Waste Management xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Solid recovered fuel: An experiment on classification and potential applications

C. Bessi [a], L. Lombardi [b,*], R. Meoni [c], A. Canovai [c], A. Corti [d]

[a] Industrial Engineering Department, University of Firenze, via S. Marta 3, 50139 Firenze, Italy
[b] Niccolò Cusano University, via Don Carlo Gnocchi 3, 00166 Rome, Italy
[c] ASM S.p.A., via Paronese 104/110, 59100 Prato, Italy
[d] Department of Information Engineering and Mathematics, University of Siena, via Roma 56, 53100 Siena, Italy

ARTICLE INFO

Article history:
Received 30 January 2015
Revised 24 July 2015
Accepted 10 August 2015
Available online xxxx

Keywords:
Solid Recovered Fuel
Refuse Derived Fuel
Mechanical treatment
Residual Municipal Solid Waste
Characterization
Sampling

ABSTRACT

The residual urban waste of Prato district (Italy) is characterized by a high calorific value that would make it suitable for direct combustion in waste-to-energy plants. Since the area of central Italy lacks this kind of plant, residual municipal waste is quite often allocated to mechanical treatment plants in order to recover recyclable materials (such as metals) and energy content, sending the dry fractions to waste-to-energy plants outside the region. With the previous Italian legislation concerning Refuse Derived Fuels, only the dry stream produced as output by the study case plant, considered in this study, could be allocated to energy recovery, while the other output flows were landfilled. The most recent Italian regulation, introduced a new classification for the fuel streams recovered from waste following the criteria of the European standard (EN 15359:2011), defining the Solid Recovered Fuel (SRF). In this framework, the aim of this study was to check whether the different streams produced as output by the study case plant could be classified as SRF. For this reason, a sampling and analysis campaign was carried out with the purpose of characterizing every single output stream that can be obtained from the study case mechanical treatment plant, when operating it in different ways. The results showed that all the output flows from the study case mechanical treatment plant were classified as SRF, although with a wide quality range. In particular, few streams, of rather poor quality, could be fed to waste-to-energy plants, compatibly with the plant feeding systems. Other streams, with very high quality, were suitable for non-dedicated facilities, such as cement plants or power plants, as a substitute for coal. The implementation of the new legislation has hence the potential for a significant reduction of landfilling, contributing to lowering the overall environmental impact by avoiding the direct impacts of landfilling and by exploiting the beneficial effects of energy recovery from waste.

1. Introduction

The European strategy for waste management imposes as a priority order for waste management: "prevention; preparing for re-use; recycling; other recovery, e.g. energy recovery; and disposal" (Directive 2008/98/EC). In this frame, landfills have a residual role and are devoted to pre-treated wastes. Energy recovery is the route to be followed for those streams of waste for which material recovery is not effectively applicable. Residual Municipal Solid Waste (MSW), the stream left downstream of the source-sorted collection of urban waste, has no potential for material recovery – with the exception of metals – and its appropriate destination is energy recovery (Lombardi et al., 2015). In most European countries, residual MSW is already suitable for energy recovery by direct combustion, having average heating values of about 10 MJ/kg (Reimann, 2012). However, in other cases, a different strategy may be followed, based on pretreatment of residual MSW, and eventually being mixed with appropriate industrial waste, in order to produce a refined stream with improved combustion characteristics (i.e., increasing the heating value by reducing moisture and ash contents) and technical and environmental parameters. The high heterogeneity of residual MSW, due to both seasonal and local factors, greatly influences the composition of mechanical and biological treatment plants (MBT) output streams, which are typically: a combustible fraction, a wet fraction to be stabilized, sorting residues and metals to be recovered (Di Lonardo et al., 2012). The combustible stream may be used in waste-to-energy (WtE) plants, but the real advantage (Cimpan and Wenzel, 2013) is the possibility of feeding it to other

* Corresponding author.
E-mail address: lombardi.lidia@gmail.com (L. Lombardi).

http://dx.doi.org/10.1016/j.wasman.2015.08.012
0956-053X/© 2015 Elsevier Ltd. All rights reserved.

industrial plants such as cement kiln plants or thermal power plants, replacing solid fossil fuels.

The interest of European industry, primarily cement plants, in alternative energy sources to fossil fuels has led to the editing of a long series of technical standard references for Solid Recovered Fuel (SRF) production, sampling, analysis and characterization, mainly in the range of norms UNI CEN/TS 15357-15747 (Rada and Andreottola, 2012).

Such standardization, carried out by the CEN, through the 343 Committee, has enabled the creation of a common language with which producers and consumers, but also other stakeholders, can speak. The standardization of SRF also helps to promote its use, while ensuring a level of environmental protection at least equivalent to the traditional fossil energy it is trying to replace. Public acceptance of WtE plants may also benefit from transparency with regard to the origin of incoming waste and the guarantee of a high level of environmental protection deriving from SRF standardization (Gawlik et al., 2007).

The standardization at the European level has not concerned the end-of-waste issue, but instead remits the legislation to the individual member states (Talola, 2014).

The use of SRF in cement factories could provide environmental benefits (reduction of both greenhouse gases and NOx/SOx emissions), in addition to following the objective of energy recovery and landfill reduction. Contrariwise, some SRF features, such as the content of chlorine, mercury, lead and cadmium, are worse than in fossil fuels and require the implementation, if not present, or adjustments of the flue gas treatment system for abatement of micro pollutants (Rada et al., 2014).

A problem not to be underestimated for high quality SRF production, suitable for co-combustion in thermal power plants or cement plants, is the cost uncertainty (Rada and Andreottola, 2012). SRF producers have no guarantee of stability in market demand and prices and, for the most part, the producer has to pay the user. Furthermore, the commitment to sampling and analysis has increased, and therefore the associated costs. However, there are some cases, such as in the experience of Austrian cement plants, where users are charged for supplying SRF (Sarc and Lorber, 2013).

The need for an effective and cheap process control, to guarantee product uniformity, has also driven the development of rapid methods for process control in support of the analytical results obtained by applying the standardized methods (Rotter et al., 2011).

The quality of input material is another important factor for SRF. Both source-sorted waste collection and the matter recovery targets, set in national legislation and the EU Waste Framework Directive, are closely connected with the SRF quality issue. In particular, high levels of source-sorted collection, such as biowaste, metals and glass, make a significant contribution to residual waste characteristics in terms of Net Calorific Value (NCV) and contaminant elements. In regions with efficient source-sorted collection of biowaste, residual waste may already have suitable characteristics to be classified as recovered fuel of an acceptable quality. A little homogenization treatment is, however, required (Rada and Zatelli, 2014). In this context, door-to-door waste collection is the collection type that gives the best performance (Rada and Ragazzi, 2014).

In Italy, a new regulation related to SRF was recently introduced, giving new opportunities for energy recovery, including for those waste streams which, on the basis of the previous laws, would have been landfilled. Indeed, the technical standard reference for SRF (EN 15359:2011) allows as many as 125 types of classification for this waste. This suggested that an investigation should be carried out with the aim of characterizing and classifying, by a sampling and analysis campaign, all the different output waste streams originating from an existing waste mechanical treatment plant. Other studies have been carried out in order to evaluate the application of the new SRF characterization and specification method, by analyzing the output of different processing streams from mechanical treatments (Franzese et al., 2014; Gallardo et al., 2014).

Generally, when the mechanical treatment of MSW is applied, one main stream, characterized by improved energy content, is produced and addressed to energy recovery. Other streams exiting from the mechanical treatment are: metals, effectively recovered; a wet stream, which after aerobic biostabilization may be used for site restoration or more likely for landfill daily cover; and residual streams which are generally landfilled. However, all the exiting streams may also have non-negligible energy content, especially when the entering MSW already has high NCV. The landfilling of waste streams with high energy content should be avoided as far as possible, partly because of its negative environmental impact, but mainly because of the low recovery of resources from this option (Gallardo et al., 2014). If the strategy of MSW mechanical treatment is selected in a given territory, it is thus important to understand which streams exiting from the treatment are suitable for energy recovery, beside the main one, and can then be diverted from landfilling, reducing the overall environmental impact also thanks to the beneficial effect deriving from the recovery processes. With this purpose, in this study, we analyzed as a study case the waste mechanical treatment plant located in the town of Prato in central Italy. The district has about 250,000 inhabitants and it is characterized by an intensive textile industrial district, operating in the textile regeneration and in the most recent "ready-to-wear" clothes production from synthetic fabric managed by the Chinese community. About 90,000 t of residual MSW are produced per year, vs about 80,000 t of source-sorted collection per year (reporting year: 2014). The plant receives both residual MSW, about 89,000 t/y, and industrial waste, about 4000 t/y, vs a maximum authorized input treatment capacity of 150,000 t per year. The plant also treats recyclables, about 3700 t/y (reporting year: 2014), in particular plastics and metals from multi-material source-sorted collection.

This study reports the investigation of the mechanical treatment output flows originating from this plant and illustrates the methods and techniques adopted for their classification and characterization.

2. Materials and methods

The waste mechanical treatment plant of this study has been operating since 2000. Over the years, there has been continuous upgrading of the treatment lines, until reaching the current plant configuration for refined SRF production. It consists of (Fig. 1): a primary slow rotation shredding, a magnetic separation of metallic parts, and a rotary drum sieve for the separation of the fraction larger than 50 mm (dry fraction) and the fraction smaller than 50 mm (wet fraction). The wet fraction is sent on a conveyor belt for loading on trucks and is transported to other plants for aerobic biostabilization. The dry fraction continues the treatment with: a secondary slow rotation shredding, this additional shredding being necessary because of the high textile waste content in order to make the waste suitable for processing; a ballistic separation of the heavy discarded fraction from the light fraction. From the heavy fraction a flow of magnetic and non-magnetic matter is recovered by an Eddy Current Separator (ECS). The light fraction is refined by three fast shredders with output dimension control (50 and 30 mm grids) in order to obtain fluff SRF. If necessary, the SRF can also be compacted, increasing its specific weight by appropriate devices.

Please cite this article in press as: Bessi, C., et al. Solid recovered fuel: An experiment on classification and potential applications. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.08.012