SEPARATE - Enabling high-quality recycling of bio-waste through innovative waste separation technologies

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Abstract

Bio-waste from separate collection and Municipal Solid Waste (MSW) can be valorised twice: through capture and use of the biogas emanating from anaerobic digestion and through the preparation of the organic matter into high-quality compost and fertiliser. However, despite the great potential for more bio-waste recycling, the recycling rates of bio-waste fall behind the steadily growing rates of material recycling. Today, the majority of the 88 million tonnes of bio-waste that Europe produces each year is still lost through landfilling (40%) and incineration (20%). The main challenge is the clean separation of mixed waste with a view to obtain high quality products and to achieve the bio-waste recycling targets of the EU Waste Framework Directive 2008/98/EC (WFD).

Mechanical separation through shredding and sieving is the most widespread method today, but its efficiency is not optimal. The assumption behind traditional MBT is that the smaller fraction is organic and the larger fraction is non-organic. This is only partially true since the small fraction typically contains still 30% of non-organic impurities, while the large fractions typically contain around 30% organics. This high remainder of organic in the non-organic fraction and vice-versa of non-organic matter in the organic fractions causes treatment problems in both fractions and prevents a high-quality use of the product groups present in mixed household waste.

A novel approach to central separation is emerging. A Dutch company db technologies has developed a range of separation technologies that separate by type of material (organic-, non-organic) rather than by size. This article will discuss the novel approach that was put to the test in a European project “SEPARATE”.

The innovative waste separation technology named “SEPARATE waste system” allows to produce high quality products from: a) clean organic fraction that is perfectly suitable for anaerobic digestion; and b) a dry non-organic fraction that can be used for the production of refuse-derived fuel (RDF) and for recyclables. The removal of organic substances from the rest waste ensures that no organic waste is burnt in incinerators or RDF power plants where thermal use is made of the dry fraction, and no organic waste ends up in landfills in cases where the dry rest waste is simply disposed of.

Treatment of MSW with the SEPARATE waste systems functions as follows: Incoming mixed waste is loaded into a hydraulic press by which it is separated into a very clean organic fraction and a non-organic dry fraction. From the dry non-organic fraction more recyclables can be extracted if economically viable or politically desirable. After this, it can be prepared as RFD and sold to cement plants or used in RDF power plants. The organic fraction goes into an anaerobic digester where the biogas is produced. The gas can be transformed into electricity in a combined heat and power (CHP) unit, or it can be purified and bottled as liquid gas or injected in the gas grids where this option is more interesting. After it has released most of its gas, the digestate is stabilised and prepared into high-quality compost. A similar process is applicable for separately collected bio-waste.

Recent tests certified by renowned institutes and laboratories with UK Municipal Solid Waste (MSW) and source-segregated organic waste (SSO) have shown interesting results for both, organic and non-organic fractions: The analysis has confirmed that after separation, the organic fraction is very clean and shows high methane potential. The organic fraction is homogenous and is perfectly suitable for anaerobic digestion. The cell structures of this organic material are broken up whereby a high gas yield with shorter retention times can be achieved. Short retention times are of economic importance as they reduce the investment costs for the digesters. The high purity and low contamination of the organic fraction is likely to result in continuous smooth functioning of AD plants without need for digester cleaning.

On the other hand, the separation has significantly reduced the moisture content in the non-organic fraction thus increasing the calorific value. By extracting the organics form the rest waste, this becomes drier, loses much of its weight and volume and is thus more valuable as RDF, or cheaper to dispose of at landfills.

Keywords
Municipal waste, bio-degradable waste, waste separation, waste pre-treatment, waste recycling, refuse derived fuel, recyclables, energy from waste

1. Introduction

Separating mixed waste is a main challenge for achieving the recycling targets of the EU Waste Framework Directive (2008/98/EC). Most waste professionals recognise today that MSW and other impure waste streams contain potentially valuable product groups. The big challenge is how to separate mixed wastes that contain organics and recyclables into a pure organic fraction and a pure non-organic fraction.

Only if a high level of purity can be achieved, it is possible to make high-value use of the two waste fractions. But to date, effective and efficient separation of MSW and other mixed wastes remains a barrier.

MSW is mainly composed of: (i) materials ("dry") such as wood, plastic, paper and cardboard and (if not previously removed) metals and glass; (ii) humid and fermentable organic substances ("wet").

The function of a so-called OREX (ORganic EXtruder) is to treat solid urban waste by way of high-pressure extrusion into two valuable streams of material that are each more valuable with the absence of the other.

1.1 Current situation in Europe

Europe’s largest waste stream is municipal solid waste (MSW): the daily waste from our households. It consists of 6 main product groups: biological waste, paper & cardboard, plastics, glass & rubble, metals and other rest waste. Rather than importing these valuable raw materials and resources from other parts of the world, it makes sense to re-use and recycle them efficiently. Bio-waste represents the largest fraction of MSW, yet the recycling of bio-waste is still in its infancy. If treated properly, bio-waste can result in high-quality fertilizer and biogas thus avoiding the emission of greenhouse gases and the loss of high-value material.

Today, Europe loses 60% of its 3 billion tons of solid waste through landfilling and incineration each year. Bio-waste makes up 30-45% of EU27 municipal waste, each year representing 88 million tons of total Municipal Solid Waste (MSW). Currently, around 40% of bio-waste goes to landfills (up to 100% in some member states) and 20% is being incinerated. As a result, the great potential of recycling this organic material through anaerobic digestion (AD) and as fertilizer as well as the reduction of greenhouse gas emissions remains largely untapped (Figure 1).

EU Directives such as the Waste Framework Directive (2008/98/EC) and the Landfill Directive (1999/31/EC) are slowly changing this situation towards a circular economy [1, 2]. Moreover, in July 2014, the European Commission has released the Communication “Towards a Circular Economy” and a new Legislative Proposal for Amending the Waste Directives putting forward ambitious recycling targets for 2030 [3, 4].

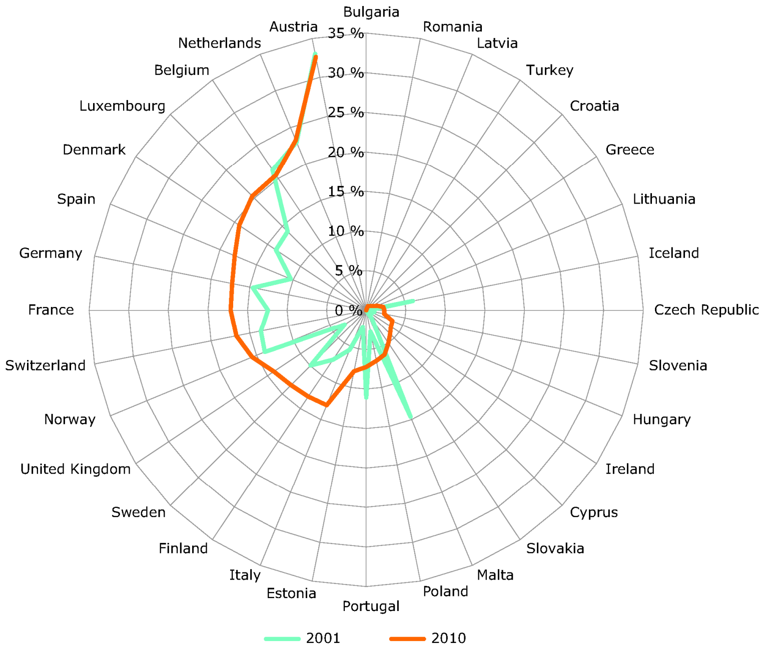

Fig 1: Bio-waste recycling as a % of municipal waste generation in 32 European countries (2001 and 2010) – EAA Report, No2/2013 [5]

1.2 The challenge: efficient separation

In municipal solid waste, the valuable material streams are all entangled, mixed together, contaminated. It is easy to sort dry recyclables, but the real challenge is to get the organics separated from the rest of the waste. There are two available options for the separation of bio-waste:

- *separation at source or so-called "kerbside collection"*. The households are asked to sort their organic waste in specific bins. While source separation is theoretically the best means to achieve clean organic waste, the reality look different. Mentality and culture influence the participation rate and the separation efficiency, but regardless of these, experience has shown that it is hard to implement organic kerbside collection in densely populated urban areas.

- *centralized separation at waste treatment facilities*. Due to problematic hygiene conditions and high personnel cost, manual separation of bio-waste is not an option. Mechanical separation through shredding and sieving is the most widespread method today, applied in most existing MBT plants.

The efficiency of the "shredding and sieving approach" is however not optimal. The assumption behind traditional MBT is that the smaller fraction is organic and the larger fraction is non-organic. This is only partially true since the small fraction typically contains still 30% of non-organic impurities, while the large fractions typically contain around 30% organics. This high remainder of organic in the non-organic fraction and vice-versa of non-organic matter in the organic fractions causes treatment problems in both fractions and prevents a high-quality use of the product groups present in mixed household waste.

A novel approach to central separation is emerging. A Dutch company db technologies has developed range of separation technologies that separate by type of material (organic-, non-organic) rather than by size. This article will discuss their approach that was put to the test in a European project "SEPARATE".

The innovative separation system (OREX and CYCLON), overcomes these problems with an unprecedented separation efficiency: it removes up to 98% of total soluble organics from contaminated waste streams, leaving the organic fraction pure, and the non-organic fraction dried and clean.

While many Mechanical-Biological Treatment (MBT) plants fails to effectively separate mixed waste into its components, the novel technology overcomes this problem and allows to obtain clean organic waste that is perfectly suitable for anaerobic digestion. It ensures as well that almost all organic waste is removed from the non-organic rest waste and does not end up in landfills.

2. Methods

2.1 European eco-innovation project SEPARATE

The European eco-innovation project SEPARATE supports the market entry of this innovative separation and cleaning technology. The SEPARATE project involves four organisations from Belgium, Germany, the Netherlands and the UK. With the help of a testing unit of the hydraulic press OREX and cleaning system called CYCLONE, the SEPARATE team have carried out on-the-spot tests of different waste streams and have analysed the quality and characteristics of the waste streams that have been separated with the new technology with regard to quality of the organic feedstock, substances contained and eventual suitability for agriculture use (compost/fertilizers). Long-term tests are taking place at Entsorgungsgesellschaft Westmünsterland (EGW), Gescher, in Germany, a public waste management company of the city. The short-term tests are taking place at different waste treatment sites in the UK. The sites included an MBT plant with Anaerobic Digestion (AD) and an AD plant processing food and garden waste. The results of the analysis are certified by renowned institutes and laboratories in the test countries.

For each of the different waste streams, samples were collected to be analysed at different stages of the treatment process. Samples were taken from the original incoming waste to see how the situation was before treatment. After the separation by the press, samples were collected from both the dry non-organic and wet organic fraction.

For the incoming waste, the dry and the wet fraction, different kind of parameters were analysed including among others total solids volatile solids, ach and moisture.

2.2 Approach to waste processing using the new separation technologies

The waste treatment system is built around an innovative technology – a hydraulic press with a high separation efficiency of 98% that allows the optimal use of the organic matter in anaerobic digestion and improves digester performance. Under the high pressure, the soluble organic matter behaves like a liquid and is separated from the dry fraction. The organic fraction is further cleaned to limit the remaining impurities such as plastics and inner materials to less than 0.5% of the total organic matter.

For the European project, the OREX hydraulic press and the CYCLONE were named “SEPARATE Waste Systems”.

Fig 2 Separation of waste input into organic and non-organic fraction

The result is a homogenous paste that is perfectly suitable for anaerobic digestion and ensures low maintenance costs of the digesters. The cell structure of this organic material are broken up whereby a high gas yield with shorter retention times can be achieved. Short retention times are of economic importance as they reduce the investment costs for the digesters.

Treatment of MSW with the SEPARATE Waste Systems is shown in Figure 3. Incoming mixed MSW is first manually sorted for large recyclables, mainly paper, cardboard, large plastics and metals. The waste then goes into a hydraulic press by which it is separated into a pure organic fraction and a pure non-organic fraction. From the dry non-organic fraction more recyclables can be extracted if economically viable or politically desirable. After this, it can be prepared as RFD (refuse-derived fuel) and sold to cement plants or used in RDF power plants.

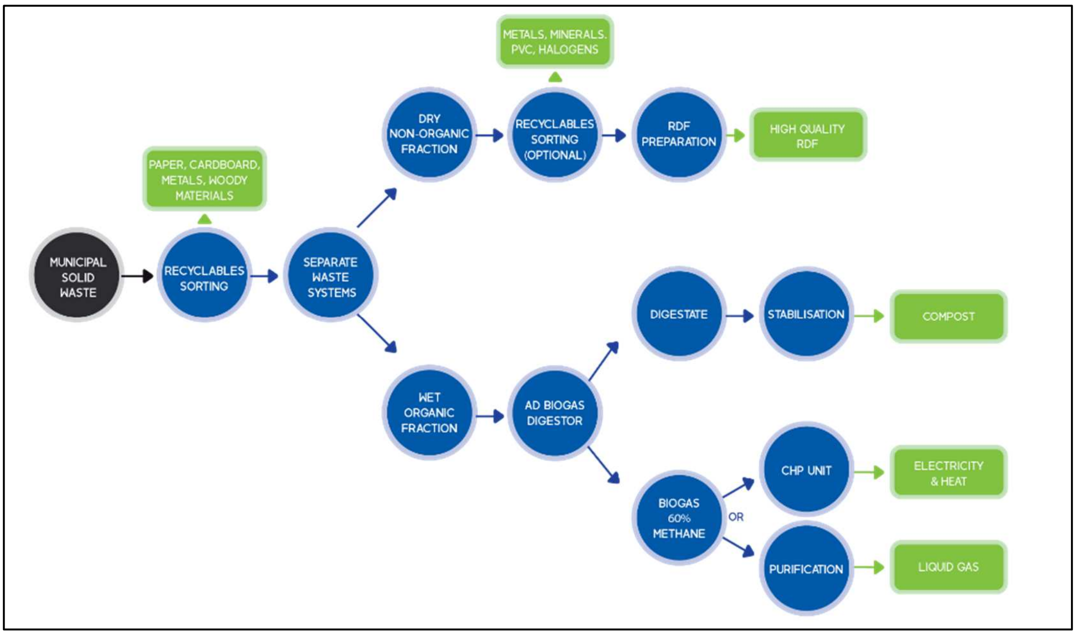

Fig 3 SEPARATE waste systems for treatment of municipal solid waste (MSW)

In the next steps, the organic fraction is further cleaned in a cleaning system and a series of sink tanks leaving only 0.5-2% of impurities in the organic material. This represents an almost revolutionary 30% efficiency improvement in terms of separation and purification resulting in high-added value organic material that is perfectly suitable for a) anaerobic digestion thus avoiding greenhouse gas emissions and b) fertiliser production that saves resources by substituting phosphate, potassium and lime fertilizers and by improving the quality of depleted agricultural soils in the EU.

The organic fraction goes into an anaerobic digester where the biogas is produced. The gas can be transformed into electricity in a combined heat and power (CHP) unit, or it can be purified and bottled as liquid gas or injected in the gas grids where this option is more interesting. After it has released most of its gas, the digestate is stabilised and prepared into high-quality compost. A similar process is applicable for separately collected bio-waste (Figure 4).

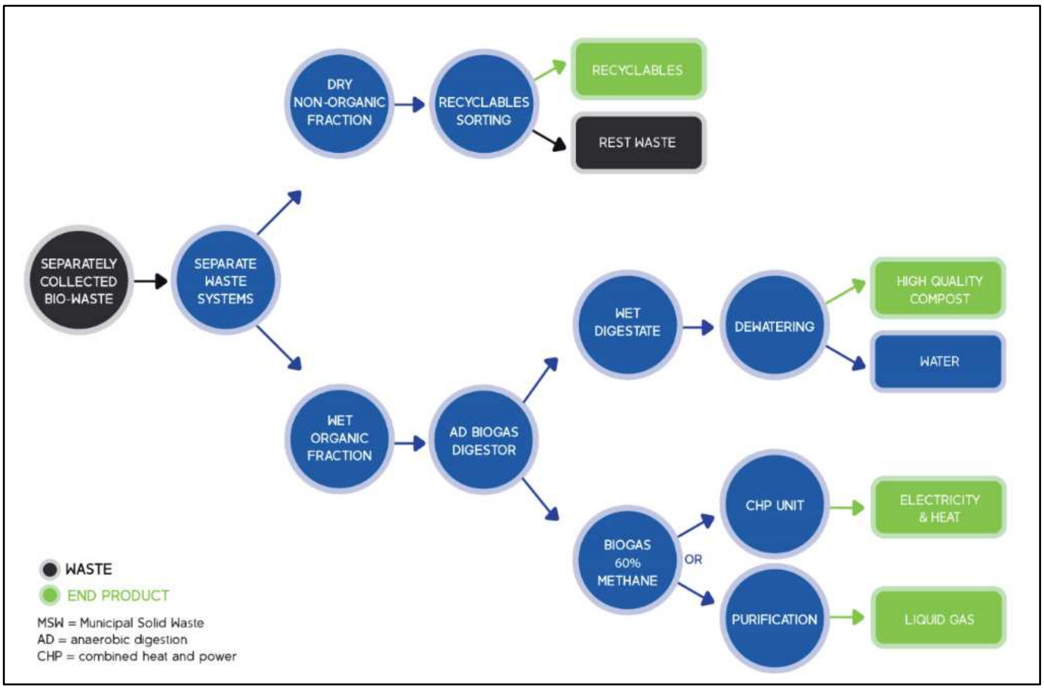

Fig 4 SEPARATE waste systems for treatment of separately collected bio-waste

3. Solution for the treatment of MSW and SSO

3.1 Waste separation with hydraulic press

The process involves the treatment of the solid municipal waste “as it is collected” and the use of a very simple form of refuse-disposal technology, which is considered compatible with the situation of practically any territorial or local administration department.

The OREX (ORganic EXtruder) is a waste pressurizing machine designed to physically separate waste into two fundamental fractions, an organic wet fraction with hardly any non-organics and a solid dry fraction with almost total absence of organic substances. The OREX press has a modular construction. It consists of the “active part” which is the press ram, the guiding and all the functional parts are located in a self-supporting structure in an electro-welded construction, and the central “passive” part of the structure containing the main cylinder and the extrusion chamber. **The extrusion process** is carried out in three phases:

1. Feeding phase;
2. Compression phase;
3. Expulsion phase.

The feed cylinder feeds the incoming organic waste via a pre-press ram from the feeding hopper into the extrusion chamber then the main cylinder compresses the material via the main ram to extrude the material that turns into a liquid under this extreme high pressure. When the compression phase is finished, the ram retracts, a side door opens and the feed cylinder brings out the structural dry material that remained in the compression chamber. The feed ram retracts and the door closes for the next cycle.

3.2 Result of the extrusion process

The municipal solid waste or source separated organics (SSO) is split into a dry non-organic and a wet organic fraction, the physical and biological characteristics of which allow for advantageous further use of both.

3.2.1 The dry fraction

The dry fraction is formed by materials which are mechanically more stable and strong such as plastic, wood, paper and cardboard, various minerals and metal with the following significant physical properties:

- upstream density 0,7/0,8 t/m^3 approximately
- residual humidity about 18%-20%
- average calorific level > 14/16,000 kj/kg
- organic (except wood) < 4-5 %

The dry fraction can be used as a raw material for refuse-derived fuel (RDF). RDF is a fuel producing thermal or electrical energy. Part of it can be further separated in special sorting plants extracting recyclables. The dry fraction that cannot be put into recyclables or RDF can be advantageously disposed of in landfills or storage areas, because of the considerable reduction in volume (up to 1/3 of the volume), with considerable savings in terms of the duration of the landfill or waste-disposal unit (e.g. a 2-year old landfill or disposal area could be used for a further 5-6 years). Its volume reduction also gives reduction in logistics or transportation costs. Finally, the minimal amount of organic substances and moisture result in minimization of damping and gas forming, resulting in less odours and insects.

3.2.2 The wet fraction

The wet phase is essentially formed by organic substances (foodstuff refuse) with low quantities of various fibers, plastic materials and minerals. The physical appearance is that of a semi-fluid, fine-grain paste (depending on the moisture). In particular, the low quantities of glass and ceramics have a granulometric shape. The characteristics of the wet fraction are:

- the level of humidity is about 60-65% and there is no floatation of material from the paste-like mass;
- the upstream density is approximately 0.8-0.9 t/m^3;
- in case of anaerobic digestion:
  - biogas yield >180m^3/h;
  - CH_4 approximately 60%.
- extrusion efficiency of digestible organics approximately 95%.

3.2.3 Products from MSW

The process described above allows the user to obtain the following products from municipal solid waste (mass % depends on the input):

- wet fraction 30-40 % approx
- dry fraction 60-70 % approx

Off which: metals 1-3 % approx.; sand and minerals 10-15% approx.; remaining plastics, wood, cardboard, textiles and leather and whatever is in the solid waste; the remaining organics 5% approx..

All of the above products are almost biologically inert and therefore do not generate the negative effects typical for a landfill for municipal solid waste such as leakages, pollutants, biogas, and noxious odour.

3.3 Usage of products coming from the extrusion process

3.3.1 The dry fraction

The dry fraction, characterized by a degree of humidity lower than 20%, can be used in incinerator plants, gasification, pyrolytic or cement factories systems as RDF. This contributes significantly towards the reduction of the mass of waste transferred to landfill areas and disposal sites in general and the equally significant advantage owing to a recovery of energy. If the mineral and metal fraction are separated from the dry waste the calorific value will increase accordingly, also the amount of slag will reduce significantly since the inert fraction that is taken out is the main part of the slag. The RDF can be formed into bales or briquettes for later use. To facilitate transportation the blocks can be wrapped in (recycled) plastic.

If incineration for the conversion to energy is not an option, nor is any other thermal conversion, then the remaining option is disposal of the material to a landfill. It should be noted that the size of the mass is reduced five or six times with respect to the size of the original waste treated, this because the organic wet fraction is removed from it and the dry fraction is compacted. The immediate advantage, besides the considerable saving due to the reduction in transportation costs is that of a significant increase in the life of the landfill area and simplification of the operation cost of the disposal unit itself be- cause of the fact that the processed waste material is highly biological inert.

3.3.2 The wet organic fraction

The organic fraction that is produced by the OREX is very suitable as raw material in digestion or composting processes. The mechanical effect, to which the material is submitted in the compression and extrusion phase, causes a breaking-up of the solid material forming the wet phase, which allows for a rapid fermentation process, the initiation of which is also facilitated by a raise in temperature of the extruded mass when it comes out of the extruder compactor. Because the material is pressed through small holes in the extruder, this functions as a screen allowing only small material to reach the wet fraction. During the compression, the solid material in the compression chamber holds itself, allowing only minor movement. In this way less solid material and no mechanically hazardous material end up in the wet fraction. Stainless steel knives, for instance, could ruin pump linings potentially resulting in downtime of the later fermentation process. Depending on the input material and end products needed, the organic fraction can be further cleaned to limit the remaining impurities by the CYCLONE.

4. Waste cleaning with CYCLONE

4.1 Description of the process

The system to further clean the organic fraction is the CYCLONE. It operates in two phases. In the first phase, the material is rotated in the CYCLONE at high speed pushing the organic material through a perforation and separating it from the material that is bigger than the perforation – typically plastic film. Whilst the organic fraction is pressed through the holes of the cyclone, the remaining plastic falls over the top and is trans- ported away by a screw conveyor.

In a second phase, inert material and contaminants such as very small pieces of stone, glass and sand are removed from the fraction. During this second phase, the biodegradable organic material is moved into a sink tank in which the material sets to rest. Heavy material such as small stones and glass has the time to sink down in this tank. At the bottom, there is a scraper bar that slowly brings the sunken fraction out of the tank, above water level.

4.2 Result of the waste cleaning

Through the CYCLONE, the organic fraction is cleaned to limit the remaining impurities, such as plastics and inert materials to less than 0.5% of the total organic matter. The result is a homogenous paste that is perfectly suitable for anaerobic digestion and ensures low maintenance costs of the digesters. The cell structures of this organic material are broken up whereby a high gas yield with sorter retention times can be achieved. Short retention times are of economic importance as they reduce the investment costs for digesters. As a result of the very clean separation, a number of high quality products can be obtained.

5. Testing the innovative solution

5.1 Description of the long-term tests

The test hydraulic press and cleaning system are installed at Entsorgungs-Gesellschaft Westmünsterland (EGW) at Gescher in Germany and are integrated in their existing waste treatment systems, e.g. a traditional MBT plant. The test unit separates the incoming waste fraction into two fractions: (i) a wet organic fraction is optimally prepared as homogeneous feedstock for the biogas plant and subsequent fertilizer production; (ii) a dry non-organic fraction is further sorted for recyclables and prepared into high quality RDF.

The long-term test is split into three tests:

- test 1: input material- organic mono-stream waste
- test 2: input material- separately collected bio- waste
- test 3: input material- unsorted municipal solid waste

The incoming materials as well as the two outgoing fractions is analyzed. Furthermore, several short term tests are carried out in the UK.

5.2 Description of the short-term tests

For the short-term tests in the UK carried out in December 2014, different operators of waste treatment plants have been approached to agree on possible trials with Municipal Solid Waste (MSW) and Source Separated Organic Waste that is used in anaerobic digestion. The main motivation to trial the SEPARATE Waste System directly with "local" waste is to overcome the perceived barrier that in each region the waste is specific and that test results with waste from other regions do not apply to the local conditions. The performance of the OREX press was trialed with the help of a mobile unit on different waste streams.

The following parameters were analysed before the waste streams entered the mobile press:

- Dry matter
- Organic matter
- Ash
- Moisture
- Fermentation (biogas produced, CH_4 content, CO_2 content)
- Bio-methane potential

These parameters were also tested for the two fractions coming out of the press. The short-term tests in the UK were accompanied by a qualified external waste analysis laboratory that is certified in the UK. The laboratory carried out the analysis on incoming waste and on the non-organic dry and the organic wet fractions resulting from the separation.

6. Results and discussion

The short-term test in UK with MSW and bio-waste in the winter season (December 2014) have been generating promising results.

Municipal Solid Waste

The following waste streams were put through the mobile test press at a VIRIDOR-owned MBT plant in Manchester:

- MSW Black Bag Waste (original household waste, de facto rest waste since recyclables and organic waste are collected from households in separate bags)
- MSW Black Back Screen (120mm fraction from a sieve drum that is screened to produce an AD feed)

– MSW trommel fines (80mm fraction that is screen to produce and AD feed)
– MSW Heavy Reject Fraction (so called “spuds and shoes” fraction that goes to the landfill)
– Organic from the “Stockport” area (screened MSW with smaller particle size and a high content of organics)

In addition, MSW Black Bag Waste (original household waste, de facto rest waste since recyclables and organic waste are collected from households in separate bags) from Liverpool was tested at the same location.

The original Black Bag Waste from both Manchester and Liverpool was separated into 55% non-organic dry fraction and 45% of organic wet fraction.

- In the **non-organic fraction**, the moisture content was reduced to 37% and 41% respectively whilst the Total Solids have been increased to 63% and 59% respectively.

  The gross calorific value of the dry fractions are very high with 16,600 kJ/kg in Manchester and 14,200 kJ/kg in Liverpool (Figure 5).

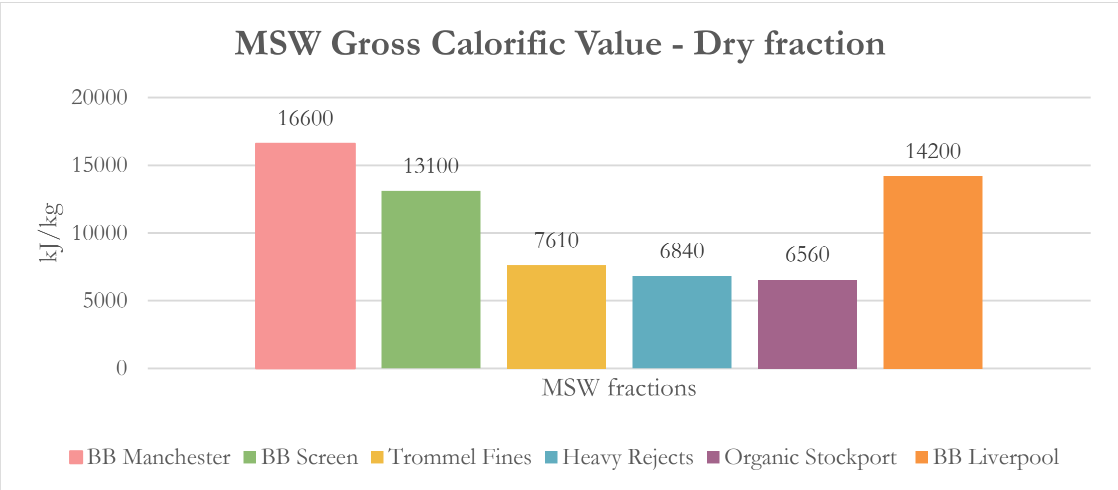

Fig 5 MSW Gross Calorific Value – dry fraction

- In the **organic wet fraction**, the Total Solids have been reduced to 28.6% and 25.5% respectively. Both organic fractions have been very clean with 4.3% in Manchester and 2.6% in Liverpool and are thus very suitable for anaerobic digestion.

  With regard to digestability, excellent results have been achieved. The organic fractions have very high methane yields 616 L CH_4/kg VS and 576 L CH_4/kg VS respectively. Also the biogas values are very high with 257.6 m3/ton in Manchester and 230.9 m^3/ton in Liverpool.

  Also the methane evolution shows very good effects regarding the separation with the extrusion press. For both organic fractions from Manchester and Liverpool, the majority of readily degradable material was converted to methane on days 1-6 thus allowing a short retention time in the digesters.

The other different waste streams that had undergone further treatment in the MBT plant in Manchester also showed positive effects from the separation.

The Black Bag Screen was separated into 71% dry fraction and 29% wet fraction, The Heavy Rejects into 73% dry and 27% wet fraction.

- In the **non-organic fraction**, the moisture content was reduced to 39% in both cases whilst the Total Solids have been increased to 61%, also in both cases.

  The gross calorific value is high with 13,100 kJ/kg for the Black Bag Screen and rather low for the Heavy Rejects with 6,840 kJ/kg.

- In the **organic wet fraction**, the Total Solids have been reduced to 37.3% and 31.9% respectively. With 12.6%, the organic fraction resulting from the Black Bag Screen will require further cleaning whilst the organic fraction resulting from the Heavy Rejects is very clean with only 6% contaminants.

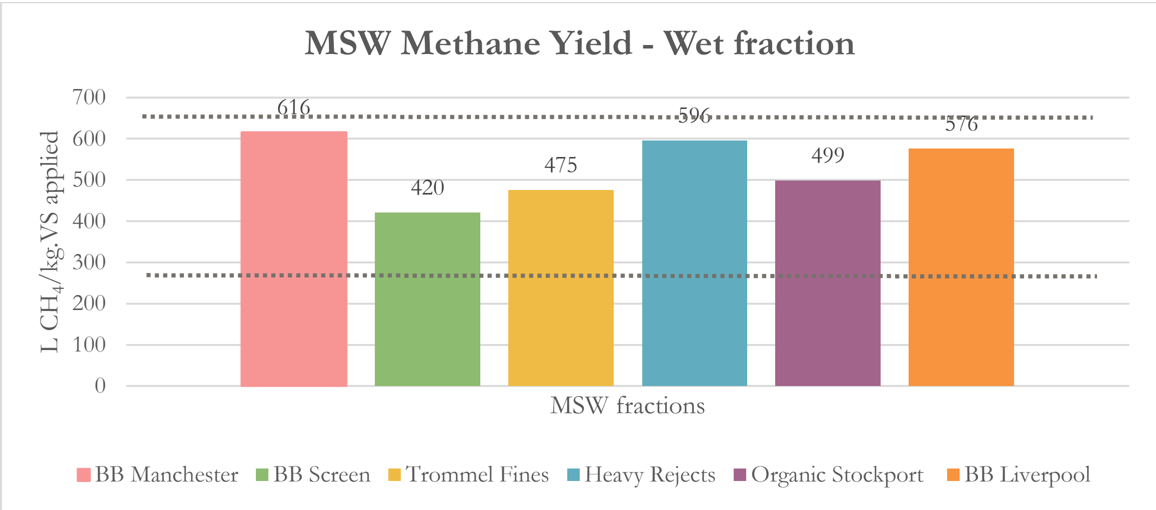

Fig 6 MSW Methane Yield – wet fraction

With regard to digestability, very good results have been achieved. The organic fractions have very high methane yields 420 L CH_4/kg VS and 596 L CH_4/kg VS respectively. The Black Bag Screen achieves good values for biogas (178.9 m^3/ton) and for the Heavy Rejects the biogas value is very high with 253.1 m^3/ton.

Also the methane evolution shows very good effects regarding the separation with the extrusion press. The majority of readily degradable material was converted to methane on days 1-6 for the Black Bag Screen and on days 1-7 for the Heavy Rejects thus allowing a short retention time in the digesters.

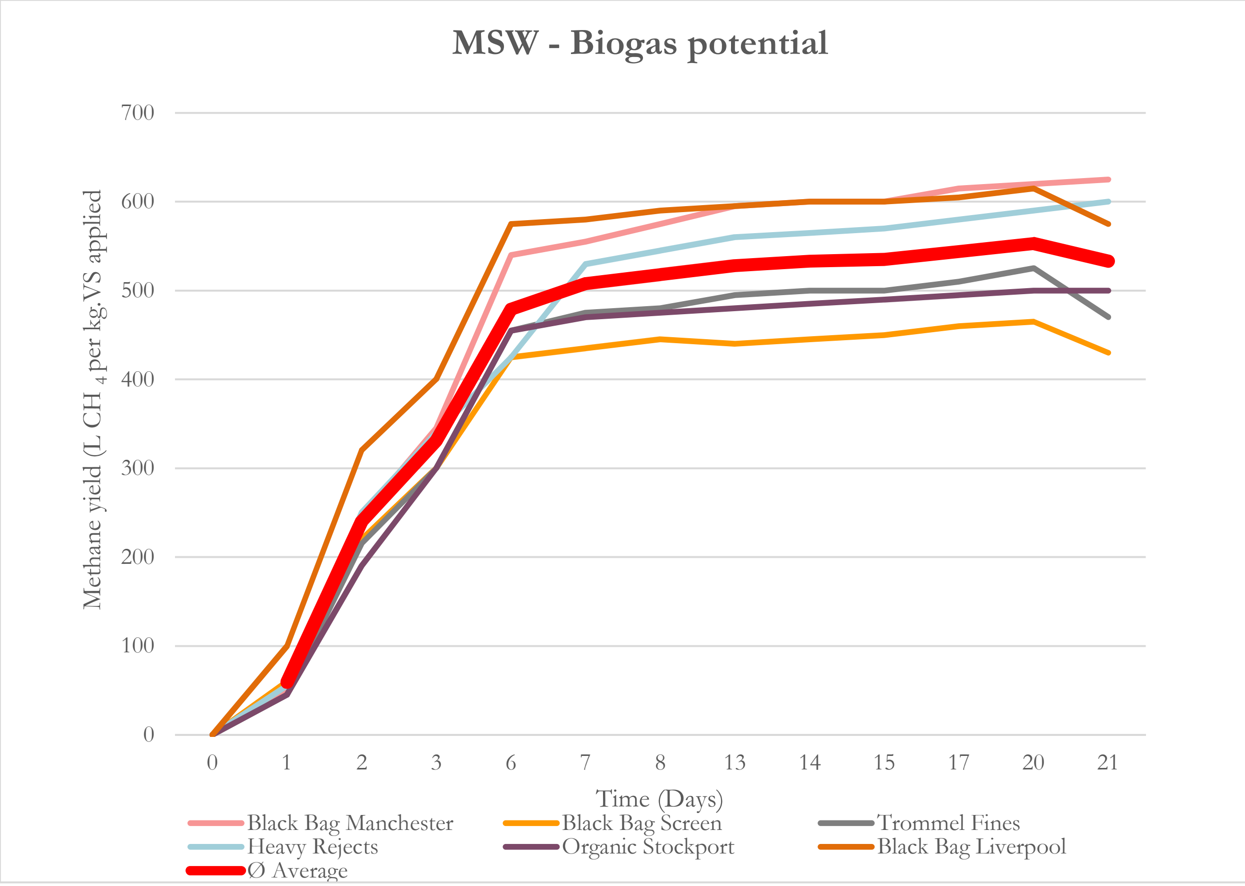

Fig 7 MSW – Biogas potential

The Trommel Fines were separated into 35% dry fraction and 65% wet fraction; the Organic Stockport into 36% dry and 64% wet fraction.

- In the **non-organic fraction**, the moisture content was reduced to 31% and 26% respectively whilst the Total Solids have been increased to 69% and 74% respectively.

  The gross calorific value of the dry fractions are relatively low with 7,610 kJ/kg for Trommel Fines and 6,560 kJ/kg for Organic Stockport.

- In the **organic wet fraction**, the Total Solids have been reduced to 40.5% and 39.8% respectively. The organic fraction stemming from the Trommel Fines has been very clean with 4.1% whilst the organic fraction resulting from the Organic Stockport with 15.7% would require further cleaning.

  With regard to digestability, very good results have been achieved. The organic fractions have very high methane yields 475 L CH_4/kg VS and 499 L CH_4/kg VS respectively. The biogas values are good with 209.7 m^3/ton for Trommel Fines and 224.1 m^3/ton fir Organic Stockport.

  Also the methane evolution shows very good effects regarding the separation with the extrusion press. For both organic fractions, the majority of readily degradable material was converted to methane on days 1-6 thus allowing a short retention time in the digestors.

Bio-waste – Green Waste

The SEPARATE team also trialed with Source-Separated Bio-waste from UK AD plant developer Tamar Energy (Bedford site). The material has been green waste and had been shredded before it has been tested with the SEPARATE Waste System.

The separation of the Bio-waste resulted in a split up of 93-94% of the total weight to the wet organic fraction and 6-7% of the total weight to the dry fraction.

- In the **non-organic fraction**, the moisture content was reduced to 44% whilst the Total Solids have been increased to 56%.

- In the **organic wet fraction**, the Total Solids have been reduced to 32%. With 7.9% the organic fraction stemming from the bio-waste is relatively clean but would require further cleaning to remove contaminants.

  With regard to digestability, very good results have been achieved. The organic fraction has high methane yield of 343 L CH_4/kg VS. The biogas values are reasonable with 131.1 m^3/ton.

  Also the methane evolution shows very good effects regarding the separation with the extrusion press. The majority of readily degradable material was converted to methane on days 1-6 thus allowing a short retention time in the digesters.

7. Conclusions

By using the SEPARATE Waste Systems, it is possible to separate municipal solid waste and source separated organics (bio-waste) into two streams of material, a dry mainly non-organic fraction and a wet organic fraction, that each are more valuable with the absence of the other.

The analysis has confirmed that after separation, the organic fraction is very clean and shows high methane potential. The organic fraction is homogenous and is perfectly suitable for anaerobic digestion. The cell structures of this organic material are broken up whereby a high gas yield with shorter retention times can be achieved. Short retention times are of economic importance as they reduce the investment costs for the digesters. The high purity and low contamination of the organic fraction is likely to result in continuous smooth functioning of AD plants without need for digester cleaning.

On the other hand, the separation has significantly reduced the moisture content in the non-organic fraction thus increasing the calorific value. By extracting the organics form the rest waste, this becomes drier, loses much of its weight and volume and is thus more valuable as RDF, or cheaper to dispose of at landfills.

Acknowledgments

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