NEW INTEGRATED DESIGN OF DRY ANAEROBIC DIGESTION WITH COMPOSTING RESULTING IN 5 PRODUCTS: GREEN GAS, CO_2 , HEAT, CONDENSATE WATER AND COMPOST

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ABSTRACT

This paper is about a new integrated design of dry anaerobic digestion with composting resulting in the production and use of 5 products. Digestion: 1) green gas (local grid) 2) CO_2 for greenhouses. Composting: 3) heat from composting to greenhouses 4) clean condensate water for street cleaning 5) compost.
The design of the plant started in 2009 and it is in operation since the end of 1011 at De Meerlanden, Rijsenhout (near Schiphol airport).
The biogas from digested municipal bio-waste is upgraded to green gas which is fed into the public grid. The separated CO_2 is to be used in greenhouses in the direct surrounding of the plant. A very important advantage of this approach is that the digestate from the digesters is not separated by a press in a liquid and a press cake. The digestate from the digester is – without any press – mixed with add-back material from the composting and a small amount of fresh bio-waste to get a compostable mix.
The air management in the composting is designed in a way that air is re-used over and over again in composting tunnels but also in between composting tunnels, thus increasing the exhaust air temperature to 60-62 ^{o}C. This air releases its heat in a heat exchanger which produces hot water that is used to warm up a greenhouse of 2 hectare. The clean condensate water is used as water supply to street cleaning vehicles of the company. Connection of more greenhouses is planned.

KEY WORDS: digestion and composting, integrated design, five end-products

INTRODUCTION

Public awareness and growing requirements to sustainability lead to a transition in the treatment of municipal biowaste from composting to anaerobic digestion, followed by composting. Concepts which include digestion are ecological superior but often complex and expensive. We designed a new integrated design with the aim to:

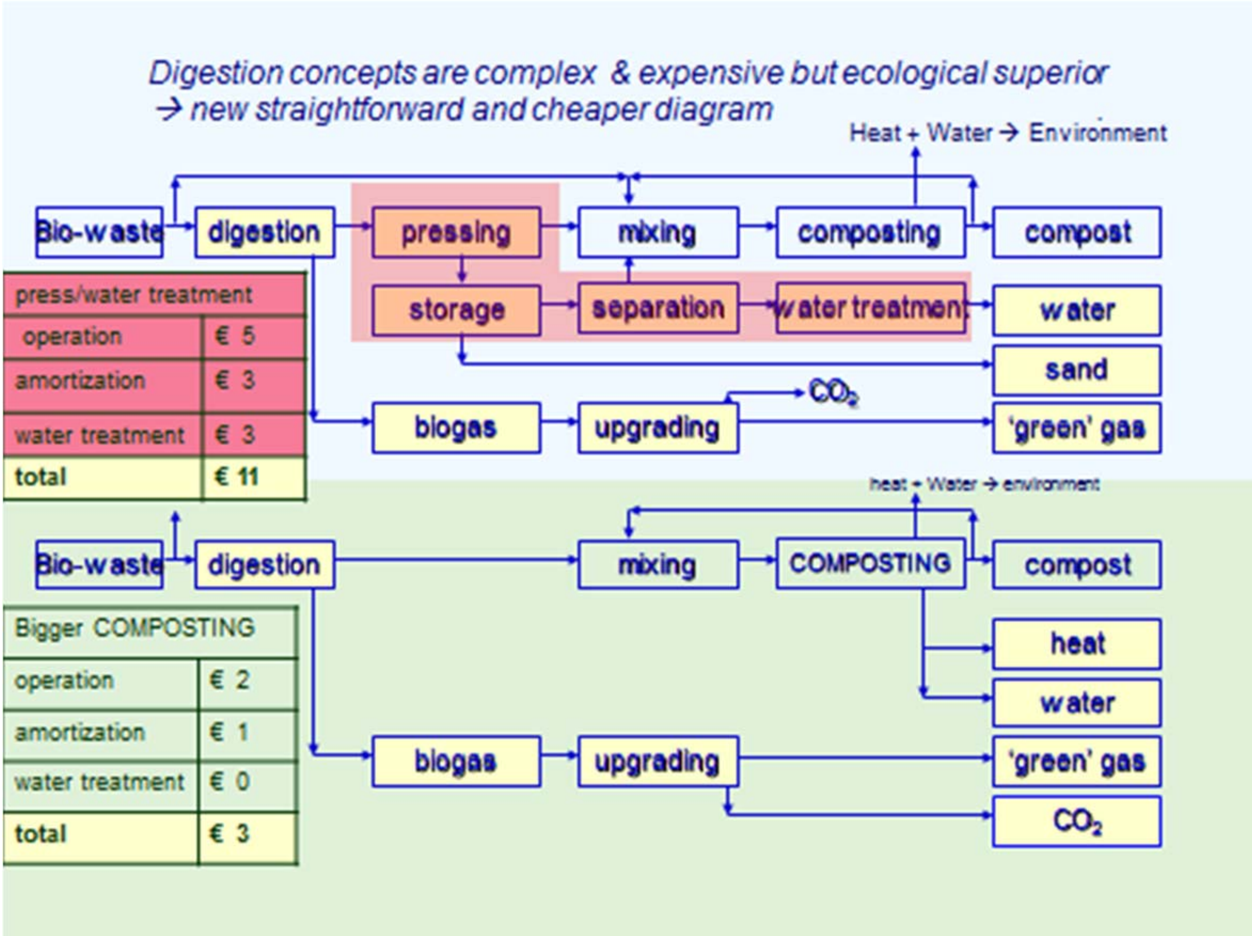
1. Lower the costs
2. Simplify the technology and make it more straight forward
3. Increase the overall sustainability by re-use of heat and water from the composting, thus adding up with compost to three products from composting, together with the gas and CO_2 from digestion; 5 products in total.

RESULTS AND DISCUSSION

In the ‘traditional’ diagram it was common practice that digestate from continuous digestion systems like Axpo Kompogas, Strabag and OWS is separated in a press in a dry press cake (for composting) and a liquid fertilizer. The disadvantages are operational problems and high costs for wear and tear connected with the presses, seasonal and / or legal problems with the sales of the resulting liquid fertilizer, or even legal ban

(NL). This is demonstrated in the red coloured part of the upper diagram in the figure below, FIGURE 1

FIGURE 1



This problem has been solved in the lower diagram of the same figure 1, in which the digestate is composted without de-watering. All attention goes to the composting which should be designed with a higher capacity, this is a higher capacity to evaporate water. The mix for the feedstock of the composting has to be prepared with more care and enough energy content to evaporate sufficient water. We used the experience which was available in the composting of sewage sludge and which includes a high add-back volume from the composting in this mix. Careful design of the aeration makes it possible to re-use the energy that is produced in the composting. We found that the energy (heat) produced in composting and released by the exhaust gas equalizes about 70% of the energy that is set free in the form of biogas in the digestion.

We can illustrate the proposed diagram according to figure 1 with the results as are reached in the project De Meerlanden. The plant started up with a capacity of 55 kton municipal bio-waste. About 30 kton is digested (the aim is to increase this amount slowly to 40 kton). The resulting 30 kton digestate (70% moisture) is mixed with add-back material and fresh bio-waste to a mix of about 60% moisture content. It is important that sufficient structure material is in the mix to ensure a good aeration. The digestate mix is composted for two weeks in tunnels and dried to 40-45% moisture content before screening, resulting in about 20 kton compost. The hot exhaust air (about 60-62 ^{0}C and 100% saturated) releases its heat over a heat exchanger. By means of this exchanger, a water circuit is warmed up to about 45 ^{0}C. A greenhouse at a distance of 1 km uses the heat. Especially in winter nights, the greenhouse uses up to 1,3 MW heat. To optimize the use of this heat, the greenhouse has doubled its capacity of heating pipes through the greenhouse.
After starting up at the end of 2011, the performance of de Meerlanden plant is increasing over time. In addition to municipal bio-waste, two tanks are installed to be able to supply liquid feedstock. With an input capacity of 55 kton municipal bio-waste, about 4 mln Nm^3 biogas can be produced, resulting in 2,7 mln Nm^3 green gas, 2,5 kton CO_2, 20 kton compost, 15 kton re-usable condensate water and 1,5 – 2 MW heat from the heat exchanger.

CONCLUSIONS

Typically in Dutch market conditions, the proposed diagram without presses can have a lot of advantages. We judge the costs of presses and water treatment can add up to € 11 per ton bio-waste input. Very important is that the press water cannot be sold as fertilizer under Dutch law. At the same time, because of its composition it is difficult to treat press water in water cleaning systems. Another important point is that – just because of the efficiency of the dewatering in the presses, it is needed to use structure material as feedstock to the digesters. Also, feedstocks like grass can cause problems for efficient dewatering. Therefore the whole process is less efficient because of these limitations to feedstock.

Without presses, more water has to be evaporated during composting. This means that more composting capacity has to be installed. This will lead to extra costs of about € 3 per ton bio-waste input. The cost advantage without presses is € 11 - € 3 = € 8 per ton input of bio-waste.