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Production of clean compost out of mixed MSW: a giant leap towards Zero Waste

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Abstract

One of the latest innovations in Mechanical Biological Treatment-plants is a new process, called SORDISEP (SORTing, DIgestion & SEParation).

It was developed to treat contaminated digestate from mixed (or residual) waste organics in order to assure the production of a high quality compost and recyclable fractions from mixed waste digestate.

Keywords

MSW, clean compost, digestion, washing, SORDISEP, DRANCO, zero waste

1 Introduction

The production of clean compost out of mixed waste has posed many challenges. The failure to produce a marketable compost from mixed waste led to uncertainty about the effectiveness of composting as a solid waste treatment process and in the worst cases to the closure of many composting plants. Small plastics and glass and inerts remained in the compost, and were visually obtrusive. Compost may be refined mechanically to a great extent but this often results in too little acceptable 'clean' compost that is ultimately produced, sometimes as little as 10 to 20% of the non-refined compost leaving the regular composting process.

In order to overcome this challenge, source separate collection of the organic fraction was implemented in many European countries in the nineties in order to assure the cleanliness and marketability of the compost generated from household waste organics. Source separate collection, however, increases the cost of collection significantly and many countries are reluctant to implement a three bin collection (recyclables + SSO + residual black bin).

A novel process has been developed to remove the visual and other contamination in compost derived from mixed waste household organics called SORDISEP (SORTing, DIgestion & SEParation). It was specifically developed to clean the organic fraction after anaerobic digestion from mixed household waste organics, called digestate, and

to ensure the production of high quality compost along with the recovery of simple recyclable fractions.

2 Motives & objectives

The organic waste fraction is the largest fraction remaining in the MSW after source separation of the recyclables and yard waste, and therefore represents the largest potential for increasing diversion and recycling. The organics amount to 30 to 50% (varying between multi-family and single households) of the total mixed waste bin and are mostly composed of food waste, yard waste and soiled paper. Due to the fact that this organic fraction is co-mingled with all the other components in household mixed waste, it poses a very big challenge to produce a good quality compost from the mixed household waste. Aerobic composting produces a fairly dry end material that can be screened over screens with holes no smaller than 10 to 12mm (1/4 to 3/8 of an inch).

However, this is not sufficiently small enough to remove a sufficient amount of glass and plastics that are often smaller in size. Too much plastic and glass remains and is visually obtrusive, causing the compost to be unmarketable. Ballistic and pneumatic separation have been added in several plants to alleviate the problem of contamination of the compost, but with mixed results.

With the increased use of anaerobic digestion as a preliminary biological step, a new opportunity arises to produce cleaner composts out of mixed waste. After mechanical pretreatment to extract the organics and remove as many contaminants as possible, digestion of mixed waste organics can be readily performed in a properly designed digestion system (dry, high solids rather than wet digestion). However, the resulting digestate still contains a significant quantity of contaminants, too high to meet regulations for clean compost.

Fortunately, anaerobic digestion of the mixed waste organic fraction produces a digestate that is more amenable to separation than the incoming mixed waste. Because the digestion converts around 65% of the volatile solids – mostly the "stickier stuff", the organics remaining in the digestate are the more fibrous materials that do not decompose easily as well as the microbial biomass. At this point, the addition of water to the digestate results in heavies and lights separating quickly from the organics. Dry digestion allows for the maximum amount of organics to be digested and may contain a certain level of contaminants in the feedstock. The wet separation process then easily separates the compost (short fibers plus biomass) from the larger visually obtrusive plastics and glass, yielding a clean washed compost material as well as a clean recyclable inert fraction and high-calorific plastic fraction. The feasibility to produce clean compost along with recovering additional recyclable materials from mixed waste

represents a significant increase in diversion potential and “zero waste” becomes attainable.

3 The SORDISEP process

A mixed waste processing facility (MWPF) generally has 3 main objectives regarding front-end material separation:

- 1) Recover recyclable or combustible materials as marketable by-products;
- 2) Reduce the levels of visible inert materials (e.g. plastics and glass) in the organic fraction; and
- 3) Reduce the levels of chemical contaminants (e.g. heavy metals) in the organic fraction.

During the past three decades, many dry mechanical separation technologies based on physical parameters have been developed to recover recyclable, combustible and inert materials from solid waste. These new technologies, along with collection and separation schemes for hazardous household waste, make it more feasible than before to produce a clean compost from mixed municipal solid waste.

However, even in largely automated MWPF-plants, human beings still play an important role to achieve the highest level of separation. In most reception halls or waste bunkers, dangerous or bulk goods are manually diverted by the workers (e.g., removal of propane canisters before entering the pretreatment). But in many cases, manual workers are also assigned to conveyors to sort out contaminants so that they do not remain in the organics fraction to create issues either in a subsequent anaerobic digestion or aerobic composting process. This exposes workers to odorous and sometimes hazardous materials, and produces a reject fraction laden with residual organics.

Because of its robust nature and ability to cope with both heavy and light contaminants, the DRANCO anaerobic digestion technology can reduce the need for (manual) pretreatment, and in combination with SORDISEP as a post-digestion technology to ‘wash the digestate’, a clean compost can be produced.

During the DRANCO digestion, about 60 to 65% of the volatile solids (representing the easily degradable and often wet and sticky/odorous organic components of the waste) are converted to biogas in the digester. The remaining volatile solids are the more fibrous materials that do not decompose easily as well as microbial biomass. The resulting digestate can be easily separated using screens and other wet separation equipment, as developed in the SORDISEP process. Sand, short fibers and inerts can

be recovered and cleaned in order to produce marketable end products. This increases landfill diversion up to 85% and recovery of materials out of mixed waste to 50%.

See figure 1.

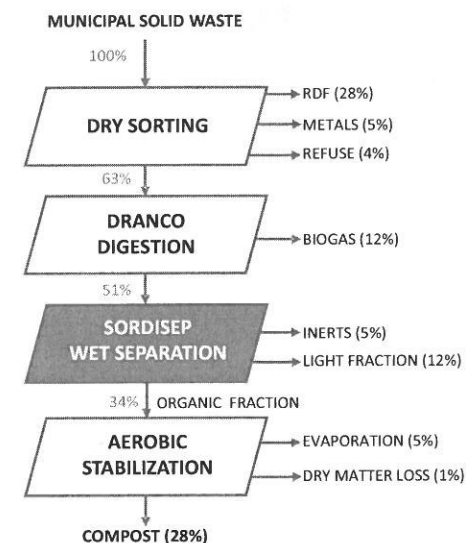


Figure 1 Schematic overview of the SORDISEP process and integration in a MWPF

SORDISEP’s wet separation technology primarily makes use of density differences (like air classifiers do) but using water rather than air as the floatation medium. SORDISEP is ideal to separate particles of glass, sand, light and heavy particles from organic materials prior to composting.

And of particular importance, SORDISEP continuously recycles the water used for separation, avoiding the need for added water and producing minimal liquid effluent.

4 SORDISEP integrated in the MWPF of Bourg-en-Bresse

A first full-scale plant including a SORDISEP-unit was integrated in the Mixed Waste Processing Facility (MWPF) of Bourg-en-Bresse, in France, with operations starting in 2016.

This plant treats the mixed waste of 329 000 inhabitants of 17 municipalities.

The plant is designed to annually treat 66 000 metric tons (73 000 US tons) of mixed waste and 7 500 metric tons (8 300 US tons) of green waste. The plant will produce

10 000 MWh of electricity per year and 11 000 MWh (38 000 MM BTU) of heat. But what makes this plant truly unique is that it produces annually about 20 000 metric tons (22 000 US tons) of clean compost, fully compliant with the French norm NFU 44-051, out of the mixed waste organics. It takes <3 months between the arrival of the waste and the production of the final compost.

The overall flow is shown in Figure 2.

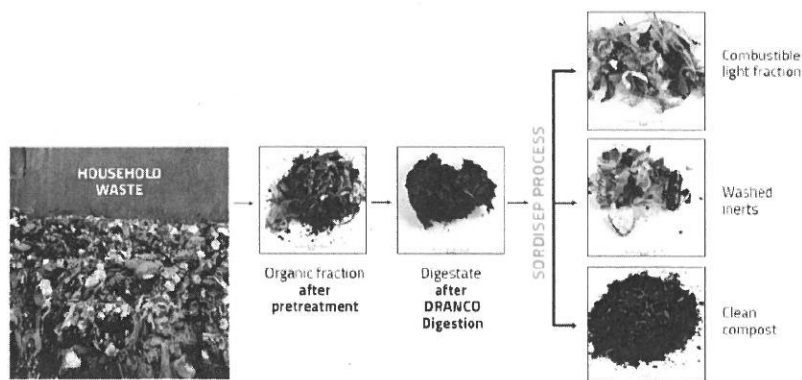


Figure 2 Overall flow of the SORDISEP process in Bourg-en-Bresse

4.1 Pretreatment

Household waste is introduced into 2 'long residence' rotating drums. See Figure 3.

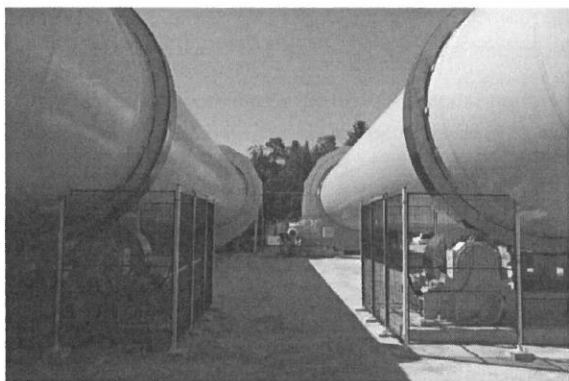


Figure 3 Long residence rotating drums at Bourg-en-Bresse

The waste traverses these tubes over a period of 2 to 3 days, at a temperature of about 40°C (104°F) due to the onset of spontaneous/natural fermentation that begins as the garbage bags open and the waste is mixed via the tumbling action. While tumbling, the organics (especially soiled paper) in the waste also tend to be reduced in size. At the exit of the mixing tubes, the processed waste is conveyed by a conveyor belt to the sorting plant where the remaining large elements >20 cm (8") are separated from the smaller materials by an initial screen. The rejected overs go directly to the landfill. The smaller materials <20 cm (8") are conveyed to a second rotary screen with a mesh of 5 cm (2"), with the undersized fraction containing most of the organic matter. The organic waste fraction then passes under magnets to sort out the ferrous metals that can be recovered.

Finally, a large part of the inert waste (pebbles, sand) is removed from the organic fraction by 3 ballistic separators. The organic matter then goes to the anaerobic digester. This simplified sorting process allows for more organic matter to be introduced into the digester, thus generating more biogas production.

4.2 DRANCO anaerobic digestion

Immediately before introduction into the digester, the organic fraction is intensively mixed with digestate in a closed mixing vessel, along with process water and/or steam to obtain the desired temperature (55°C or 131°F). This mixture is pumped to the top of the digester and falls on top of the biomass/digestate inside. The digesting mass goes down by gravity as digestate is extracted at the bottom outlet. During this process biogas is produced by the microorganisms and diffuses up through the digestate. The biogas is extracted from the digester to supply energy for 2 gas engines that generate electricity. As mentioned before, this anaerobic digestion converts a huge part of the volatile solids and renders the digestate more amenable to separation.

See Figure 4 & 5.

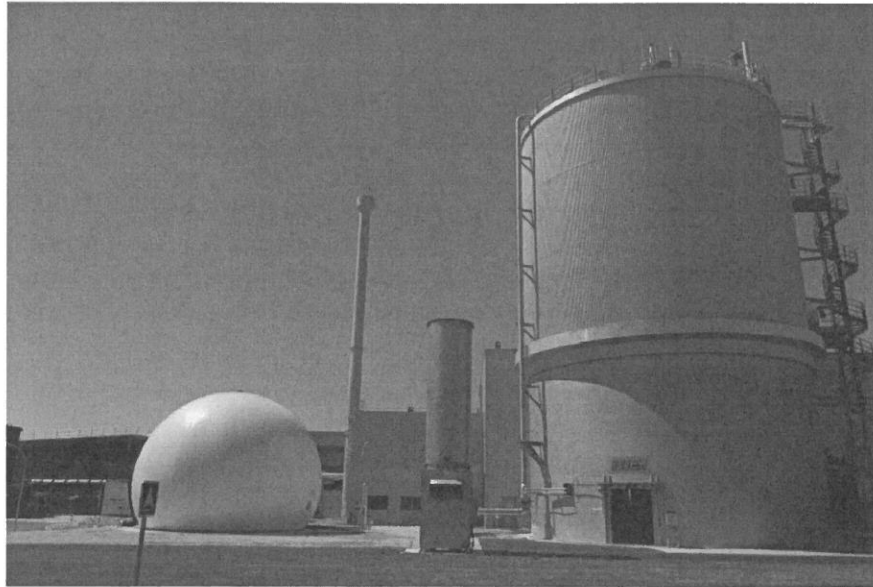


Figure 4 DRANCO anaerobic digester

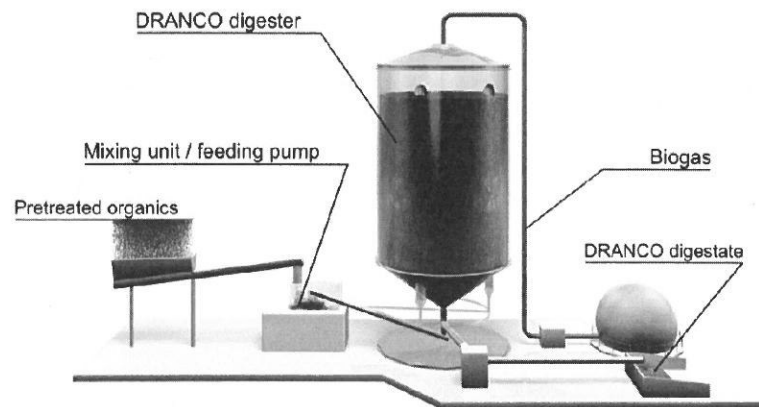


Figure 5 DRANCO anaerobic digestion flow

4.3 SORDISEP

The most special feature of this waste treatment plant is the actual SORDISEP-process.

By means of washing, sorting and centrifuging, the organic matter leaving the digester is cleaned and separated from the plastics and other inert materials which are still present in the digestate.

The main parts of this process consist of:

- Dilution of digestate and screening over 3mm (0.1"). See Figure 6.
- A separation of light and heavy fraction. See Figure 7.
- Centrifuges to remove organics <3mm (0.1") in order to produce clean process water. See Figure 8.

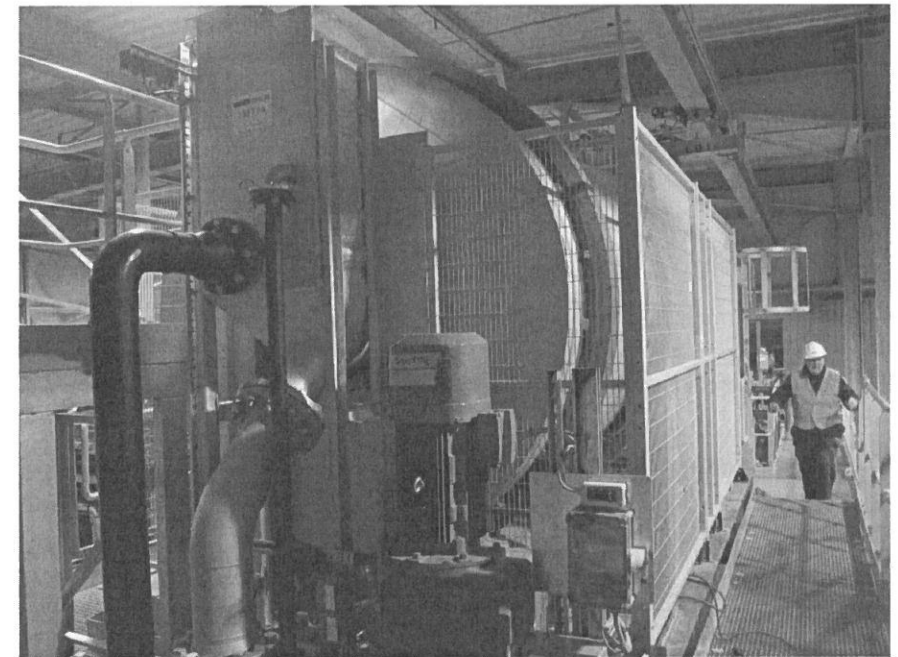


Figure 6 diluting the digestate

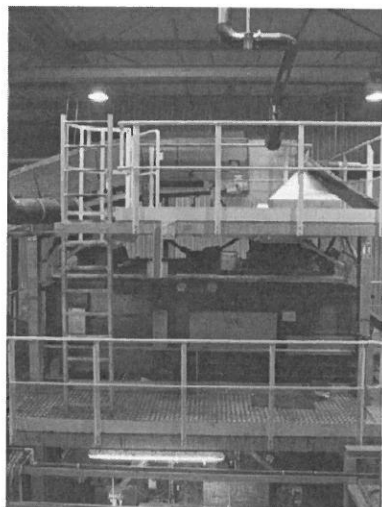


Figure 7: Separation of light and heavy fraction

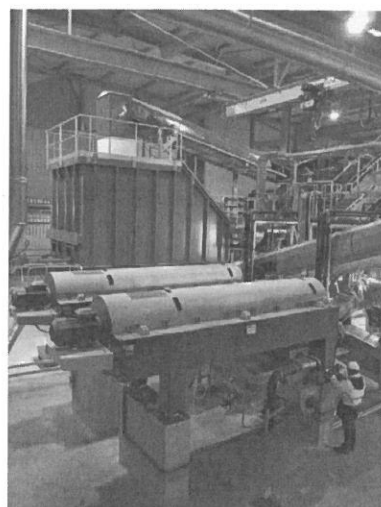


Figure 8: Centrifuges to remove digested organics <3mm (0.1')

This process has two advantages. It first helps to improve the quality of the compost by cleaning the organic matter of any undesirable element. But it also makes it possible to send more organic matter, be it more contaminated as well, to the digester since it will be refined very finely once digested.

The water used for dilution is recovered in the centrifuge step and recycled for dilution of incoming digestate. Only a small amount of excess liquid is removed from the process, and no fresh water is necessary.

4.4 Composting

The organic matter coming off the centrifuge is mixed with shredded green waste consisting of branches, grass clippings and leaves. This mixture is spread in aerobic maturation tunnels, which allow for drying and therefore initiating the composting phase of the material and gradually bringing it to maturity. After this stage, the compost is conveyed to one of the post-maturation boxes. After 3 weeks, it is turned and stored in a second box. This 'turning' makes it possible to aerate and to provide the oxygen necessary for the final stabilization of the compost.

The stabilized compost is then refined, sieved by a 2 cm fine mesh screen. The pieces >2cm (0.8") serve as bulking material and are mixed again with the organic matter coming from the centrifuge. The resulting compost is homogeneous and marketable.

Before being sold, it is analyzed to confirm compliance with the French NFU-norm for compost quality.

4.5 Results

The plant was started up and brought to nominal operation by the end of April 2016. It was commissioned end of August, 2016 and has been operating at full capacity since. After almost a full year of operation at full-scale of the SORDISEP technology, the results are proving that the process is performing and produces the required end products. Analyses of the different fractions are as follows:

4.5.1 Digestate

The end product after the DRANCO digestion (=digestate) is the input for the SORDISEP process. The digestate has following properties:

- Particle size: <50 mm (2")
- Overall composition:
 - TS: 31%
 - VS: 50%
 - pH: 8.5
- Composition on TS content:
 - Fine organic fraction < 3 mm (0.1"): 48-52%
 - Light materials > 3mm (0.1"): 35-40%
 - Heavy materials > 3mm (0.1"): 12-14%

See Figure 9.

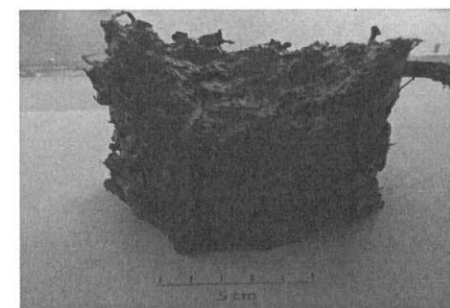


Figure 9 DRANCO digestate (from mixed waste)

4.5.2 Light fraction

During the SORDISEP process a 'light fraction' is produced, containing textiles, large fibers, woody material, plastics, etc. and has following properties:

- Particle size: <50mm (2") in 2 dimensions
- Composition:
 - Light plastics: 25-35%
 - Hard plastics: 5-20%
 - Synthetic textiles/fibers: 25-45%
 - Other: 15-25%
- Calorific value:
 - Lower combustion value: 12 MJ/kg (5,160 BTU/lb)
 - Higher combustion value: 14 MJ/kg (6,020 BTU/lb)

See Figure 10.

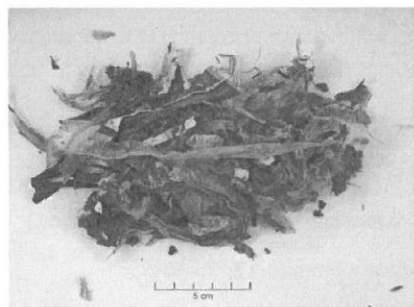


Figure 10 Light fraction after SORDISEP

4.5.3 Inerts

Inert materials are sorted out during the SORDISEP process. This material has the following composition:

- Particle size: < 50mm (2")
- Composition on TS content
 - Glass: 70-85%
 - Stones: 5-20%
 - Metals: 0-5%

- Other: 5-15%

The quality meets the clients' specifications for the definition of 'inert' nature (leachate test to determine soluble matter and TOC).

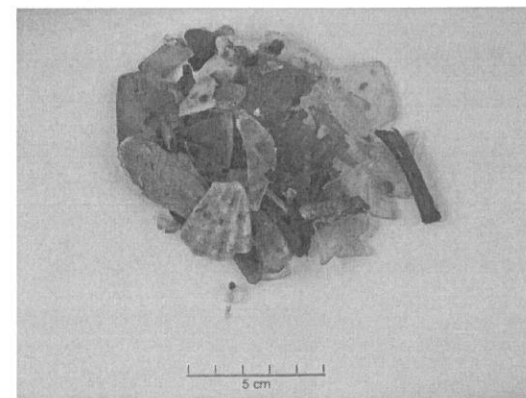


Figure 11 Inerts after SORDISEP

4.5.4 Compost

The final compost produced complies with the French NFU 44-051 norm. PCB's, petroleum based compounds (plastics) and pesticides as well as small inerts were all way below the limits. In Table 1, the values for heavy metals are shown.

Table 1 Compost values & French and USA norms for heavy metals

Metals mg/kg TS	Compost Bourg- en-Bresse mg/kg TS	Norm France mg/kg TS	Norm Ontario Class A mg/kg TS	Norm US EPA mg/kg TS
Arsenic	2.4	18	13	75
Cadmium	0.8	3	3	85
Chromium	67	120	210	3 000
Copper	126	300	400	4 300
Lead	66	180	150	840
Mercury	0.2	2	0.8	57
Nickel	57	60	62	420
Zinc	402	600	700	7 500

In Table 2, results for PCB's, pesticides, herbicides & petroleum are shown.

Table 2 Compost values & factor lower than standard

Product	Factor lower than standard*
PCB's	10-100
Pesticides	10-1000
Herbicides	100-1000
Petroleum based mineral oils	Absent

* Hawaii standard

Below, 2 pictures of the final compost from this facility can be found.

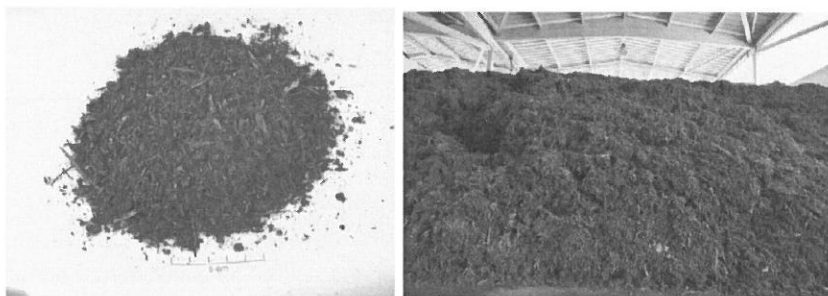


Figure 12 Final compost at the Bourg-en-Bresse facility

5 Conclusion

The primary purpose of the first generation MWPFs was to produce RDF. However, due to rising prices of raw materials, most facilities added upgrades or were revamped in order to increase the recovery of certain recyclables. The steady growth of MWPFs and the rising value of recyclables contributed to the growing sophistication and efficiency of processing equipment. Now with the addition of SORDISEP sorting and washing technology applied to the digestate from anaerobic digestion of the organic fraction of mixed, MWPFs continue to evolve and improve. Adding SORDISEP makes it possible to reach higher diversion rates and obtain more recoverable streams and to produce clean compost from mixed or residual waste.

The MWPF in Bourg-en-Bresse annually treats about 66 000 metric tons of mixed waste and 7 500 metric tons of green waste. Due to the implementation of a well-engineered

wet separation and cleanup process (SORDISEP), this plant is able to produce high quality compost from mixed household waste.

The compost is low in heavy metals (comparable to compost from *source separated organics*) and other contaminations are way below standards (herbicides, PCB's, PAH's & petroleum based mineral oils).

The heavy fraction (glass, stones,) is free of organics and plastics and can be recycled in road construction. The light fraction is free of glass and stones and has a high calorific value.

The production of a clean compost and recyclable fractions out of mixed waste organics is now feasible and represents a giant leap in the progress towards 'Zero Waste'.

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