Co-production of Compost and Biofuel from Biowaste

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EXECUTIVE SUMMARY

Since 1994, Twence has exploited a tunnel composting plant for the conversion of 70,000 tonnes per year of municipal biowaste to compost. In 2004 a project was carried out with the goal to implement several techniques to produce biofuel from the residues of composting and to diminish the amount of residue to be landfilled. Implementation of these techniques enabled the capacity of the plant to be increased to 115,000 tonnes per year (tpy), and a substantial amount of biofuel to be produced for the Twence bio-power plant that will begin operation in 2007.

Initially the composting process took about 5 weeks, after which the compost was screened. The screening residues were recycled several times in the composting process until the amount of contamination such as plastic, stones, glass, ferrous and non-ferrous metals in the compost was about to exceed the norms. This resulted in residues with a relatively high content of organic materials that had to be landfilled or incinerated in a waste incinerator.

The objective of the project was to introduce various techniques to clean the residues after screening the compost. These included:

- Wind shifting the residue to separate plastic foil;
- Separating iron & steel parts using a magnet;
- Separating the residue into lighter and heavier fractions using strong airflow;
- Separating stones, non-ferrous parts and glass by washing the heavier parts in a water-separator;

After recombining the lighter shifted parts and the heavier washed parts, the residues can be shredded to the required size for the respective biopower plant using a special vertical shredder.

In this way a yearly quantity of about 20,000 tonnes of biofuel can be produced. Additionally, the quality of the compost improves as a result of the constant cleaning of the residues during the process. The amounts of the remaining residues being cleaned in this way, such as plastic foils, iron & steel, stones, glass and non-ferrous particles are substantially reduced, resulting in lower exploitation costs. Also the quality of these residues provides the option of further recycling, which has also been partly implemented.

The conclusion of this project is that the co-production of biofuel from municipal organic waste is both possible and profitable and the techniques used are proven. Integral conversion of municipal biowaste into biofuel though proves to be very difficult because of the huge amounts of contamination such as sand, stone, plastic and ferrous & non-ferrous particles. Partial conversion using various techniques has proven to be feasible.
INTRODUCTION

Since 1994, Twence has exploited a tunnel composting plant for the conversion of 70,000 tonnes per year of municipal biowaste to compost.

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PROJECT SCOPE

To reduce the amount of residue being landfilled

Initially the scope of the project was to reduce the amount of screening residues that had to be landfilled. From 1994 to 2004 extensive amounts of screening residues were produced. This was due to the process that was used in this period. After the composting process, the compost was screened and the screen overflow was reintroduced to the composting process. This recycling of screen overflow was repeated until excessive screen overflow piled up in the composting plant. Subsequently this screen overflow was landfilled. Another reason for landfiling the screen overflow could be the increase of non-compostable contamination such as glass, plastics and other non-compostable materials present in the screen overflow. After a period, repeated mechanical treatment caused the contamination particle size to decrease to the extent that it could pass through the compost screen. This led to an increase in the amount of contamination in the compost.

Of course the screen overflow could have been shredded to increase the composting speed, but this would also have involved shredding the contamination present into small particles. These small particles would have contaminated the compost with small bits of glass, plastic and other materials.

To separate the more reusable residues like stones, iron and steel and plastic foils instead of land filling.
The idea was that by using positive instead of negative sorting of these contaminants in the screen overflow, the overflow would become clean enough to be shredded without increasing the amount of non-compostable particles in the compost.

*To be able to produce biomass for conversion into energy.*

The alternative would be to clean the screen overflow in order to use it subsequently as bio-fuel. For this purpose the screen overflow would be cleaned, but not shredded intensively or not shredded at all.

*Increasing the capacity of the composting plant from 70 – 115 kilotonnes per year (ktpy).*

The recycling of screen overflow in the composting plant uses a lot of capacity. Prolonged recycling increases the amount of screen overflow present in the plant from initially approx. 30% to over 50%. Shredding and recycling the screen residues also causes the capacity to decrease, but much less - from 30% to about 40%. A much better situation would be if almost all the screen overflow could be cleaned and made suitable for biofuel. In that way the capacity of the plant could increase drastically from 70 to 115 ktpy.

**TECHNIQUES USED**

*Windshifter*

We use a windshifter for the separation of plastic foils. The overflow is brought from the drum screen to the windshifter. The windshifter is a perforated cross-belt running above the material through which an air stream of 60,000 m$^3$/hour causes the plastic foil to stick to the belt. After this the plastic falls into a press container. Four tonnes of plastic is separated every day using this technique.

*Magnets*

A cross-belt magnet separates the magnetic materials from the screen overflow. About 500 kg/day of iron & steel is separated in this way. This includes garden equipment, empty cans, nails, knives etc.
Windshifter

A second windshifter separates the heavier from the lighter fractions. In this way the lighter fibrous parts are separated from the wooden particles. Some of the plastic parts in the lighter fraction are removed with the outgoing air stream. The heavier fraction contains stones, glass and non-ferrous materials.

Water separator

This last fraction is brought to an upstream water separator. The wood fraction floats through the water container and is brought to a special conveyor. The stone, glass and non-ferrous fractions sink to the bottom where another conveyor transports them out of the water container.

The heavy organic fraction from the water-separator is combined with the lighter organic fraction from the second windshifter.

Shredder

The product is shredded by a vertical hammer mill. The shredder for this purpose should be capable of shredding intensively for processing screen overflow into a compostable product, or lightly shredding for chopping only the biggest particles. A vertical hammer mill was chosen for this purpose. The number of pivoting hammers can be varied from 2 to 18. The counter knives can vary
from 0 to 36 and can also be varied in length. Finally the speed of the rotor can be varied with a frequency controller.

*Changed process parameters for more drying instead of composting*

In order to produce biomass, attention also needs to be given to the water content and ash percentage. These two aspects both improve if the material becomes drier before screening. The drier composting process also required improvements to the dust control equipment.

**QUANTITY AND QUALITY PRODUCED**

About 25 kilotonnes of biofuel can be produced from 100 kt of organic waste. Potential bottlenecks in the specifications for biofuel are chloride & ash contents as well as particle size. The following specs must be met:

- **Chloride:** \( \leq 3 \text{ g/kg dry matter (DM)} \)
- **Ash:** \( \leq 10\% \text{ DM} \)
- **Plastics:** \( \leq 3\% \text{ DM} \)
- **Particle size** 90\% > 1 mm; 100\% < 500 mm (evenly divided)

These requirements can be met using the above-mentioned process. Moreover screenings from external compost plants can be processed to meet these requirements in the same plant.

**ENVIRONMENTAL AND FINANCIAL ADVANTAGES.**

The amount of residues that has to be landfilled has decreased from 7 kt to less than 3 kt. Over 2000 tons of these are stones, glass and non-ferrous metals that can be reused as construction material. In the Netherlands landfilling actually costs €86.91 in taxes per tonne and this implies a reduction of €521,000 in annual taxation.

The amount of energy that can be produced from the amount of biomass from this composting plant is 12 GJ/ton \( \times \) 25,000 tonnes = 300,000 GJ. This is equivalent to about 8,600 m\(^3\) diesel or about 129,000,000 km of car driving.

The amount of iron & steel that can be recycled from the organic waste is about 130 tonnes per year.

The energy consumption for the composting process is also less when biomass is produced:

- The aeration is less intensive, because of the drier process.
- The screen overflow is no longer recycled, which means less handling and other operational processing.

**CONCLUSION**

The co-production of biofuel from municipal biowaste is both possible and profitable and the techniques used are proven.

Energy conversion from non-separated municipal biowaste proves to be very difficult because of the huge amounts of contamination such as sand, stone, plastic, ferrous and non-ferrous particles.

Partial conversion using various techniques has proven to be feasible
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