Waste Management xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Waste Management

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

# Investigation into the non-biological outputs of mechanical–biological treatment facilities

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ARTICLE INFO

*Article history:*
Received 23 May 2015
Revised 11 September 2015
Accepted 12 September 2015
Available online xxxx

*Keywords:*
Mechanical–biological treatment
Optimisation
Material quality
Contamination

ABSTRACT

Mechanical–biological and biological–mechanical treatment (MBT/BMT) are effective methods for reducing biogenic additions to landfill, producing fuel products and recovering recyclate from residual waste. However, large amounts of contamination in the non-biological outputs reduce their market value. The aim of this study was therefore to identify the principal drivers and barriers to the marketability of ferrous metals (MBTFe) and heavy inert rejects (MBTr) recovered from four UK MBT/BMT plants. The plants were either using biodrying or anaerobic digestion (AD-MBT) for biological processing. Samples were collected at the different recovery stage processes and characterised for elemental composition and particle size distribution. Results showed that processes at the two biodrying plants produced MBTFe with 10% less contamination by non-target materials than the two AD-MBT plants. Further to this, approximately 10% of the MBTFe fraction sampled at all four facilities comprised non-target material which had become entrapped in the folds of metal food containers. A possible cause is waste comminution in the cutting gap of the low-speed high-torque cutting mills. Upgrading MBTFe outputs could save the UK MBT/BMT industry up to £4.4 million per annum which equates to £230,000 per annum for an average sized facility (i.e. capacity 108,000 tpa). Glass content in the MBTr samples ranged between 44% and 62%, however all plants showed approximately 85% combined content of glass, bricks, stones and ceramics. The biodegradable content in the MBTr samples indicated that only minimal upgrade would be required to achieve the Landfill Directive requirements for inert waste. Again valorisation of MBTr could save the UK MBT/BMT industry up to £1.9 million pa which equates to £160,000 per annum for an average sized facility.



## 1. Introduction

The European Landfill Directive (ELfD) (EC, 1999) is driving the UK waste management industry to develop a range of treatments to reduce biogenic additions to landfill. One technological approach is mechanical–biological and biological–mechanical treatment (MBT/BMT) which, since 2007, has been successfully implemented across 22 plants in the UK with a combined treatment capacity of >2.3 million t of residual municipal solid waste (MSW) per annum (Fig. A.1 and Table 1). The Green Investment Bank (2014) has estimated that by 2020, MBT capacity will increase by >50%; accounting for approximately 15% of the UK's residual waste treatment capacity. MBT/BMT plants incorporate a range of mechanical and electromagnetic processing components which can be configured in different combinations to meet the specific objectives of the plant (Banks et al., 2010). Broadly, they can be grouped into two major categories: mechanical–biological treatment (MBT) and biological–mechanical treatment (BMT) (Fig. 1; Wiemer and Kern, 1995; Velis et al., 2010).

### 1.1. BMT facilities

BMT (biodrying) facilities incorporate a front-end stage in which shredded residual MSW is partially composted for between 7 and

*Abbreviations:* AD, anaerobic digestion; BD, biodegradable; BG, brown glass; BMT, biological–mechanical treatment; CG, clear glass; Defra, Department for Environment, Food and Rural Affairs; ELfD, European Landfill Directive; FM, ferrous metal; GBSC, non-recyclable glass, bricks, stones and ceramics; GG, green glass; M, metal; MBT, mechanical–biological treatment; MBT/BMT, mechanical–biological and biological–mechanical treatment; MBTFe, mechanical–biological treatment ferrous metal fraction; MBTr, mechanical–biological treatment heavy reject fraction; MC, moisture content; MRF, materials recovery facility; MSW, municipal solid waste; NBOM, non-biological output materials; NCO, non-combustible other; OBM, over-band magnet; pa, per annum; POC, plastic and other combustibles; PRN, packaging recovery note; PSD, particle size distribution; PSF, particle size fraction; rpm, revolutions per minute; SWOT, strengths, weaknesses, opportunities and threats; T, textiles; TOC, total organic carbon; tpa, tonnes per annum; USEPA, United States Environmental Protection Agency; VS, volatile solids; WDF, waste derived fuel; WEEE, waste electrical and electronic equipment; WFD, Waste Framework Directive.

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http://dx.doi.org/10.1016/j.wasman.2015.09.014
0956-053X/

**Table 1**
Overview of operational MBT/BMT facilities in the UK.

| Plant Ref. | Operator | Facility name | Location | Technology provider | Biological process used | Design capacity (tpa) |
|---|---|---|---|---|---|---|
| 1 | Amey Cespa | Waterbeach | Cambridge | BAM Nuttall/ Kelag | Composting | 179,000[a] |
| 2 | Biffa | Hoods Close | Leicester | Not specified | AD | 100,000[a] |
| 3 | Global Renewables Lancashire | Farington | Leyland | UR – 3R Process® | AD/Composting | 170,000[e] |
| 4 | Global Renewables Lancashire | Thornton | Fleetwood | UR – 3R Process® | AD/Composting | 170,000[e] |
| 5 | Hills Waste | Northacre | Westbury | Entsorga | Biodrying | 60,000[f] |
| 6 | John Wade | Aycliffe Quarry | Darlington | Not specified | Biodrying/composting | 50,000[h] |
| 7 | Levenseat Ltd | Levenseat Waste Management Site | Lanark | Not specified | Composting | 60,000[i] |
| 8 | New Earth Solutions | Avonmouth | Bristol | Not specified | Composting | 200,000[d] |
| 9 | New Earth Solutions | Canford | Wimborne | Not specified | Composting | 75,000[d] |
| 10 | New Earth Solutions | Cotesbach | Leicestershire | Not specified | Composting | 50,000[d] |
| 11 | Shanks | Frog Island | London | Ecodeco® | Biodrying | 180,000[a] |
| 12 | Shanks | Jenkins Lane | London | Ecodeco® | Biodrying | 180,000[a] |
| 13 | Shanks | Hespin Wood (Northern Resource Park) | Carlisle | Ecodeco® | Biodrying | 75,000[b] |
| 14 | Shanks | Sowerby Woods (Southern Resource Park) | Barrow | Ecodeco® | Biodrying | 80,000[c] |
| 15 | Shanks | Locharmoss | Dumfries | Ecodeco® | Biodrying | 65,000[a] |
| 16 | SITA | Byker Reclamation Plant | Newcastle | Not specified | Composting | 85,000[h] |
| 17 | Veolia | Southwark | London | WTT Germany | Biodrying | 87,500[a] |
| 18 | Viridor | Reliance Street | Manchester | Enpure | AD (includes pre-pasteurisation) | 100,000[g] |
| 19 | Viridor | Longley Lane | Manchester | Eggersmann Haase | AD | 130,000[g] |
| 20 | Viridor | Cobden Street | Salford | Eggersmann Haase | AD | 70,000[g] |
| 21 | Viridor | Bredbury Park Way | Stockport | Enpure | AD | 110,000[g] |
| 22 | Viridor | Arkwright Street | Oldham | Enpure | Output is transferred for AD | 110,000[g] |

Although the mechanical treatment processes in Plant 22 are similar to those in plants 18–21, the biological outputs are not processed on site but transported to another facility. It has therefore been included in the list as the material undergoes the same treatment as other MBT/BMT plants.
Three other facilities have been reported as operational but are not included in this table. The Western Isles Integrated Waste Management Facility which is operated by Comhairle nan Eilean Siar Council was originally constructed as a MBT plant, however due to operational difficulties the plant has been reconfigured as a materials recovery facility accepting dry recycling and an AD plant accepting source segregated municipal solid waste (MSW) (Cambell Personal communication). The facility operated by Organic Waste Management Ltd. was also reported as being operational however this study found that construction has not commenced (Brookes Personal communication). The Viridor facility reported to be operating near Northwich had its funding withdrawn in 2012; construction did not commence.
After: Eunomia (2014), Defra (2013b) and Ibbetson (2006) except:
[a] Defra (2013b).
[b] Shanks (2013a).
[c] Shanks (2013b).
[d] New Earth Solutions (2014).
[e] Global Renewables (2014).
[f] Hills (2014).
[g] Mannall and Chinn (2011).
[h] SKM Enviros (2010), Bains and Robinson (2012).
[i] Sullivan (2013).

15 days in containers, closed halls or rotating drums (Robles-Martínez et al., 2012). The heat from the exothermic decomposition evaporates moisture from the surface of waste particles and the moisture is then transported between the waste fragments via mechanical aeration (Frei et al., 2004). The biodried material, which undergoes mechanical separation, is a dry shredded matrix that has been reduced in mass and volume, and has considerably lower adhesive properties making mechanical processing easier (Velis, 2010). A drawback of primary comminution (size reduction of as-received waste prior to material separation) is that finer, brittle particles such as glass can become embedded into softer materials, such as textiles, paper, and food, and thus affect output product specification (Barton et al., 1985; Tchobanoglous et al., 1993).

The main output of biodrying facilities, waste derived fuel (WDF), retains a large proportion of the dried biogenic material from the input waste (Velis et al., 2009) and will also include materials such as plastics, man-made fibre textiles, as well as metals and inert material which have not been removed by other separation processes. Exports of WDF from the UK to Europe have increased in recent years from 11,000 t in 2010 to over 2.2 million t in the first six months of 2014 (EA, 2014b), with a small portion of WDF produced remaining within the UK for use in existing waste-to-energy facilities (Lets Recycle, 2015). Biodrying is therefore an attractive option for waste disposal authorities because only a very small proportion of the material is landfilled which helps them to meet the UK's next ELfD target, to reduce the biodegradable fraction of waste sent to landfill to 35% of 1995 levels by 2020 (EC, 1999).

### 1.2. MBT facilities

In MBT type facilities, the mechanical separation takes place before biological treatment (Bardos, 2004). As with BMT plants, material undergoes comminution prior to mechanical separation.

The biological stages in MBT plants include composting and anaerobic digestion (AD). Whilst composting fulfils the requirements of the ELfD, AD has the additional advantage of biogas production which can be used to generate electricity and hence attract subsidies in the form of renewable obligation certificates (The Renewables Obligation Order, 2002). This type of power generation also helps England achieve its target to generate 15% of its energy through renewable sources by 2020 (DECC, 2011).

Please cite this article in press as: Cook, E., et al. Investigation into the non-biological outputs of mechanical–biological treatment facilities. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.09.014