WET FERMENTATION TECHNOLOGY FOR BIO-WASTES

SUMMARY

Due to rising energy prices and an increasing interest in renewable energy, biogas production from bio-waste is still attracting increasing attention. A growing number of anaerobic waste treatment plants in Germany, Switzerland, Sweden and Austria reflect the potential of this technology as an alternative energy source.
The example of a successful bio-waste fermentation plant described in this contribution (Fig. 1) is operated by Bio-waste Digestion “Markgrafneusiedl”. The plant with an annual capacity of 15,000 tonnes went into operation in 2006. It can process a variety of bio-waste material such as waste from the meat processing industry, separately collected bio-waste from households and even food waste contained in steel barrels of up to 200 litres.
The plant applies a dissolver treatment process developed by the Austrian company KOMPTECH. This provides automatic discharge of the contaminants and produces a pumpable, homogenous material stream for the associated wet fermentation process. At full capacity, the plant generates 360 kW of power, which is fed into the public grid. Around 10,000 m^3/year of liquid fertilizer from the plant is used in nearby agricultural areas.

Fig.1: Overall view at the two digesters of the biogas plant Marchfeld. Between the digesters the desulphurisation reactor is situated.

INTRODUCTION

For the digestion process it proofed beneficial to use the broadest possible spectrum of bio-waste, since this offers the greatest scope for the generation of energy-rich substrates resulting in high biogas yields. However, a biogas plant running on food residues, animal by-products and other organic wastes causes high requirements on the operator and on the process technology.

A wide range of bio-wastes is principally suitable for biogas production using wet fermentation anaerobic technology. But the successful operation of a waste treatment plant crucially depends on the composition of the raw material, on a suitable process technology and last not least on an experienced operator. Unfortunately the type, consistency, quality and amount of raw materials arriving at a biogas plant can change on a daily basis. Planning a plant must therefore incorporate flexibility into its design. Only with high flexibility, operators can control the processes optimally for each incoming raw material. In addition, contaminants such as packaging, stones, ceramics, glass, metals and sand can cause technical problems during fermentation. As a result, several separation treatment steps are needed to produce a more uniform, purified substrate. By using reliable technologies, even heavily contaminated market wastes and expired foodstuff can be treated in a fermentation plant alongside less contaminated bio-waste and food residues. The main contaminants of bio-wastes and treatment processes commonly applied, are summarized in Table 1.

Table 1: Contaminants and available treatment strategies for different input materials

Contaminants	**Food residues**[a]	**Expired food**[b]	**Source-separated organic household waste**
Stones, ceramics, metals	✔	✔	✔
Plastics	✔	✔	✔
Sand			✔
Treatment strategy			
Shredder	✔	✔	✔
Dissolver and wet screen	✔	✔	✔
Spiral press			✔
Sand removal tank			✔
Sanitization	(✔)	✔	

[a] Food residues such as wastes from restaurants often contain dishes, knifes, forks, etc. Treatment plants therefore need to have facilities for handling this material.
[b] Expired food means food from shops that has already reached its expiration date and is mainly still packaged.

INITIAL PREPARATION OF THE BIO-WASTE

A schematic representation of the process flow is given in figure 2. The first stage in treating contaminated organic waste is pre-shredding to open packaging. The waste can then be diluted (liquefied) in a pulper unit or pressed in a screw press to separate the liquid substrate components. As indicated in Table 1, the liquefaction process is suitable for most types of bio-waste, including heavily contaminated bio-waste. In contrast, the screw press process is particularly well suited to the treatment of separately collected organic household waste, but is not suitable for expired food because the associated packaging material cannot be treated properly.

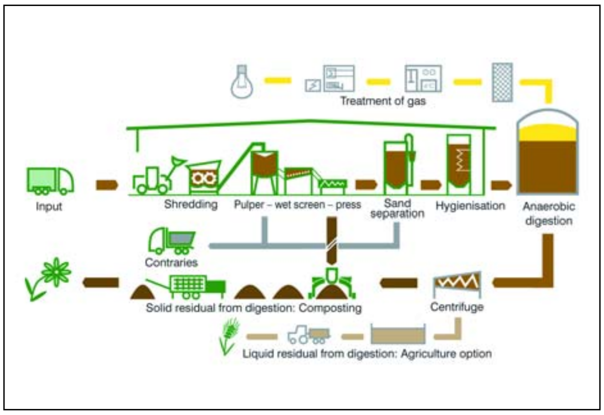

Fig. 2: Overview of the bio-waste treatment plant Marchfeld – process scheme, showing the waste pre-treatment line, the digestion step and the biogas resp. digestate use.

LIQUEFACTION OF BIO-WASTE USING A WET SCREEN

The shredded waste is transported in batches into a closed container where it is diluted with process water and well mixed. Unwanted heavy materials settle and are discharged through a sluice to a special hopper. The liquid and lighter materials (10% solid content) arrive at a wet screen where oversized particles such as fibres and packaging residues are sorted out (Figure 3). The remaining liquid is fed into a hydro-cyclone for final sand separation.

About 70%–80% by weight of the initial input material (depending on the quality of the material) is suitable for fermentation. This approach is economical for a system input of › 15,000 tonnes/year.

Fig. 3: Pulper unit optionally used for waste liquefaction resp. contaminant removal

TREATMENT OF BIO-WASTE IN A SPIRAL PRESS

The input material is first homogenized in a mixing unit using mixing screws. If necessary, a screening step can be used prior to pressing to separate plastics and larger contaminants. After homogenization, a spiral press separates the material into a liquid and a solid phase.
Between 30% and 50% by weight of the input material is yielded as press liquid containing approximately 15% solid matter. The liquid substrate is ready for anaerobic digestion, while the residue is processed in a composting facility. A view of the waste preprocessing line is given in figure 4.

Fig. 4: Overview of the mechanical waste pre-treatment part of the biogas plant Marchfeld

This approach offers greater scope for combined fermentation and composting, and is economical for a system input of ›10,000 tonnes/year.

SAND SEPARATION

In the sand separator, abrasive fine material is separated from the substrate using a hydro-cyclone technology operating in parallel with a sand separation tank. The separated material is discharged via a screw to a container. After this process, the substrate is pumped into a collector tank, thus completing mechanical treatment of the bio waste.

SANITIZATION

After mechanical treatment, the pre-conditioned substrate is stored in a collector tank. The collector tank acts as a buffer storage for achieving consistent digester feeding and allowing the introduction of liquid input materials such as fat and oil that require no pre-treatment.
From the agitated collector tank, the homogenized substrate enters the sanitization unit. The sanitization unit is heated by reusing the energy from the sanitized material and hot water from the cogeneration unit. The heat expended is mostly recovered by heat exchangers, thus considerably reducing energy consumption. After sanitization, the substrate is introduced into the digester unit.

FERMENTATION

The 2 digesters are equipped with propeller agitators, keeping homogenious conditions and providing sufficient liquid–gas separation to prevent floating- or bottom layers. If necessary, settling sediments can be pumped from the reactor bottom. The substrate is left for at least 15 days mean residence time in the digester to achieve complete degradation.
The digestion process generates a raw biogas and a liquid residue that contains nitrogen, phosphorus and stabilized organic substances. The digestion residue is utilized as fertilizer in nearby agricultural areas.
Where direct agricultural use is not possible, wastewater treatment is a reasonable option for the liquid residue prior to discharge to sewer or a watercourse.

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ENERGY RECOVERY

The raw biogas generated in the digester is stored in gas tanks before being treated further to optimize the efficiency of energy conversion. The hydrogensulphide (H_2S) content of the biogas is reduced to <50 ppm in a biological desulphurization unit. By this means the life time of the CHP combustion engine is increased significantly.
After desulphurization, the biogas passes a dehydration unit, where water vapour is condensated by cooling. The biogas is then fed within a carefully controlled environment via a compressor into the gas motor. In the cogeneration unit a generator is driven by a combustion engine and the electricity generated is fed into the grid via a transformer.

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