LANDFILL MINING OF A MIXED MUNICIPAL SOLID WASTE AND COMMERCIAL WASTE LANDFILL: APPLICATION OF EXISTING PROCESSING TECHNOLOGY – OPPORTUNITIES AND LIMITATIONS

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Introduction

Several research projects on "landfill mining (LFM)" have been conducted in the past. Recent examples for these projects are "Landfill Mining Austria – Pilot Region Styria (LAMIS)"[1] and the LFM project "MINE" under the leadership of FCC Austria Abfall Service AG, which was co-funded by the Austrian Research Promotion Agency and conducted in cooperation with the Horizon 2020 project "EU MSCA-ETN NEW-MINE". The project "MINE" was initiated to find out whether it is possible to detect hotspots (volume elements that *e.g.* contain relatively high amounts of metals) inside a landfill and whether a separation of high value materials is possible using a state of the art mechanical-biological-treatment-plant on site. This plant was neither built nor especially adapted for the task of processing landfill mining material, in order to find out whether the built-in machines can handle the excavated material. Most importantly the potential economic risks and opportunities of such a project should be evaluated for a company contemplating a LFM project.

Materials and methods

The project involves the recovery of valuable material from an existing landfill site in Halbenrain (Austria), which was mainly used to deposit household and commercial waste. The sector of planned raw material recovery is located in a part of the landfill, which was filled in the years 1997-1999 and is currently in the aftercare phase. The project envisaged the experimental landfill mining of around 5,000 tonnes from a defined area of 2,000 m² of the landfill site. The excavated material was processed in the existing MBT plant at the project site. The generated output fractions were either sold or properly deposited at the extraction area.

Because accurate records of the amount of landfilled material have been available since the second half of 1990 and these have been carried out in digital form since 1997, statements on the composition of the landfill body could be made. In total, the landfill was filled with 62 wt% of commercial waste, 22 wt% of sludge (from galvanic processes, effluent sludge and tannery sludge) and 16 wt% household waste.

If one combines the information about the temporal and spatial separation with that of the materials delivered, different interesting areas of the landfill body could be distinguished. Afterwards an evaluation of each individual area with respect to its content was made. Based on these evaluations a promising landfill compartment was defined as a hotspot and chosen for the exploitation of landfill mining material. This hotspot is characterised by the fact that, with increasing depth, high metal concentrations were expected due to delivery recordings. The LFM material was excavated layer to layer. Each layer was then dried separately in a rotting tunnel to keep them separated. This way a spatial resolution is maintained.

Figure 1: Sampling point for the exploitation of landfill mining material

The landfill material was excavated by means of an excavator, transported to the processing plant with trucks and then filled into rotting tunnels. There it was dried prior to the mechanical treatment. The drying time was initially set to approximately one week. However, as described in the results section, it was found that a three week drying time was necessary in order to ensure a successful mechanical treatment. Figure 2 presents the processing scheme of the MBT plant. The processing of landfill material can be divided into three steps:

- Drying stage
- Coarse processing (> 60 mm)
- Fines processing (< 60 mm)

During the whole drying process, fresh air was used. For this drying stage three rotting tunnels were applied. The drying process lasted on average three and a half weeks.

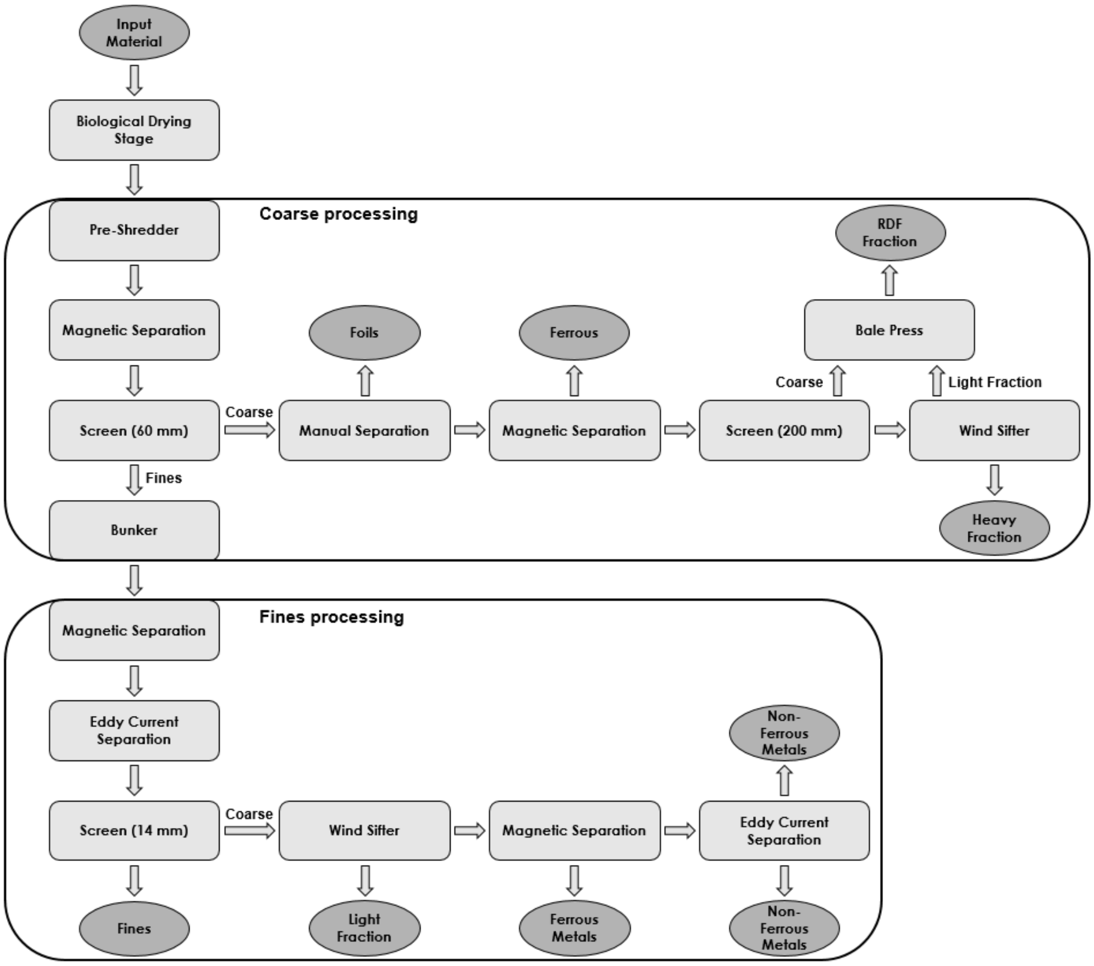

Figure 2: Processing scheme of the MBT plant on the landfill in Halbenrain, used within landfill mining project

The mechanical processing is divided into two stages, which were conducted on different days: “coarse processing” and “fines processing” (See Figure 2). After the biological drying stage, the material from each rotting tunnel (*ca.* 300 - 400 m³) passed the “coarse processing” stage at first. In this process a fines fraction (< 60 mm) was produced which was then stored in a bunker for one to three days until the “coarse processing” was finished and “fines processing” could be conducted. Afterwards the qualities of the non-ferrous metal products were analysed in a laboratory, determining the purity of the products. Additionally, trials with an eddy current separator were conducted with the fines < 14 mm. Within these trials non-ferrous metal products were produced.

Results

Excavations

During the excavation work low odour emissions were found and the stability of the embankment has proven to be problem-free. The space requirement for reaching the desired depth has been found to be larger than originally expected, since among other factors the quantity of covering material was underestimated.

Drying process

For the drying stage a residence time of one week was planned at first. During the tests it was found that this residence time was not sufficient, since the waste was still too wet to enable mechanical processing. As a result of this, at the beginning machines and conveyor belts clogged. In an iterative process, the residence time was extended to about three and a half weeks, so that mechanical treatment was possible.

Mechanical processing

The manual foil separation of high-density polyethylene (HDPE), polyethylene terephthalate (PET) and low-density polyethylene (LDPE) films was reduced after a week to the removal of LDPE foils since the remaining parts were marginal. The eddy current separation of the medium grain (14-60 mm) significantly improved the yield of non-ferrous metals. During the excavation a gas drainage was found. In doing so, stones were excavated, which subsequently caused increased wear on machine components. In combination with the clogging of different aggregates due to the initially too high humidity of the material from the biological drying stage, this factor had a negative effect upon the motivation of the employees. The plastic foil fraction exhibits considerable amounts of defilements. The influence on a possible use of this fraction as RDF is questionable. Although the plastic products obtained were contaminated, they did not undergo visual changes. The wind sifter heavy fraction (60 - 200 mm), which has not been further processed, contains a considerable amount of ferrous and non-ferrous metals. In particular, the amount of ferrous metals is significant but characterised by corrosion and impurities, *e.g.* plastic foils. The fines fraction contained sewage sludge as well as sludge from tanneries, which is in agreement with the documentation of the landfill. This is demonstrated by the high copper and aluminium content of the fine fraction. In Table 1 the quantities of all output fractions, produced throughout the complete “MINE” project, can be seen.

Table 1: Output quantities of mechanical processing stages within "MINE"

Fraction	tonnes	wt%
RDF fraction > 60 mm	408	13.2
Residuals	697	22.5
Ferrous metal products	65	2.1
Non-ferrous metal products	4	0.1
Windshifter light fraction	90	2.9
Fines (< 14 mm)	1312	42.4
Windshifter heavy fraction	186	6.0
Plastic foils (only produced during half of the process time)	23	0.7
Impurities (stones)	10	0.3
Material losses	296	9.6

Prediction of Hotspots

The mechanical processing results show that the predicted hotspots correspond to the amount of metals found in the layers. As predicted, increased metal concentrations were detected with increasing depth (Figure 3).

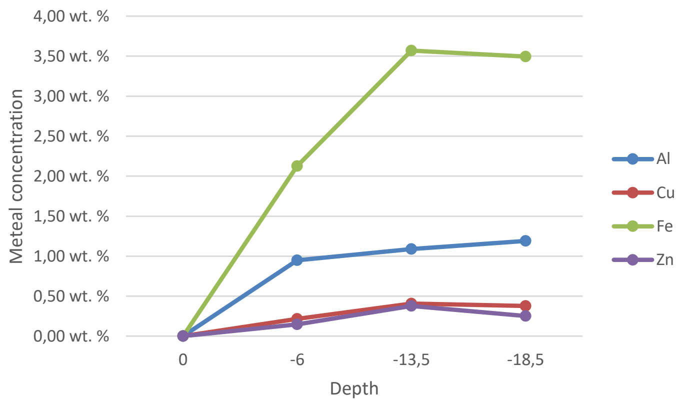

Figure 3: Amount of metals, found in increasing depth

Financial aspects

The analyses have shown that the non-ferrous metal concentrates produced are of marketable quality. The iron concentrates are of poor quality due to corrosion and because part of the contaminants from the conveyor belt were included into the ferrous fraction through the overband magnets. Due to the market price of 0 € for RDF at the time no profit could be made. Taking everything into consideration, the sole financing of LFM at the site in Halbenrain by the recycling of valuable materials using the MBT plant has proven to be impossible. The produced non-ferrous concentrates are promising, but quantities are too low to make their separation profitable. For the economic realisation of LFM projects of this size, the extraction of metals from the largest fraction < 14 mm is indispensable. However, the mechanical processing technology reaches its limits at this point. Further trials have shown that while concentrates can be produced, the quality of these is very poor. From this it can be concluded that, in an ideal case, further processing of the fines < 14 mm must be carried out wet-mechanically.

Risks and Dangers

From today's point of view, there is no negative impact on the environment at the site in Halbenrain, since hardly any gases that are harmful to the environment were emitted to the extent that this could be investigated with the available measurement methods. LFM can also be considered as non-problematic regarding work safety. It is also stated that the organics, if they are biodegradable, have been reduced to a large extent. As the only organic fraction, wood could be found to a greater extent in the wind sifter heavy fraction of 60 - 200 mm. An incalculable risk would be the discovery of hazardous waste, *e.g.* asbestos, dust or oil barrels, which could lead to health risks as well as environmental damage and thus highly increase expenses. This risk should be minimised when exploring the landfill and potentially contaminated areas should not be used for Landfill Mining projects.

Conclusion

With the available plant on site, landfill mining is theoretically possible. Though the current process does not enable an economically viable treatment of the tested landfill material. In order to enable economically viable processing of landfill material especially the treatment of the fine fraction < 14 mm has to be improved, showing great potential due to its high mass fraction. All in all, landfill mining will not be pursued in the near future on site.

Acknowledgement

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