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Recovery of glass contained in the heavy residual fraction of Portuguese mechanical Biological Treatment Plants

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A B S T R A C T

The aim of this work is the valorisation of the heavy residual fraction of Mechanical Biological Treatment (MBT) plants fed with mixed Municipal Solid Waste. This product contains a significant amount of glass. In the present work, it was found that the glass content in this product varies from plant to plant. Minimum and maximum values of 33 and 67% were determined. This material is not recycled today, being instead landfilled, because the contamination with other materials is so high that is not possible to process it by optical sorting, which is the end-of-line technology used in glass recycling. Nevertheless, it is possible to upgrade this product by removing a significant percentage of the stones, the main inert contaminant, with a simple and cheap process, RecGlass, which exploits the differences in the shape of glass particles and stones. This paper presents the results of a study carried out with samples of 5 Portuguese MBT plants of different characteristics. The fraction <5.6 mm, composed mainly by organic matter, was removed. The influence on the results of the main operational parameter, the belt inclination, and the samples' characteristics, composition and particle size were evaluated. In only one processing step, the samples with a glass content of 58–69% were upgraded. By removing 50–90% in weight of the stones, the concentrated product reached 63–97% in glass content.

1. Introduction

The increase in waste generation and the scarcity of natural resources and of the space needed to construct landfills are major concerns in many countries (Halvorsen, 2012). Mechanical Biological Treatment (MBT) is one of the strategies used in Europe to minimize the quantity of biodegradables landfilled (Lornage et al., 2007; Montejo et al., 2010; Pires et al., 2011; Tintner et al., 2010; Vellini and Savioli, 2009). In Portugal, for instance, in 2012, 15.7% of the Municipal Solid Waste (MSW), representing more than 410 thousand tons of waste, was sent to MBT plants (APA, 2013). MBT plants treat selectively collected biodegradable waste (green waste and/or food waste) or mixed MSW, consisting mainly of household garbage. In Portugal, in 2014, there are 7 plants fed with biodegradable waste and 14 fed with MSW.

The mixed waste contains a variety of items and materials besides organics. The plants that process this type of waste, besides recovering the recyclables, also produce biologically stabilized organic matter and primarily two types of solid residual fractions: the light residual fraction, which may be used to produce Refuse-Derived Fuel (RDF) and the heavy residual fraction (MBTr). Dias et al. (2014) characterized the MBTr produced in the 6 MBT plants working in Portugal in 2012 and showed that this product is composed mostly by glass (33–82%). They estimated that in the MBTr there were about 17,000 tonnes of glass. This value represents, approximately, 20% of the glass recycled in Portugal in the same year (Embopar, 2013). The glass in MBTr was landfilled because the glass Material Recovery Facilities (MRF) do not accept this product as it is, mainly due to the high content in contaminants like ceramics, organic materials and, most significantly, stones. Optical sorting, the main technology used in glass MRFs to remove infusible, is quite inefficient in terms of removing stones due to their roundness, which causes an erratic trajectory.

The equipment Recglass was developed to exploit the differences in shape of the particles of glass and stones, the main inert constituents of MBTr. Using one sample of MBTr, Dias and Carvalho (2012) showed that the equipment is efficient in upgrading in glass the MBTr by removing a significant percentage of stones. In the present paper, the applicability of the Recglass process to upgrade MBTr with different characteristics, namely composition and particle size distribution, is discussed. In the study, samples from the heavy residual fraction of 5 MBT plants in operation in Portugal

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were used. The differences in the samples are superimposed by the MBT plant feed characteristics, diagram and equipment parameters.

2. Methodology

2.1. Samples

The 5 samples of MBTr used in the study were supplied by the Portuguese plants that were operating in 2012 with MSW – AMARSUL (AS), RESIESTRELA (RE), SULDOURO (SD), VALNOR (VN) and VALORLIS (VL). Fig. 1 shows the location of the plants. Besides the equipment parameters and feed composition, the main differences between the 5 MBT plants are the type of biological treatment (SD and VL have aerobic and anaerobic treatment while the other plants use aerobic treatment only). The detailed characteristics of these plants can be seen in Dias et al. (2014).

The samples, weighing 35–60 kg, were collected by the plants' staff, who used the appropriate sampling standards to assure the representativeness of the samples. Fig. 2 shows the particle size distribution of the samples. Two of the samples (SD and VL) are quite coarse, with a particle size of over 16 mm in almost half of the sample. Two others (AS and VN) are fine products with particles no larger than 16 mm.

Fig. 3 presents the composition of the samples. The composition was determined manually by sorting the different materials. The following materials were identified: plastic, metal (ferrous and non-ferrous), glass, ceramic, brick, stones and "others". The class "others" is composed mainly of organic matter and materials that are difficult to identify. Plastic, metal, ceramic and brick, which appear in small percentages, were considered in the same class named CPBM.

The differences in composition in the 5 MBTr samples are determined mainly by the composition of the MBT feed, the upstream MBT plant diagram, the equipment parameters and by the existence of structuring material added in the biological process associated with a high moisture content (over 13%) can increase the

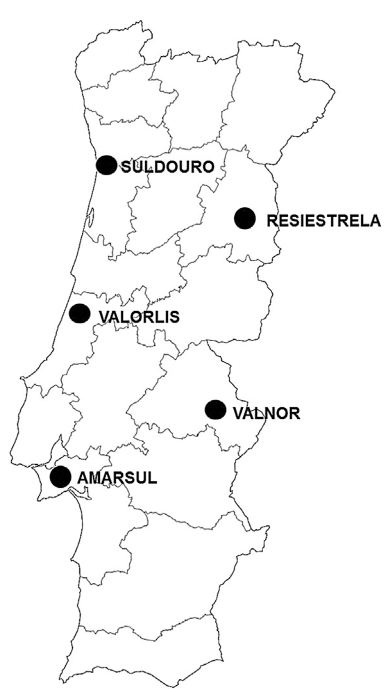

Fig. 1. Location of the MBT plants that supplied the samples for the study.

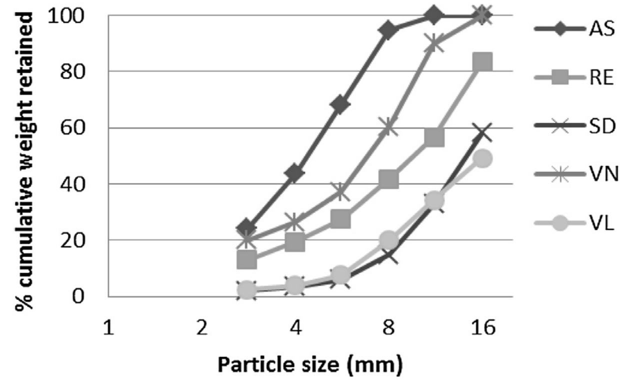

Fig. 2. Particle size distribution of the MBTr samples (Dias et al., 2011).

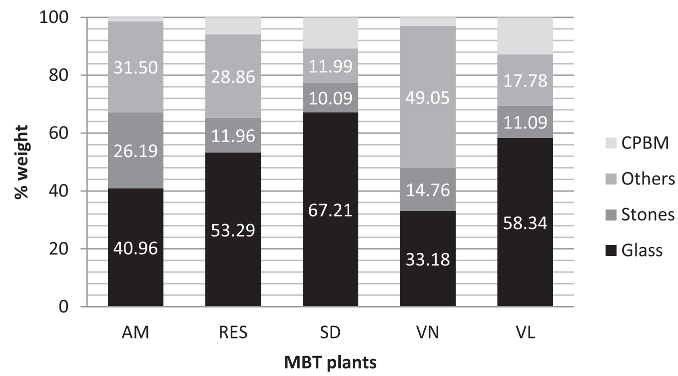

Fig. 3. Composition of MBTr samples (Dias et al., 2011).

content in organics that constitute the "others" class (as in AS and VN plants). The upstream sorting of glass bottles in the case of VN also contributes to the reduction of the glass content in the corresponding MBTr. Nevertheless, despite the low content in glass, VN MBTr is an interesting case study due to the large feed flow rate and consequent amount of glass landfilled. According to Dias et al. (2011), VN produced around 12,423 ton of MBTr in 2012, corresponding to about 4122 ton of glass that were landfilled.

The composition analysis by particle size fraction (Dias et al., 2014) showed that, excluding the +16 mm fraction, the glass content increases with particle size and the opposite occurs in the "stones" class. In the finer particle size fraction the "others" content is very high and the glass content is very low. Therefore, the particle size fractions below 5.6 mm were discarded for the present study.

Fig. 4, with the resulting composition ($MBTr_{>5.6}$), shows the obtained significant upgrade in glass after screening. The glass content increased significantly in all MBTr samples, with the exception of SD and VL's, which increased less than 2%, because in those plants less than 20% of the contaminants contained in MBTr are concentrated in the fraction lower than 5.6 mm while in the others plants is opposite.

2.2. Equipment – RecGlass

The RecGlass process was developed to separate the round stones from the flat particles of glass. It is a dry process, efficient in the particle size operating range between approximately 6 and 11 mm. As represented in Fig. 5A and B, its main part is an inclined belt moving upwards. The material of the belt guarantees a significant friction coefficient with the particles. The feed falls from a vibrating feeder and, when in contact with the moving belt, the

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