Waste products – RDF or SRF as energy source in EU

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Abstract

The aim of the report is to evaluate the mechanical pre-treatment of non-sorted and partly sorted municipal solid waste by carrying out the analysis of waste composition and properties using different sorting lines in Latvia. The authors determined the parameters of separated components (calorific value (NCV), moisture, ash content, carbon, nitrogen, hydrogen, sulphur, chlorine, metals). All the parameters were determined using the EN Standards. The morphological content was determined by manually sorting. The results of sorting the Flow 1 – non-sorted municipal waste, consists of 33.6% of biological waste, 10.0% of paper and cardboard, 11.5% of plastic and 5.5% of glass and other components. Flow 2 – has less paper and plastics as ~15% of them were sorted at the source. Municipal waste collection cannot avoid the bio mass waste in the Flow 3 (there were separately collected 62%), but their content is the smaller – 14%. Moisture was 27%, ash content – 11% and NCV – 17 MJ kg^{-1} in Flow 3. It was concluded that biologically degradable waste separation at the source is necessary to lower moisture and ash content and higher heating value for potential fuel production from waste.

Keywords: refuse derived fuel, solid recovered fuel, waste to energy, municipal solid waste, pre-treatment.

Introduction

The use of separated organic part as a fuel can be considered as one of the solutions to reduce amount of the landfilled waste. Production of refuse derived fuel (RDF) and solid recovered fuel (SRF) from municipal solid waste shall play a strategic role in an integrated waste management system and are discussed according the European Union (EU) action plan for the Circular Economy. Therefore following the EU waste hierarchy principles ‘waste to energy’ can deliver `win-win` results with the EU energy and climate policy [1].

One of the pre-treatment technologies for municipal non-hazardous waste is mechanical-biological waste treatment (MBT). The technology has strongly evolved during the past two decades. Today, there are over 100 plants operating in Europe using some form of mechanical biological treatment on residual wastes. Many of them are located in Baltic States. The National Waste Management Plan of Latvia for 2013–2020 provided the installation of mechanical biological treatment equipment in all waste management regions to prepare waste for composting, co-incineration or other treatment method where no waste sorting is established at source. In 2016 according to data of Latvian Environment, Geology and Meteorology Centre [2], 550 thousand tons of non-sorted municipal solid waste (EU waste code: 200301) are collected in Latvia, which is potential material for mechanical pre-treatment lines. The author`s previously experiments [3, 4] shows, that non-sorted municipal waste after pre-treatment can be used as material for fuel production. The aim of the article is to evaluate the mechanical pre-treatment of non-sorted and partly sorted municipal solid waste by carrying out the analysis of waste composition and properties using different sorting lines in Latvia.

The SRF is a fuel produced from non-hazardous waste and sampled, tested in accordance with EU standards for SRF, especially EN15359. The RDF is a non-defined term and refers to waste that has not undergone proper processing and is not standardized than SRF [5]. RDF (EU waste code: 191210) is imported in Latvia since 2008 according to data of Latvian Environment, Geology and Meteorology Centre. 105 thousand tons of RDF were imported in 2015, 123 in 2014, 102 in 2013 and 123 in 2012. Whereas there were only 23 thousand tons of RDF produced in 2015 in Latvia.

The quality of SRF is summarized in three parameters: mercury (indicating environmental impact), chlorine (indicating technical behaviour) and net calorific value (indicating the performance) (Table 1) [6]. Combustion of waste fuels with a high chlorine content can cause corrosion, slagging and fouling in boilers [7]. The presence of chlorine can also increase emissions of hydrochloric acid and cause the formation of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans. Mercury can escape with the flue gas upon combustion due to its high vapour pressure and volatility [8]. Because of its middle and long term negative impacts on health, mercury has been recognised as one of the most significant global environmental pollutants [9].

Table 1. The system of solid recovered fuel classification (adapted from: LVS EN 15359:2012 [6]).

Classification characteristic	Statistical measure	Unit	Classes				
			1	2	3	4	5
Net calorific value (NCV)	Mean	MJ/kg	≥25	≥20	≥15	≥10	≥3
Chlorine (Cl)	Mean	%	≤0.2	≤0.6	≤1.0	≤1.5	≤3
Mercury (Hg)	Median	mg/MJ	≤0.02	≤0.03	≤0.08	≤0.15	≤0.50
	80th percentile	mg/MJ	≤0.04	≤0.06	≤0.16	≤0.30	≤1.00

Methods

Sorting effectiveness of the automatic sorting equipment (screener and separator of metal) for the non-sorted and partly sorted waste were detected in cooperation with "Viduskurzemes waste management organization" Ltd. Only two municipalities (out of 119) are using separated collection of biological (including kitchen) waste from apartment houses in Latvia. The company mentioned above is collecting waste into one of those municipalities (Broceni) and also is producing fuel from waste. The experimental truckloads of the collected waste (biological and partly sorted) were selected from the apartments in Broceni town in autumn season, when the population of Latvia consumes the most fruits and vegetables [10]. Each truckload were weighed and the mass balance were established. A representative waste samples (approximately 20 % of the load) were taken with the grab method. Coning and quartering were used as methods for sample reduction. Manual sampling were used as a sampling procedure. The parts of income waste were selected by following main types – paper and cardboard; plastics; biological waste (include wood); fine particles (<20 mm); textile, rubber and leather; metal; glass, inert and other.

In order to prepare representative samples for laboratory analysis, the samples were grained and formed. The detection of the parameters of the waste materials were conducted within the laboratory of the Institute of Physical Energetics. The following parameters for coarse fraction were determined using the Standards:

- moisture content – LVS EN 15414-3:2011;
- net calorific value – LVS EN 15400:2011;
- chlorine content – LVS EN 15408:2011;
- sulphur content – LVS EN 15408:2011;
- ash content – LVS EN 15403:2011;
- content of trace elements (As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Tl, V and Zn) – LVS EN 15411:2012;
- content of major elements (Al, Ca, Fe, K, Mg, Na, P, Si, Ti) – LVS EN 15410:2012;
- C, H, N content – LVS EN 15407:2011.

The energy content was measured using a bomb calorimeter *Berthelot Mahler C.Co.* The equipment used for elemental analysis was a *Thermo Scientific FlashEA 1112*. For metal analysis was used spectrometer *CLR-7K' XRF*.

There were compared tree flows of collected municipal waste:

1) Non-sorted municipal waste (Flow 1);
2) Partly sorted municipal waste with low content of paper and plastics (Flow 2) – paper and plastics are separated at source (data were adapted from previous research [3, 4];
3) Partly sorted municipal waste with low content of biological waste (Flow 3) – biological waste (kitchen and green waste) is separated at source.

Each of flows were sorted by mechanical sorting line:

- Flow 1 – sorting line consisting of shredder, drum screener and magnetic separator;
- Flow 2 – sorting line consisting of shredder, disc screener and magnetic separator (data was adapted from previously research [3, 4];
- Flow 3 – sorting line consisting of bag breaker, drum screener and magnetic separator and manually sorting for reject material (stones, electrical waste, hazardous waste) and recyclables material (PET, cardboard; glass, aluminium packaging; metal).

Results and Discussions

1. Composition of income municipal solid waste

Table 2 represents the income composition of each of municipal solid waste flow.

Table 2. Composition of incoming municipal solid waste (mass, %).

Content	Flow 1	Flow 2	Flow 3
Fine particles (<20 mm)	27.5	50.2	30.2
Biological waste	33.6	19.9	14.2
Paper / Cardboard	10	6.1	15
Plastic	11.5	10.1	18.3
Textile, rubber, leather	4.4	4.7	6
Other	1.7	0.8	2.6
Glass	5.5	5.4	6.7
Metal (ferrous)	1.6	1.7	2.7
Metal (non-ferrous)	2.3	0.4	0.3
Inert	1.9	0.9	4

The results of sorting the Flow 1 - non-sorted municipal waste, consists of 33.6% of biological waste, 10.0% of paper and cardboard, 11.5% of plastic and 5.5% of glass and other components. Flow 2 has less paper and plastics as ~15% of them were sorted at the source. Municipal waste collection cannot avoid the bio mass waste in the Flow 3 although there were separately collected 62% of mass. However, their content is smaller than in Flows 1 and 2.

Data of previous research of the household waste composition in Latvia [11] shows that amount of biological waste is 48-51% (mass); paper – 12-13%; plastic – 7-8%; glass – 7-8%; metal – 3-5%; fine – 6-10%; other – 7-15%. Recent research of the collected household waste composition [12] shows that average waste composition is: biological waste – 39%; paper – 8%; plastic – 13%; glass – 9%; metal – 3%; fine – 12%; other – 16%.

2. Fractions of mechanically pre-treated municipal solid waste

Table 3 presents the fractions of municipal solid waste flows after mechanical sorting.

Table 3. Fractions of municipal solid waste after mechanical pre-treatment for flows 1-3.

Fractions	Flow 1 After drum screener (mass %)	Flow 2 After disc screener (mass %)	Flow 3 After drum screener (mass %)
Coarse fraction	53 (>60 mm)	22 (>80 mm)	68 (>60 mm)
Medium fraction	-	40 (25-80 mm)	-
Fine fraction	45 (<60 mm)	35 (<25 mm)	30 (<60 mm)
Metal	2	3	2

Fine fraction in Flow 3 (30%) is less of that in Flow 1 (45%). It can be explained by separation of biological waste at source and not use of a shredder before a screening, in that way supporting manual separation (especially for a glass).

About 20% reject material and recyclables material were manually separated from a coarse fraction of Flow 3: 10% glass, 1.7% PET, 4% cardboard; 0.5% aluminium packaging, 0.6% metal; 2.3% stones and ceramics; food waste 1.3%. It shows good sorting results for a rest of the coarse fraction, as there are practically no glass and metal waste within it (as an undesirable admixture for production of SRF).

3. Characterization of the content of coarse fraction

The average data of the content of municipal waste after the sorting shows that coarse fractions are potentially useful for preparing RDF or SRF. The pre-treatment using separation lines are reducing inorganic components of coarse fraction as metals, glass and stones and rising organic part as paper, plastics, textile, rubber and leather. The separated fractions in Flow 3 have lower moisture and ash content and higher heating value as it is shown in Table 4.

Table 4. The mean values of the parameters of coarse fractions.

Coarse Fractions	Moisture, %	NCV, MJ kg^{-1}	Ash, %	Cl, %	S, %	N, %	C, %	H, %
After drum screener in Flow 1	33	14	13	0.7	0.4	0.3	46	5.9
After disc screener in Flow 2	35	15	13	0.95	0.2	0.2	50	7.1
After drum screener in Flow 3	27	17	11	0.7	0.1	0.4	51	8.2

The ash content is related to the additional restrictions limiting the use of waste material for co-incineration kilns. The ash from biomass burning can be used as fertilizer, taking in to account its content, but adding it to the RDF or SRF, the content of heavy metals and other pollutants can overcome the stated limits. Table 5 presents the analyses of ash from separated coarse fractions.

Table 5. Chemical content of ashes for coarse fractions after screeners.

Element	Unit	Coarse fraction after drum screener in Flow 1	Coarse fraction after disc screener in Flow 2	Coarse fraction after drum screener in Flow 3
Hg	mg kg^{-1}	≤0.4	≤0.5	≤0.1
Cd	mg kg^{-1}	0.7	0.8	0.1
Tl	mg kg^{-1}	≤0.3	≤0.3	≤0.1
Br	M.-%	0.002	0.008	0.0001
I	M.-%	≤0.001	≤0.0008	≤0.0001
Sb	mg kg^{-1}	3	9	18
As	mg kg^{-1}	≤0.4	≤0.6	≤0.2
Cr	mg kg^{-1}	24	13	19
Co	mg kg^{-1}	7	6	2
Cu	mg kg^{-1}	26	38	14
Pb	mg kg^{-1}	9	22	5
Mn	mg kg^{-1}	136	130	37
Ni	mg kg^{-1}	5	10	6
Sn	mg kg^{-1}	108	6	18
V	mg kg^{-1}	≤13	≤14	≤10

Conclusions

The mean energetic parameters for pre-treated mechanically sorted coarse fraction in Flow 3 responds to limits stated for 3th class of SRF. Results showed that pre-shredding and screening of the wet non-sorted or partly sorted municipal solid waste by the equipment of waste separation do not ensure preparation of qualitative material for production of the fuel. Such materials only after drying and additional separation can be used as energy source in cement kilns or co-incineration plants using biomass and SRF.

The biologically degradable waste separation at the source is necessary to lower moisture and ash content and higher heating value for potential fuel production from waste.

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