy crops is not available owing to variations in growth conditions, land quality, time of harvesting, etc.

The summary highlighted the following points:

- all agricultural crops are usable in biogas plants
- optimisation of process chains is necessary
- process units have to be adapted to local conditions
- there is limited plant experience for mono-fermentation of crops
- the stabilising effect of manure affords better process control

There were 3 short oral presentations:

"Preliminary results of biomass storing and pre-treatment", by Prof.Dr.Jukka Rintala of University Jyvasklya, Finland.

A brief description of the pre-treatment of grasses in Finland was given. The short growing season in Finland means that relatively long-term storage is needed. The prime aim during storage is to maintain biomass quality at low cost. The process involves harvesting, drying and ensiling. While drying reduces both decay during storage and eventual biogas yield, up to 39% of the eventual biogas yield can be lost if grass is baled without drying and then stored for 6 months. Biogas loss can be reduced by treatment of the grass with additives before storage. Trials with NaOH, $Ca(OH)_2$ and Na_2CO_3 have produced an increased biogas yield of up to 15% for digester operation at 35^oC and a retention time of 20-40 days.

"Preliminary results form the Agrioptigas project", by Dr.Ake Nordberg of JTI, Sweden.

The aim of the EU-funded project was to demonstrate co-digestion of source separated municipal solid waste (MSW) and energy crops on a large scale with the biogas produced being up-graded for use as vehicle fuel and the digestate being used as a fertiliser. The demonstration plant at Västerås in Sweden has annualised input of 14,000 tonnes of source separated MSW, 5,000 tonnes of energy crop (ley grass, produced from 2-3 harvest per year from 300 ha on 17 farms within 20 km of the plant and ensiled on up to 7000 m^2 of area adjacent to the plant) and 4,000 tonnes of grease trap removal sludge. The power output of the plant is 15 GWh per year (equivalent to 1500 m^3 petrol) and ~ 6,500 tonnes of solid and ~15,000 liquid digestate (combined content of digestate containing 150 tonnes N, 30 tonnes P and 100 tonnes K).

"Experience with co-digestion of energy crops", by Ir.Hendrik Jan van Dooren, Wageningen University, The Netherlands.

Results of the "North Sea Bioenergy" project were presented. The aims of the project were to demonstrate use of biomass for bioenergy in the regions bordering the North Sea (partners from NL, B, D & UK), set up expertise centres for dissemination and training and to create a virtual market for biomass trade. The biomass types included dairy slurry, sugar beet root ends, grass, peas, sunflowers and energy maize (primarily from Friesland, NL and treated in an existing biogas plant) and pig slurry, sunflowers, sudan grass and energy maize (primarily from Flanders, Belgium and treated in a new biogas plant).

General Discussion

Q. What would be the key area of research, assuming unlimited funding ?
A. (Weiland) There is a whole chain of steps in the energy crop growth, harvesting, storage and biogas production and many of these are interdependent, so no single priority can be highlighted. The focus must be on collaboration between well-coordinated research activities.

Q. Why is there a 2 cent/ KWh subsidy for dry fermentation in Germany when only limited success of the process has been demonstrated ?
A. (Weiland) This is simply to stimulate research and development, to pilot plant scale to permit effective assessment of the technology.

Q. There is a lot of information in the literature on energy crop pretreatments. Are there any cost effective methods ?
A. (Weiland) Chopping during harvesting has been shown to be effective in increasing the rate of biogas production.
A. (Banks comment) Need collaboration between biogas producers and farmers to optimise input and avoid long-term storage.

Q. What is the origin of sand build-up in reactors over time ?
A. (Weiland) This is mainly physically attached sand from input materials rather than silica incorporated in, for instance, grasses. Care at the stage of harvesting and storage is therefore important.

Q. Why have 2-stage systems when apparently not necessary ?
A. (Weiland) Avoiding flotation is the primary reason and to recover floating material.
A. (Wellinger comment) We should look to develop better technologies to avoid this type of problem which is prevalent in old designs.

Q. There are frequent problems in biogas plants resulting from waste materials with unknown composition.
A. (Nielsen comment) All biogas plants should agree long-term contracts with strict specifications for material composition with all suppliers of waste products for digestion in order to avoid operating problems.