Machinery for preparing different qualities of RDF

Martin Wellacher and Rudolf Pretzler

KOMPTECH Research Center GmbH, St. Michael i.O., Austria

Abstract

The present situation in waste management in the European Union shows dynamic development of waste treatment technology. To accomplish the European Waste Directive waste treatment is essential for enhancing recycling and recovery and reducing disposal. The work was performed by means of visits to RDF plants, interviews of operating personal followed by calculations of mass balances and economical indices. Three types of RDF were defined according their qualities, "RDF light", "RDF classic" and "RDF premium". Each type was defined by summarizing three applications. A design recommendation for a ballistic-separator dominated RDF plant is given. Due to the reduced and different machinery this plant shows advantages related to a wind-sifter dominated plant. The differences in energy demand run up to -27%, in investment -23% and in operating costs -22%. Meanwhile two new RDF plants are built in Hagenbrunn, Lower Austria, A, and in Bernburg, Saxony, D, according the proposed technology.

Keywords

Waste, treatment, refuse derived fuel, shredder, ballistic separation, wind-sifting

1 Introduction

The present situation in waste management in the European Union shows dynamic development of waste treatment technology. To accomplish the European Waste Directive (ANONYMUS 2008) waste treatment is essential for enhancing recycling and recovery and reducing disposal. Reliable machine technology was developed in recent years (WELLACHER & PRETZLER 2007) in order to treat mixed waste materials like municipal solid waste (MSW) or commercial waste materials and to gain useful by-products. Refuse derived fuel (RDF) as one of the main by-products of these waste materials is widely used for replacing conventional fossil fuels for heat and electricity production for public and industrial needs.

RDF is offered in different qualities with a net calorific value >10 MJ/kg coming mainly from the components plastics, paper, wood and textiles. The quality is determined by the proper combination and exclusion of input waste materials and the proper machinery used for the treatment. Low quality RDF is incinerated in grid incinerators, medium quality RDF in industrial heat supply incinerators and high quality RDF in cement plants, power plants and lately also in steal mills (BÜRGLER 2008).

However recent years development shows considerable changes of quality demands. Whereas in 2001 high quality RDF was pelletized with a particle size <10 mm, in 2004 most of the produced RDF was non-pelletized with particle sizes <30 mm or <80 mm. Today a dynamic market with declining prices demands permanent flexibility of treatment plants for their incineration-business partner.

The European Union produced 26,2 million tons (Tg) plastic waste in 2004 (BÜRGLER, 2008). The disposal rate of it was 65% in 2004, so the potential for recycling and recovery runs up to 17 Tg. The other 35% are mainly prepared to RDF, 3,5 Tg of it in Germany (ZAHLTEN 2008). The preparation technology consists primarily of mechanically working machinery to ensure low treatment costs. By these means RDF is gained through separation of contaminants and other by-products.

2 Methods

The work was performed by means of visits to RDF plants, interviews of operating personal followed by calculations of mass balances and economical indices.

RDF plants treat a wide range of waste materials, like

- MSW and its by-products, e.g. oversize material
- Mixed commercial wastes with calorific values >10 MJ/kg and its by-products, e.g. light material from wind-sifters
- Mono-fraction commercial wastes, e.g. carpets, plastic films; these fractions are often used to pre-design certain parameters of a certain RDF quality
- Separate collected packaging waste and its by-products, e.g. sorting residues

State of the art RDF plants often use wind-sifters to separate contaminants and other by-products from RDF. In Figure 1 a schematic drawing of such an example RDF plant is shown. Figure 2 shows the output material ratios of such a plant using MSW and commercial waste materials as input materials.

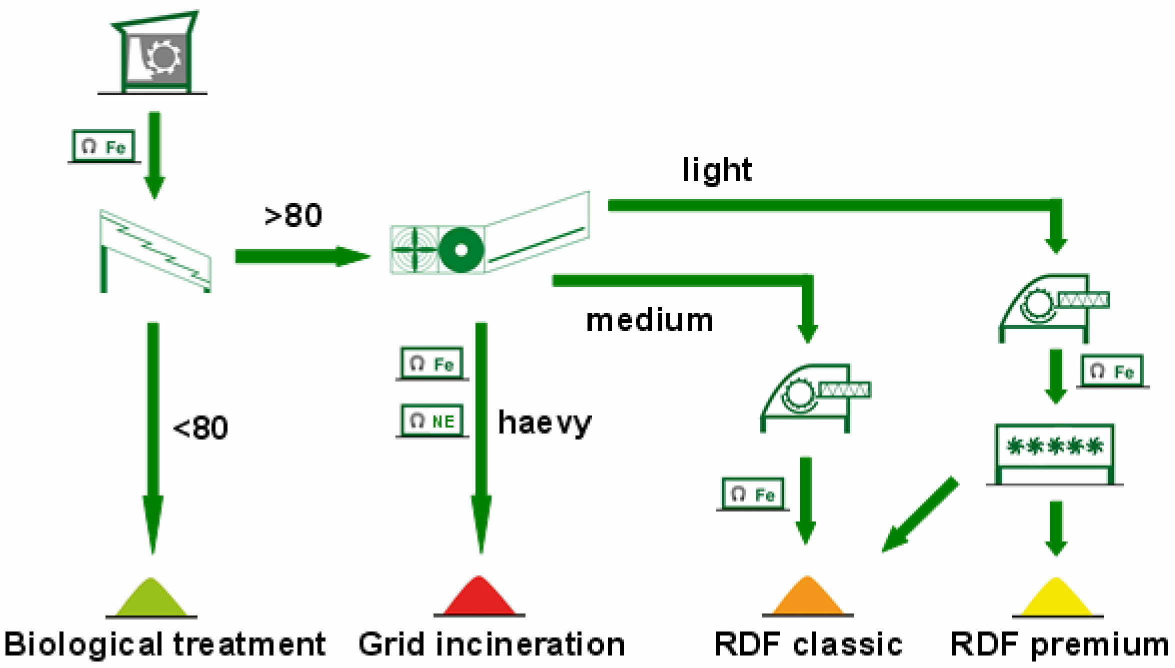

Figure 1 Example state of the art RDF plant, wind-sifter dominated

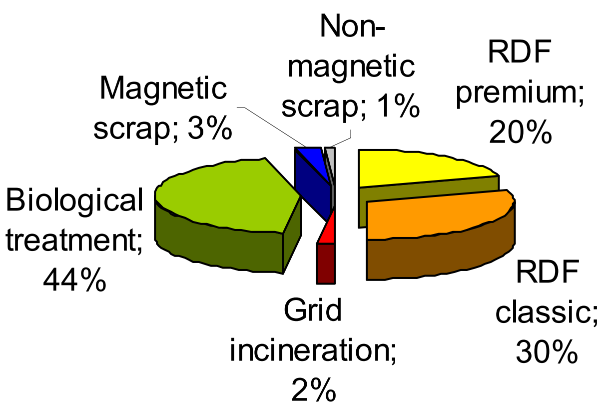

Figure 2 Output materials ration of wind-sifter dominated RDF plant

A comparison was made between a wind-sifter dominated technology versus a ballistic separator dominated technology in terms of energy demand, investment and operating costs. Profits and fees for the input and output materials are not included in the operation cost calculation. The input parameters of this comparison are shown in Table 1.

Table 1 Input parameters for the energy demand, investment and operating cost calculations

Input material	Calorific commercial waste	130.000 Mg/a
		20 Mg/h
Manipulation means	2 Loaders	8.750 h/a (in all)
Plant operation hours		7.200 h/a
Personal	Foremen	3
	Workers	12
Energy costs	Diesel	1 €/l
	Electricity	0,23 €/kWh
Wear & service	Construction	1% p.a. of investment
	Machinery	5% p.a. of investment
Interest		5% p.a.
Amortisation	Construction	20 a
	Machinery	10 a
	Loaders	15.000 h

3 Results

Three types of RDF were defined according their qualities, “RDF light”, “RDF classic” and “RDF premium”. Each type was defined by summarizing three applications, which are shown in Table 2 to Table 4.

Table 2 “RDF light” qualities, examples and summary

	Niklasdorf, A (RESCH 2007)	**WSO4, Vienna, A** (PROCHASKA 2004)	**Vattenfall, Rüdersdorf, D** (BANDILLA 2008)	**Summary** “RDF light”
Lower calorific value [MJ/kg]	12,5	13,5-14,5	12-16	**12-16**
Particle size [mm]	<120	50-250	<300	**<300**
Oversize ratio [%]	-	-	-	**<3**
Contamination ratio with inert materials [%]	-	4	<3	**<3**
Chlorine content [%]	<1	1	<1	**<1**
Ash content [%]	-	22	-	**-**

Table 3 “RDF classic” qualities, examples and summary

	Lenzing, A (BÖHMER ET AL. 2007)	**Cement kiln, D** (ANONYMUS 2009)	**Cemex Calcinator, Rüdersdorf, D** (WIRTHWEIN 2008)	**Summary** “RDF classic”
Lower calorific value [MJ/kg]	11,4	18	12-16	**12-18**
Particle size [mm]	<80	<40	20-25	**20-100**
Oversize ratio [%]	-	-	-	**<2**
Contamination ratio with inert materials [%]	<1	-	-	**<1**
Chlorine content [%]	-	<1	<0,8	**<0,8**
Ash content [%]	-	-	-	**<20**

Table 4 “RDF premium” qualities, examples and summary

	Stadtwerke Flensburg, D (OETJEN-DEHNE & KALVELAGE 2007)	**Cement kiln, D** (ANONYMUS 2009)	**Cemex cement kiln, Rüdersdorf, D** (WIRTHWEIN 2008)	**Summary** “RDF premium”
Lower calorific value [MJ/kg]	11-24	21-26	22-25	**>22**
Particle size [mm]	<50	20-25	20-25	**20-50**
Oversize ratio [%]	-	<10	-	**<10**
Contamination ratio with inert materials [%]	-	-	-	**<1**
Chlorine content [%]	<0,6	-	<0,8	**<0,8**
Ash content [%]	<30	-	<10-12	**<12**

To produce these summarized RDF qualities certain technologies are available which ensure the specific quality demands, see Table 5.

Table 5 Technologies for RDF preparation

	RDF light	RDF classic	RDF premium
Lower calorific value [MJ/kg]	Screening	Screening/ Wind-shifting/ Ballistic separation	Material selection/ Screening
Particle size [mm]	Shredding	Shredding/ Screening/ Wind-shifting/ Ballistic separation/ Fine shredding	
Oversize ratio [%]	Shredding	Fine screening	
Contamination ratio with inert materials [%]	Magnetic separation	Magnetic separation/ Eddy current separation	
Chlorine content [%]	Material selection	Near infrared sorting/ Material selection	
Ash content [%]	-	Screening	Material selection

A plant design recommendation can be given according the outcomes shown in Table 5, see Figure 3. This plant shall be able to produce all three types of RDF and shows flexibility towards possible future changes of the quality demands as well as towards changes of the input material qualities.

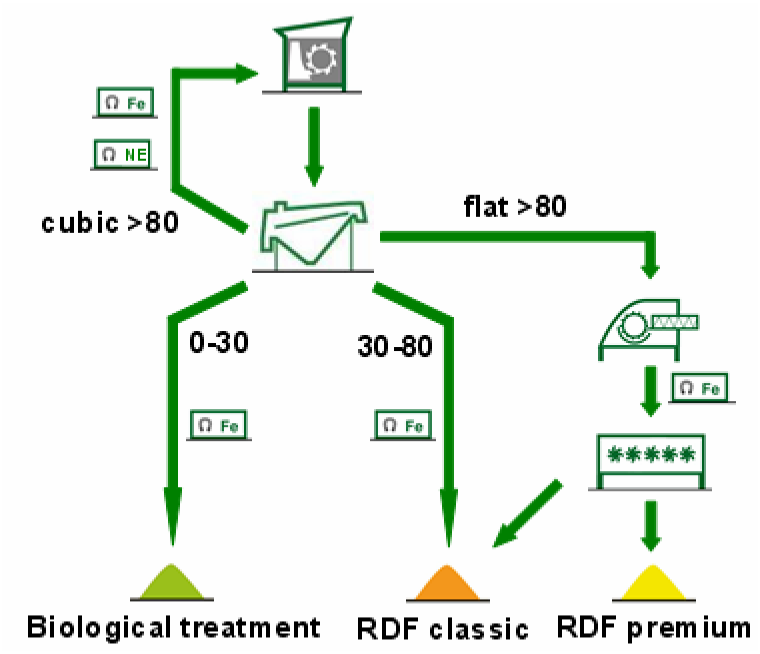

Figure 3 Ballistic-separator dominated RDF plant

The output rations of the ballistic-separator dominated RDF plant in Figure 4 show differences compared with the wind-sifter dominated RDF plant in Figure 2, e.g. the lack of a grid incineration fraction.

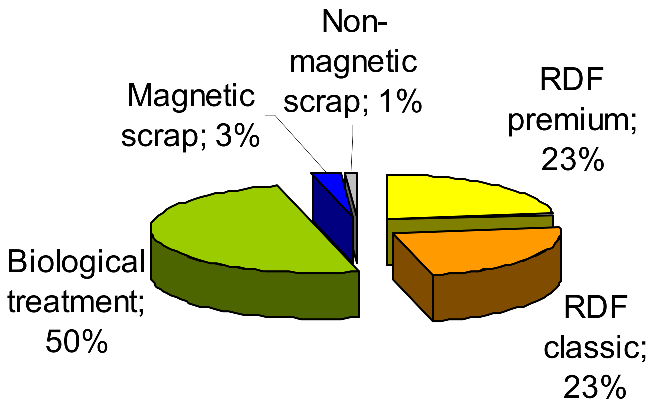

Figure 4 Output ratios of by-products of the ballistic-separator dominated RDF plant

Due to the reduced and different machinery a ballistic-separator dominated plant shows advantages related to a wind-sifter dominated plant. The differences in energy demand run up to -27%, in investment -23% and in operating costs -22%. Figures are shown in Table 6.

Table 6 Comparison of ballistic-separator dominated technology versus wind-sifter dominated technology

	Ballistic separation	**Wind sifting**
Specific investment [€/Mg]	35	43
Specific energy demand [kWh/Mg]	5,2	6,6
Specific operation costs [€/Mg]	18	22

4 Discussion

The advantages of a ballistic-separator dominated RDF plant is not only based on the replacement of the wind-sifter by a ballistic separator but additionally by use of an advanced pre-shredding technology reducing oversize >100 mm to <5wt%. Cubic materials from the ballistic separator can be recycled to the shredder after scrab separation. Each pre-shredding-cycle reduces the former cubic fraction to 50% by directing the other 50% to the undersize fraction of the ballistic separator. This prevents grid incineration fractions alike those produced with the wind-sifter dominated RDF technology.

Additionally found there were better scrap qualities in ballistic separator dominated RDF technology because metal wires which are mainly responsible for the adhesion of non-metal materials are separated to the flat fraction. Even they are metallic they do not harm the fine shredder for their thickness is low. After fine shredding they easily can be removed by usual magnet technology as they are now small pieces.

Pertinent machine development together with examination of the quality demands of RDF and by-products enables modern waste treatment plants to operate at lower energy demand and lower costs. Meanwhile two new RDF plants are built in Hagenbrunn, Lower Austria, A, and in Bernburg, Saxony, D, according the proposed ballistic-separator dominated RDF technology.

5 Literature

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Author’s address*:*

Dr. Martin Wellacher
KOMPTECH Research Center GmbH
Murfeld 3
A-8770 St. Michael i.O.
Telefon +43 3843 35 381 190
Email: m.wellacher@komptech.com
Website: www.komptech.de