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The application of SRF vs. RDF classification and specifications to the material flows of two mechanical-biological treatment plants of Rome: Comparison and implications

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ABSTRACT

This work assessed the quality in terms of solid recovered fuel (SRF) definitions of the dry light flow (until now indicated as refuse derived fuel, RDF), heavy rejects and stabilisation rejects, produced by two mechanical biological treatment plants of Rome (Italy). SRF classification and specifications were evaluated first on the basis of RDF historical characterisation methods and data and then applying the sampling and analytical methods laid down by the recently issued SRF standards. The results showed that the dry light flow presented a worst SRF class in terms of net calorific value applying the new methods compared to that obtained from RDF historical data (4 instead of 3). This lead to incompliance with end of waste criteria established by Italian legislation for SRF use as co-fuel in cement kilns and power plants. Furthermore, the metal contents of the dry light flow obtained applying SRF current methods proved to be considerably higher (although still meeting SRF specifications) compared to those resulting from historical data retrieved with RDF standard methods. These differences were not related to a decrease in the quality of the dry light flow produced in the mechanical-biological treatment plants but rather to the different sampling procedures set by the former RDF and current SRF standards. In particular, the shredding of the sample before quartering established by the latter methods ensures that also the finest waste fractions, characterised by higher moisture and metal contents, are included in the sample to be analysed, therefore affecting the composition and net calorific value of the waste. As for the reject flows, on the basis of their SRF classification and specification parameters, it was found that combined with the dry light flow they may present similar if not the same class codes as the latter alone, thus indicating that these material flows could be also treated in combustion plants instead of landfilled. In conclusion, the introduction of SRF definitions, classification and specification procedures, while not necessarily leading to an upgrade of the waste as co-fuel in cement kilns and power plants, may anyhow provide new possibilities for energy recovery from waste by increasing the types of mechanically treated waste flows that may be thermally treated.

1. Introduction

In the last two decades, hundreds of mechanical-biological treatment (MBT) facilities were built in Europe to treat residual municipal solid waste (MSW) (Lornage et al., 2007; Dunnu et al., 2009; Ponsá et al., 2010; Tintner et al., 2010). The treatments performed in these plants are aimed at reducing the environmental impacts and risks to human health related to waste landfilling, in compliance with the targets set by the European Landfill Directive 1999/31/EC (European Commission, 1999). In addition, the mechanical treatments performed in MBT plants allow to recover valuable materials such as iron and aluminium and to produce waste derived fuels, i.e. waste flows enriched in materials presenting a high calorific value (plastics, paper, cardboard and wood) that are employed for energy recovery (Rotter et al., 2004; Bezama et al., 2007; Garg et al., 2007; Di Lonardo et al., 2012a; Velis et al., 2010).

Currently in Italy, mechanical-biological treatment plants are authorised to produce the so-called refuse derived fuel (RDF), the

Abbreviations: ar, as received; BSW, biostabilised waste; CI, confidence interval; CTI, Italian Thermotechnical Committee; d, dry; DLF, dry light flow; EoW, end of waste; GCV, gross calorific value; HR, heavy rejects; MBT, mechanical-biological treatment; MSW, municipal solid waste; NCV, net calorific value; RDF, refuse derived fuel; SD, standard deviation; SR, stabilisation rejects.

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characteristics of which were defined up until recently by the Italian technical standard UNI 9903-1 (2004). This standard established two classes of RDF (RDF or RDF-Q) as a function of the calorific value (>15 or >20 MJ/kg), moisture (<25 or <18%) and ash content (<20% or 15%) of the waste. Specifications regarding the total content of a few toxic metals were also laid down by this standard (UNI 9903-1, 2004).

The definition of RDF and its classification methods were abrogated by the issuing of Italian Legislative Decree 205/2010 and replaced with those referring to solid recovered fuel (SRF), as an implementation of EU Directive 2008/98/EC (European Commission, 2008). The characteristics, definitions and analytical methods to follow for SRF classification and specifications are reported in the technical standard UNI EN 15359 (2011). The latter is the Italian version of the European Standard EN 15359 prepared by CEN's Technical Committee (TC) 343. Specifically, SRF is defined as the solid fuel obtained from non-hazardous waste through specific treatments (i.e. processed, homogenised and upgraded to a quality that can be traded amongst producers and users) in order to be employed as a fuel in combustion and co-combustion (including-waste to-energy) plants (Rada and Andreottola, 2012). The classification system for SRF is based on limit values of three properties:

- The mean net calorific value (NCV), expressed in MJ/kg of as received (ar) waste, representing the economic parameter.
- The mean chlorine content, expressed as weight % of the dry (d) waste, representing the technological parameter.
- The median and 80th percentile values of the mercury content, expressed in mg/MJ of as received (ar) waste, representing the environmental parameter; in this case the class is determined by the highest of the two statistical values.

For each parameter, 5 classes with different limit values were defined as shown in Table 1. Therefore, considering all possible combinations, 125 classes of SRF may be identified. Beside these three properties, other relevant characteristics (i.e. specifications) should or may be obligatorily (particle shape and size, moisture, ash and toxic metal contents) or voluntarily (such as bulk density, volatiles, major and trace elements contents) specified. No limits are reported for such parameters in the UNI EN 15359 (2011) standard and each Member States may independently set them.

Regardless of the classification criteria employed, it should be considered that the characteristics and quality of waste-derived fuels are site-specific. In particular, they depend upon the MSW management strategies adopted in the area, including the type and percentage of at source separate collection. For instance, an efficient separate collection of materials like PVC and thermometers could respectively reduce the Cl and Hg contents of residual MSW and improve the SRF class related to these two parameters (Rada and Ragazzi, 2014). In addition, recycling markets and the types of technologies employed in MBT facilities may affect the composition and hence classification of the final waste-derived fuel (Rotter et al., 2004; Velis et al., 2010; Wagland et al., 2011; Di Lonardo et al., 2012a). Consequently, one of the main critiques that was raised against RDF classification and specifications was that they were input-driven, that means they were affected by the variability of the input waste composition and thus could not guarantee against a good waste performance upon thermal treatment (Juniper, 2005). The new definition, classification and specification parameters of SRF were hence shifted to the requirements of the final user, i.e. are market-oriented so to try to improve the marketability of waste-derived fuels (Juniper, 2005; Gawlik et al., 2007; Velis et al., 2010). For this reason, a much wider range of calorific values, while anyhow taking into account of environmental and technical parameters, are considered for SRF as compared to RDF. In addition, also the values of specification parameters are not pre-established but are to be set on the basis of the user's requirements. As for potential end-users of SRF, cement kilns and power plants, as well as dedicated combustion plants have been indicated in several studies (e.g.: Garg et al., 2007; Velis et al., 2010; Sarc et al., 2014). Co-combustion in cement production plants seems to be the most suitable option since wide ranges of SRF classes can be used without negative effects on the final cement product and with reduced GHG emissions compared to traditional fuels (Garg et al., 2009; Velis et al., 2010; Kara, 2012; Gallardo et al., 2014; Samolada and Zabaniotou, 2014). Instead, the use as co-fuel in power plants, even if feasible, requires higher SRF quality, generally restricted to classes 1 and 2 of each of the three classification parameters (Dunnu et al., 2009; Garg et al., 2009; Velis et al., 2010). Finally, mono-combustion plants may be an interesting option for SRF presenting a lower quality (Velis et al., 2010). It has to be stressed that the choice of the final SRF user is greatly affected by local waste management strategies and market policies, as well as by public acceptance, especially in the case of waste-to-energy plants (Garg et al., 2009; Psomopoulos, 2014).

In Italy, end of waste (EoW) criteria to qualify SRF as a fuel were introduced by the Italian Ministerial Decree 22 (2013). The latter establishes that not all the possible 125 classes are suitable to classify SRF as a fuel but only combinations of the following: 1, 2 or 3 for NCV and Cl, and 1 or 2 for Hg. Moreover, maximum limit values of the toxic metals indicated by the UNI EN 15359 (2011) are set. In addition, the norm establishes that the use of SRF as fuel is only allowed for co-combustion in cement plants and in thermal power plants presenting a capacity higher than 50 MW. For SRF presenting class codes not compliant with Italian EoW criteria possible end-users are waste to energy plants and dedicated combustion plants.

In view of the new policies on waste-derived fuel come recently into force in Europe and Italy, in this study an evaluation of SRF versus RDF classification and specifications was performed by focusing on the outputs of two MBT plants operating in the city of Rome. Specifically, the quality of the dry light waste flow (until now defined as RDF) for a first classification and specification in terms of SRF was assessed. In addition, the quality of two reject flows produced in the MBT plants was evaluated in terms of SRF classification and specifications as well. Moreover, different material flows were simulated by assuming to mix the dry light fraction and the two reject flows on the basis of the composition of each type of waste and the mass balance of the MBT plants in order to

Table 1
Classification system for solid recovered fuel (UNI EN 15359, 2011).

Classification parameter	Statistical measure	Unit	Classes				
			1	2	3	4	5
NCV	Mean	MJ/kg ar	⩾25	⩾20	⩾15	⩾10	⩾3
Chlorine	Mean	% *d*	⩽0.2	⩽0.6	⩽1.0	⩽1.5	⩽3
Mercury	Median	mg/MJ ar	⩽0.02	⩽0.03	⩽0.08	⩽0.15	⩽0.50
	80th percentile	mg/MJ ar	⩽0.04	⩽0.06	⩽0.16	⩽0.30	⩽1.00

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