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Deliverable 3.4
Report on comparison of produced RDF/SRF with technical specifications and suggested modifications
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LIFE+ PROJECT NAME or Acronym

ENERGY WASTE

Data Project

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Project:
Energy exploitation of non-recyclable urban waste in a sustainable waste –to –energy market "ENERGY WASTE"

LIFE09 ENV/GR/000307

Report title:
Deliverable 3.4 Report on comparison of produced RDF/SRF with technical specifications and suggested modifications

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Summary:

The main scope of the project is the development and demonstration of a lab scale gasification facility for the conversion of Refuse Derived Fuel into syngas, with high energy content. As the inlet material stream quality plays a key role in the gasification process the analysis of the material properties is a key issue for the design and optimisation of the lab scale gasifier. For this reason, the following analyses, which are necessary for the characterisation of RDF properties, were carried out:

- Proximate analysis (water, ash volatiles, fixed carbon),
- Ultimate Analysis (C,H,N,O,S,Cl)
- Heating value
- Thermogravimetric Analysis

Based on the fuel analysis data presented, a process model of the gasifier is developed and tested. Process modeling is a useful tool in the design of a thermal process installation, while it also supports the investigation of the ongoing reaction mechanisms. Based on the fuel analysis data thermodynamic calculations are carried out, in order to predict the gasifier's operational behavior and the whole energy and mass balance.

RDF/SRF fuels are categorized mainly based on three important properties: Net Calorific Value, Chlorine content and Mercury content. Each is considered an indicator of the fuel's economic, technical and environmental performance and valued in range from 1 to 5, with 5 being the best.

The purpose of this action is to categorize the produced fuel based on the results of the Action 3.3, to compare it with other European waste fuels and to offer suggest for modifications of the production chain in order to comply with the needs of potential end-users.

Methods employed

The categorization of the produced fuel will be based on the results of the analyses of Action 3.2. Average values, as well as minimum, maximum and standard deviations for each measured quality will be recorded. Apart from the three critical parameters (NCV, Cl, Hg), other values that affect utilization will also be considered, e.g. moisture and ash content.

Comparison with other commercial RDF/SRF fuels will be performed based results of Action 1.2 and direct communication with other producers or end-users established through Work Package 2.

Finally, the database for the produced fuel properties will be linked with measured deviations in the input waste stream (e.g. fuel from different sources) or processing methods. Based on these, a set of measures for improving the quality of the fuel, according to CEN/EN 343, will be developed.

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Contents

1 Introduction

RDF/SRF fuels are categorized mainly based on three important properties: Net Calorific Value, Chlorine content and Mercury content. Each is considered an indicator of the fuel’s economic, technical and environmental performance and valued in range from 1 to 5, with 5 being the best.
The purpose of this deliverable is to categorize the produced fuel based on the results of deliverable 3.3, to compare it with other waste fuels of different plant setups and to offer suggestions for modifications of the production chain in order to comply with the needs of potential end-users.

2 RDF Classification

2.1 Calculation of RDF classification values [1]

Mathematic analysis for RDF classification values:

Calorific Value

The classification of calorific value is made on basis of the upper limit of the 95% confidence level of the the equation below:

$$\mathrm{X} = \overline{\mathrm{X}} \pm 1,96 \times \frac{\mathrm{s}}{\sqrt{\mathrm{n}}}$$

where:

X	Upper or lower limit of 95% confidence level
$\overline{X}$	Mean value of all lots
1,96	Characteristic constant for the normal distribution
s	Standard deviation
n	Number of values

The values obtained for the calculation of categorization value of calorific value are lower calorific value as received.

Mean Value

Mean value of Net Calorific value is given from the equation below:

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{14{,}40 + 16{,}41 + 12{,}47 + 13{,}96 + 11{,}17 + 14{,}61 + 12{,}29 + 12{,}17 + 14{,}91 + 10{,}84 + 12{,}73 + 15{,}39}{15} +$$

$$+ \frac{11{,}62 + 9{,}19 + 11{,}99}{15} = 12{,}94 \quad MJ/kg(ar)$$

Standard Deviation

The standard deviation is given from the equation below:

$$s = \sqrt{s^2} = \sqrt{\frac{1}{n}\sum_{i=1}^{v} X_i^2 - \overline{X}^2} = \sqrt{\frac{14{,}40^2 + 16{,}41^2 + 12{,}47^2 + ... + 9{,}19^2 + 11{,}99^2}{15} - 12{,}94^2} = 1{,}95 \ \ MJ / kg(ar)$$

Upper confidence level of Net Calorific Value

The value of the upper confidence level, according to which the final classification of RDF is made, is given from the equation below:

$$X = \overline{X} + 1{,}96 \cdot \frac{s}{\sqrt{n}} = 12{,}94 + 1{,}96 \cdot \frac{1{,}95}{\sqrt{15}} = 13{,}93 \ \ MJ / kg(ar)$$

Chlorine concentration

The classification of chlorine concentration is made on basis of the lower limit of the 95% confidence level of the the equation below:

$$\mathrm{X} = \overline{\mathrm{X}} \pm 1{,}96 \times \frac{\mathrm{s}}{\sqrt{\mathrm{n}}}$$

where:

X	Upper or lower limit of 95% confidence level
$\overline{X}$	Mean value of all lots
1,96	Characteristic constant for the normal distribution
s	Standard deviation
n	Number of values

The values obtained for the calculation of categorization value of chlorine concentration are in dry basis.

Mean Value

Mean value of chlorine concentration in dry basis is given from the equation below:

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{0{,}34 + 0{,}64 + 0{,}43 + 0{,}49 + 0{,}49 + 0{,}24 + 0{,}18 + 0{,}21 + 1{,}02 + 0{,}73 + 0{,}63 + 0{,}74 + 0{,}14}{15} +$$

$$+ \frac{0{,}67 + 0{,}59}{15} = 0{,}50 \ \ mg / kg(dry)$$

Standard Deviation

The standard deviation is given from the equation below:

$$s = \sqrt{s^2} = \sqrt{\frac{1}{n}\sum_{i=1}^{v} X_i^2 - \overline{X}^2} = \sqrt{\frac{0{,}34^2 + 0{,}64^2 + 0{,}43^2 + \ldots + 0{,}67^2 + 0{,}59^2}{15} - 0{,}50^2} = 0{,}25 \;\; mg/kg(dry)$$

Lower confidence level of Chlorine concentration

The value of the lower confidence level, according to which the final classification of RDF is made, is given from the equation below:

$$X = \overline{X} + 1{,}96 \cdot \frac{s}{\sqrt{n}} = 0{,}50 - 1{,}96 \cdot \frac{0{,}25}{\sqrt{15}} = 0{,}38 \;\; mg/kg(dry)$$

Mercury Concentration

In the case of mercury, the highest value between the median and the 80th percentile value is used for classification.

Median value

In the following table the sorting from minimum to maximum of mercury concentration values in mg/MJ (ar) is given:

A/A	Mercury concentration mg/MJ (ar)
1	0,003983
2	0,004814
3	0,006161
4	0,007098
5	0,007769
6	0,011804
7	0,014607
8	0,015957
9	0,016519
10	0,017602
11	0,023588
12	0,03085
13	0,036134
14	0,076174
15	0,085128

The median value is the 8th value. Finally median is:

Median = 0,015957 mg/MJ (ar)

80th Percentile

In the following table the sorting from minimum to maximum of mercury concentration values in mg/MJ (ar) is given:

A/A	Mercury concentration mg/MJ (ar)
1	0,003983
2	0,004814
3	0,006161
4	0,007098
5	0,007769
6	0,011804
7	0,014607
8	0,015957
9	0,016519
10	0,017602
11	0,023588
12	0,03085
13	0,036134
14	0,076174
15	0,085128

From the table above, it's found the 80 percent of values is between increasing measurements A/A 12-13. More specifically it is found:

80th percentile = 0,031906 mg/MJ (ar)

As specified from the value used for the classification is the highest between median and 80th percentile. In this case we have:

Classification value = 0,031906 mg/MJ (ar)

2.2 RDF Classification

In order to categorise the Solid Recovered Fuels available in the market on the basis of their specification, a number of classification parameters is adopted by CEN. The parameters as well as the classes considered for each one of them is given in table 1.

Table 1: Ranges of values for each proposed class of the classification parameters considered

Classification property	Statistical measure	Unit	Classes				
			1	2	3	4	5
Net Calorific value (Hu)	Mean value	MJ/kg (ar)	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Chlorine (Cl)	Mean value	% (d)	≤ 0,2	≤ 0,6	≤ 1,0	≤ 1,5	≤ 3
Mercury (Hg)	Median value	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

Net Calorific Value

According to respective table that is referenced in EN 15359:2011 [1], EPANAs' RDF is classified according to NCV to class 4.

Chlorine concentration

According to respective table that is referenced in EN 15359:2011 [1], EPANAs' RDF is classified according to chlorine concentration to class 2.

Mercury concentration

According to respective table that is referenced in EN 15359:2011 [1], EPANAs' RDF is classified according to mercury concentration to class 1

According to the above, the final characterization of EPANAs' RDF is 4, 2, 1

3 Positive Sorting Setup

During the sampling period for the characterization and classification of EPANAs' RDF, there have been alterations to the setup of the waste treatment procedure. These alterations lead to the separation of streams with the capability of containing high moisture, concluding to a procedure called positive sorting. Positive sorting is actually the separation of selected streams in order to proceed to the rest of the separation procedure, therefore excluding unwanted ones.

The positive sorting sampling period lasted from March to May 2012, creating 3 lots that were sampled according to the directions of EN 15442:2011 [2].

3.1 RDF Proximate Analysis

During the sampling period of RDF, 3 lots of positive sorting were gathered. In order to determine the gasification parameters of the fuel produced from positive sorting (for comparison reasons), the proximate analysis was undergone for the analysis of moisture and ash content. In the table below (table 2) the proximate analysis of positive sorting RDF is given.

Table 2: Proximate Analysis of RDF lots from positive sorting

Proximate Analysis							
		RDF 9 - March 2012 Positive Sorting	RDF 9 - March 2012	RDF 10 – April 2012 Positive Sorting	RDF 10 – April 2012	RDF 11 – May 2012 Positive Sorting	RDF 11 – May 2012
Proximate analysis (dry)	Ash (% wt.)	8,40	12,98	7,77	13,06	7,51	9,91
	Volatiles (% wt.)	85,18	81,50	86,10	79,76	88,56	83,37
	Fixed Carbon (% wt.)	6,41	5,52	6,13	7,18	3,93	6,72
Proximate analysis (as received)	Moisture (% wt.)	17,56	31,15	11,42	27,60	11,58	23,19
	Ash (% wt.)	6,93	8,94	6,88	9,45	6,64	7,61
	Volatiles (% wt.)	70,22	56,11	76,26	57,75	78,31	64,04
	Fixed Carbon (% wt.)	5,29	3,80	5,43	5,20	3,48	5,16

As seen from the proximate analysis, all the samples derived from positive sorting setup have significantly lower moisture content than the ones derived from normal setup. The moisture reduction means that fewer RDF components that can absorb moisture are in the produced RDF. In other words the reduction of paper led to the reduction in the moisture and ash content. As a consequence due to the increase of plastics concentration, an increase to the volatiles content is observed. In the following figure (figure 1) a comparative proximate analysis diagram is given.

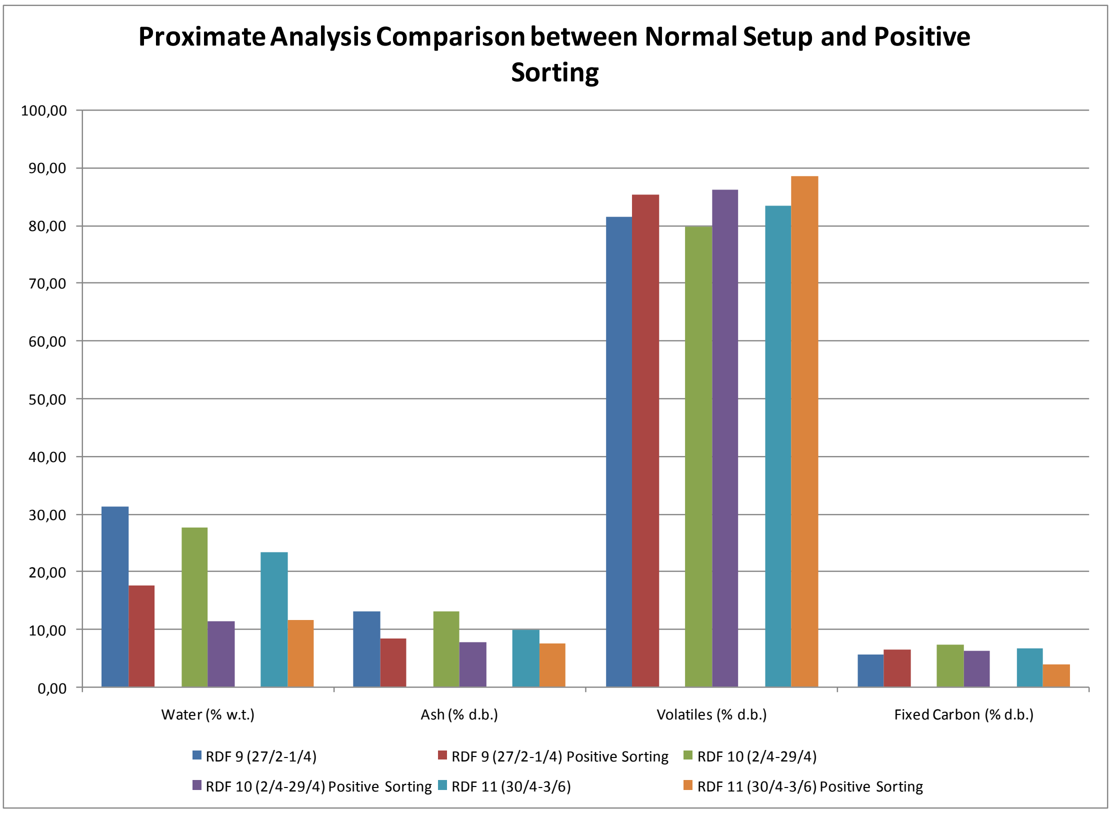

Figure 1: Comparative diagram of proximate analysis

3.2 RDF Ultimate Analysis

Another important factor for a complete RDF characterization is elementary analysis. Chlorine is an element obligatory to be measured for the final classification of RDF and the ultimate analysis plays an important role in the gasification properties of RDF. Therefore it was found necessary to carry out the Ultimate analysis. In table 3 the ultimate analysis of the gathered lots is given

Table 3: Ultimate Analysis of RDF lots from positive sorting

Ultimate Analysis							
		RDF 9 - March 2012 Positive Sorting	RDF 9 - March 2012 Normal Setup	RDF 10 – April 2012 Positive Sorting	RDF 10 – April 2012 Normal Setup	RDF 11 – May 2012 Positive Sorting	RDF 11 – May 2012 Normal Setup
Ultimate analysis (dry)	C (% wt.)	61,6	49,34	61,23	51,61	64,5	57,41
	H (% wt.)	10,44	7,50	9,95	8,33	10,58	8,99
	N (% wt.)	0,38	0,95	0,25	0,83	0,51	1,00
	S (% wt.)	0,57	0,37	0,52	0,58	0,55	0,53
	O (% wt.)	17,83	28,13	19,46	24,96	15,53	21,42
	Cl (% wt.)	0,78	0,73	0,82	0,63	0,82	0,74

	Ash (% wt.)	8,40	12,98	7,77	13,06	7,51	9,91
Ultimate analysis (as received)	C (% wt.)	50,78	33,97	54,24	37,36	57,03	44,10
	H (% wt.)	8,61	5,16	8,81	6,03	9,35	6,91
	N (% wt.)	0,31	0,65	0,22	0,60	0,45	0,77
	S (% wt.)	0,47	0,25	0,46	0,42	0,49	0,41
	O (% wt.)	14,70	19,37	17,24	18,07	13,73	16,45
	Cl (% wt.)	0,64	0,50	0,73	0,46	0,73	0,57
	Moisture (% wt.)	6,93	8,94	6,88	9,45	6,64	7,61
	Ash (% wt.)	17,56	31,15	11,42	27,60	11,58	23,19
Ultimate analysis (d.a.f.)	C (% wt.)	67,25	56,70	66,39	59,36	69,73	63,73
	H (% wt.)	11,40	8,62	10,79	9,58	11,44	9,98
	N (% wt.)	0,41	1,09	0,27	0,95	0,55	1,11
	S (% wt.)	0,62	0,43	0,56	0,67	0,59	0,59
	O (% wt.)	19,46	32,33	21,10	28,71	16,79	23,78
	Cl (% wt.)	0,85	0,84	0,89	0,72	0,89	0,82

As observed, all the positive sorting samples show higher chlorine concentration. This fact coupled with proximate analysis, confirms a higher plastic content present comparing to normal setup samples. In figure 2 a comparative diagram of ultimate analysis is presented. Moreover the H/C ratio is given for each lot, which represents the fuel quality. As seen the positive sorting lots have a higher H/C ratio than normal setup lots and according to literature [3], the higher the ratio, the lower is the ignition temperature.

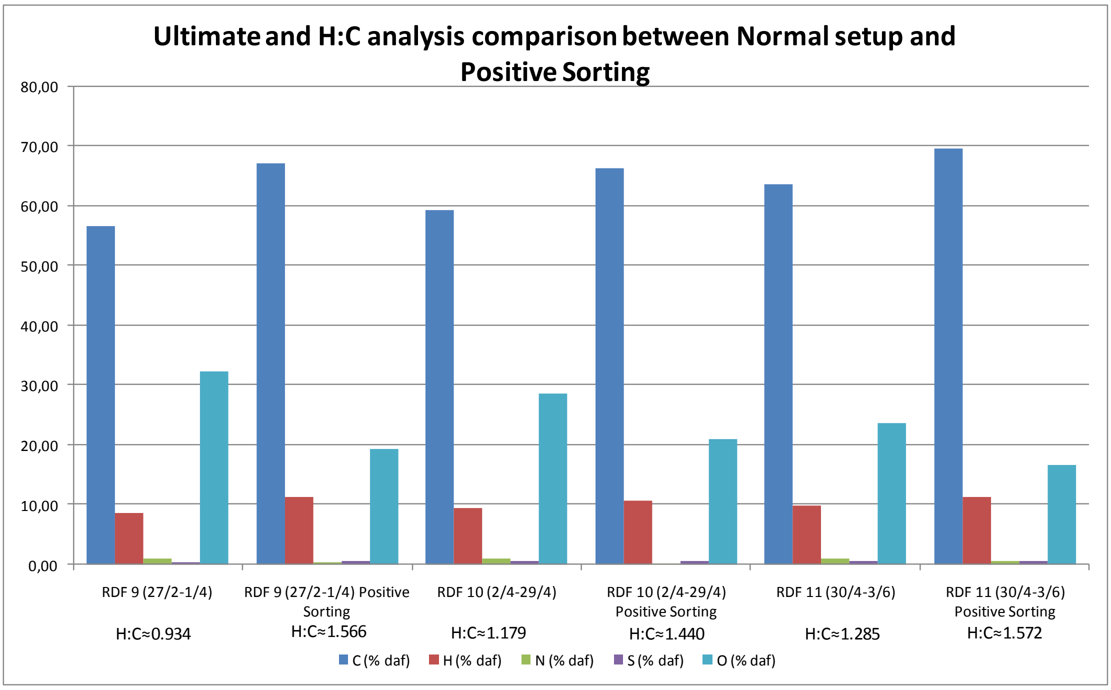

Figure 2: comparative diagram of ultimate analysis

3.3 RDF Heating value Analysis

Heating value analysis is essential as it is the factor that shows the thermal quality of the produced fuel. The analyses were made according to the instructions of standard EN 15400:2011 [4]. In the following table 4 the results of the analyses for the produced lots from positive sorting and normal setup are presented. In figure 3, a comparative diagram of the heating values measured is given.

Table 4: Heating Value of RDF lots from positive sorting

Heating Value						
	RDF 9 - March 2012 Positive Sorting	RDF 9 - March 2012 Normal Setup	RDF 10 – April 2012 Positive Sorting	RDF 10 – April 2012 Normal Setup	RDF 11 – May 2012 Positive Sorting	RDF 11 – May 2012 Normal Setup
High Heating Value (kJ/kg)	28.891	18.493	30.825	20.330	31.675	22.732
Lower Heating Value (kJ/kg) (dry)	26.613	16.857	28.654	18.513	29.367	20.770
Lower Heating value (kJ/kg) (as reveived)	21.510	10.845	25.102	12.728	25.683	15.388

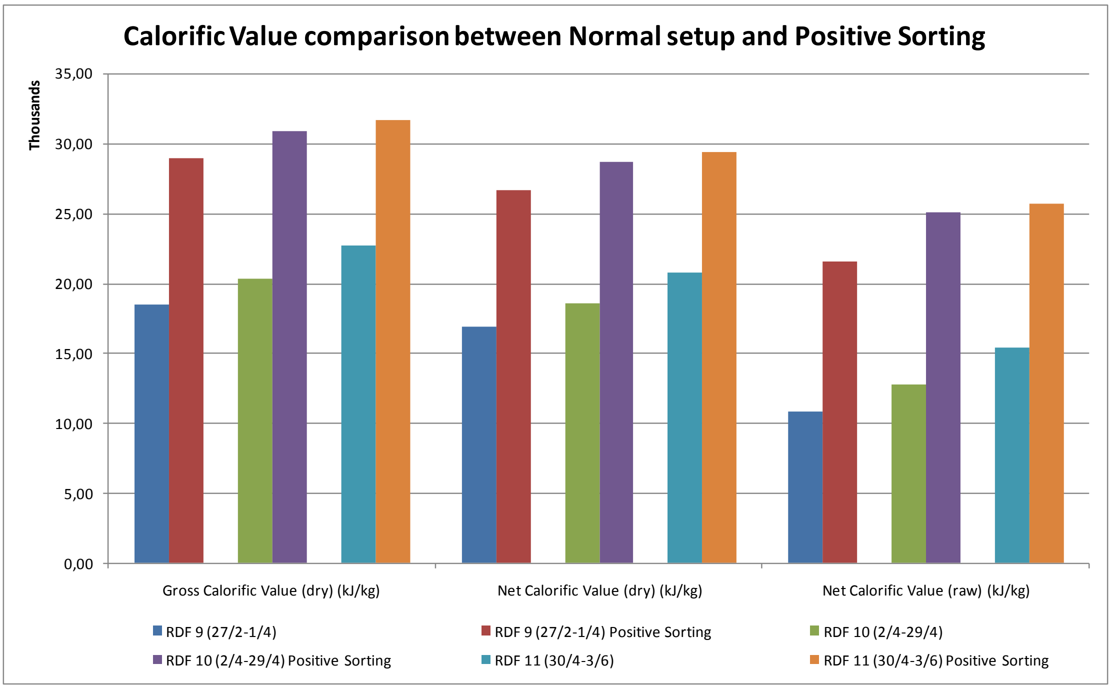

Figure 3: Comparative diagram of calorific value analysis

As seen from the results, positive sorting lots have a significantly higher calorific value in each comparative lot gathered. This is supposed to occur due to the higher concentration in plastics that is found in positive sorting lots. The increase in net calorific value ranges from 66.9 % to 98.3% in raw basis and from 41.4 % to 57.9% in dry basis.

3.4 Particle Size Distribution

A necessary parameter to be identified for the gasification process is the particle size distribution. This parameter indicates the diameter of the particle that enters the fluidized bed reactor and influences the time of the procedure. In order to estimate the size of the particles that would be used as a fuel for gasification, a particle size distribution analysis was made to the RDF as received from the shredder of EPANAs' MRF. The analysis was made for two lots April 2012 and May 2012 gathered from samples of positive sorting. Five samples of each lot were analyzed and the mean value of theses analyses is presented. The data presented below have been analyzed according to linear-linear coordinate system analysis.

Data for April 2012 – Positive Sorting

The following table (table 5) presents the mean values of the mass percentage held from a sieve of a certain diameter and the cumulative mass percentage passing from a sieve. Figures 4 and 5 present the respective diagrams.

Table 5: Mean values of particle size distribution analysis

Sieve diameter (mm)	Mass percentage held larger than sieve diameter (%)	Cumulative mass percentage passing from sieve (%)
50	0,00 %	100,00 %
25	12,13 %	87,87 %
12,5	41,93 %	45,94 %
6,3	36,40 %	9,54 %
3,15	7,73 %	1,81 %
Residue	1,81 %	0,00 %

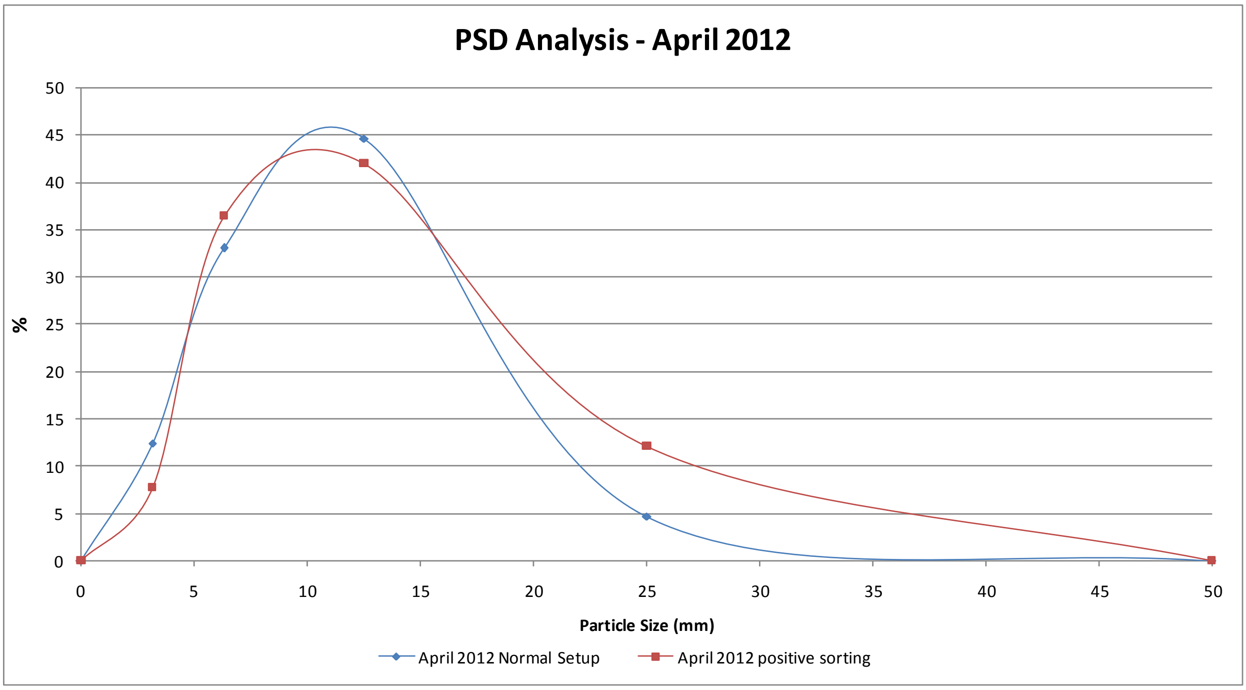

Figure 4: Particle Size Distribution Analysis – April 2012

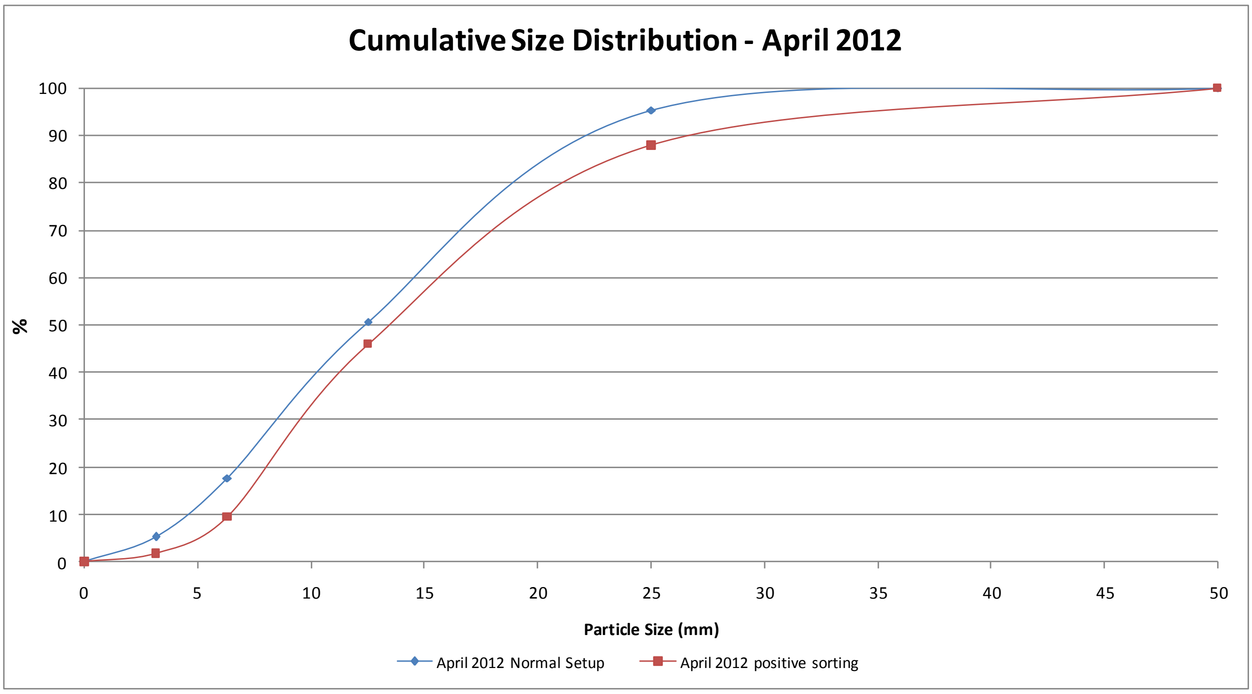

Figure 5: Cumulative Size Distribution – April 2012

As seen in figures 4 and 5, 90% of the particles are with a diameter below ≈22 mm, while the majority of the particles are of about 10-12mm.

<u>Data for May 2012 – Positive sorting</u>

The following table (table 6) presents the mean values of the mass percentage held from a sieve of a certain diameter and the cumulative mass percentage passing from a sieve. Figures 6 and 7 present the respective diagrams.

Table 6: Mean values of particle size distribution analysis

Tray diameter (mm)	Mass percentage held larger than tray diameter (%)	Cumulative mass percentage passing from tray (%)
50	0,00 %	100 %
25	32,81 %	67,19 %
12,5	39,45 %	27,73 %
6,3	18,57 %	9,16 %
3,15	6,70 %	2,46 %
Residue	2,46 %	0 %

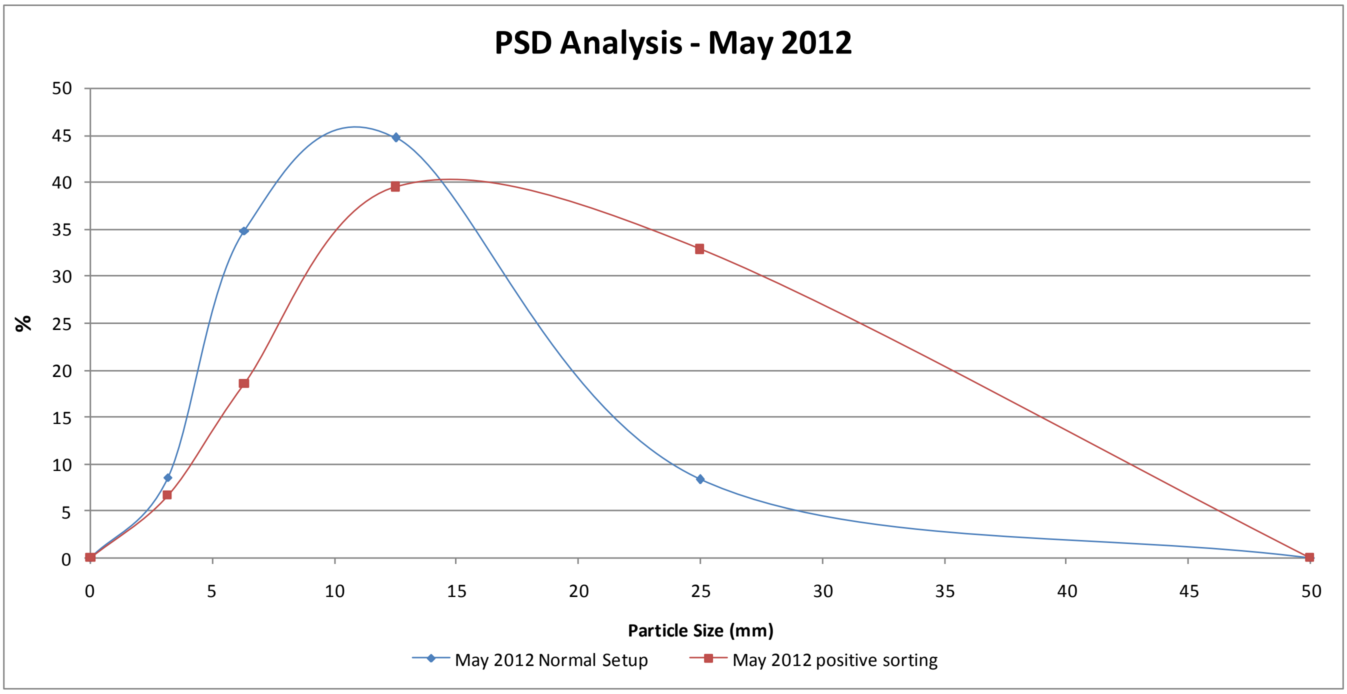

Figure 6: Particle Size Distribution Analysis – May 2012

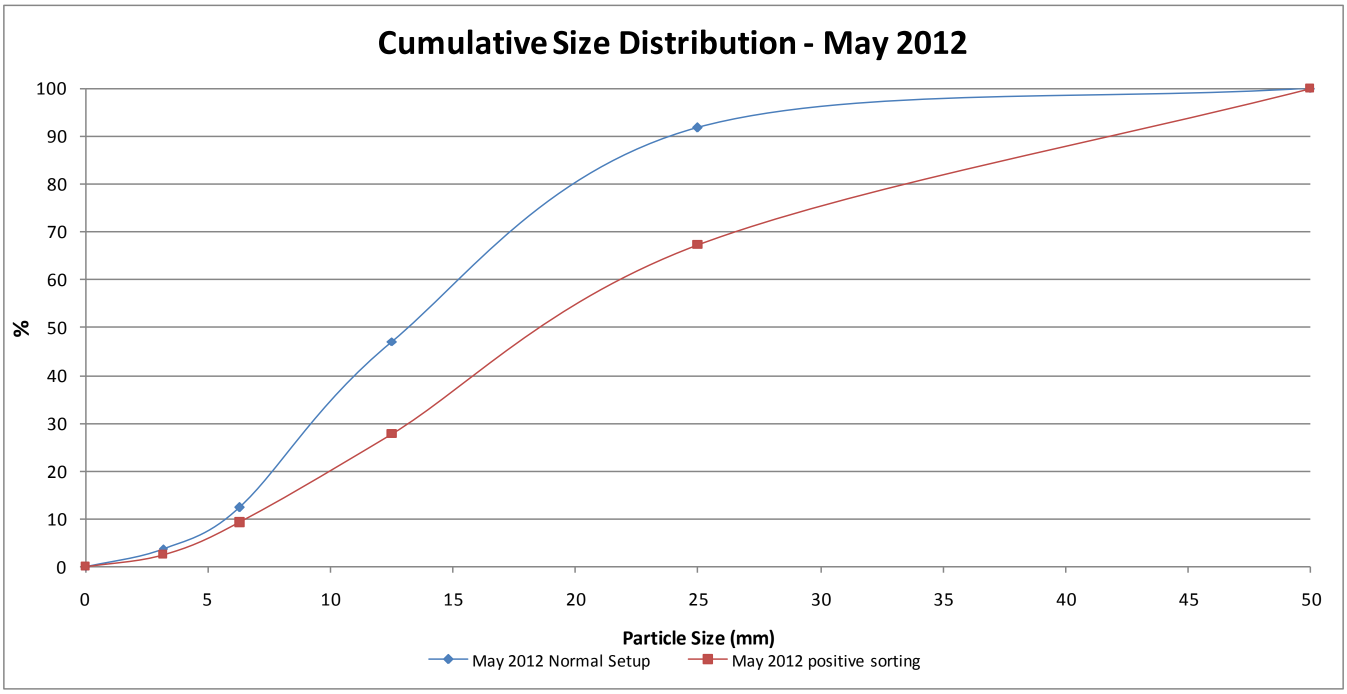

Figure 7: Cumulative Size Distribution – May 2012

As shown in figures 6 and 7, 90% of the particles are with a diameter below ≈24 mm, while the majority of the particles are of about 11-12mm.

Concluding, both of the positive sorting setup samples have particle sizes with d_{90} below 24mm. This kind of size is not expected to cause any operational problems during the gasification process.

3.5 Biogenic Content

In order to compare the alteration in biogenic content for positive sorting setup, analyses were carried out for the samples produced from positive sorting lots. The results are given in the following table (table 7).

Table 7: EPANAs' RDF Biogenic Content

Biogenic Content			
	Biomass content (%)	Non-biomass content (%)	Ash content (%)
RDF 9 – Mar. 2012	51.12	34.21	14.67
RDF 9 – Mar. 2012 Positive sorting	37.03	51.40	11.56
RDF 10 – April 2012	56.10	28.71	15.18
RDF 10 – April 2012 Positive sorting	35.08	54.77	10.15
RDF 11 – May 2012	47.89	39.86	12.25
RDF 11 – May 2012 Positive sorting	37.89	52.81	9.30
Average normal setup	51.70	34.26	14.03
Standard Deviation normal setup	4.14	5.57	1.57
Average normal setup	36.67	53.00	10.34
Standard Deviation normal setup	1.44	1.69	1.14

The average value for biogenic content in the produced RDF by normal setup is 51.70% with a standard deviation of 4.14%. However by removing a certain quantity of paper reduced the biogenic content of the RDF for about 15%. More specifically the average biogenic content value of positive sorting samples is 36.67% with a standard deviation 1.44%.

3.6 Optical "Negative" Sorting

For the needs of comparison among different setups of the plant that produce different qualities of RDF, a tweak to the last optical separator of the plant has been made. The change in the operation was the following: Instead of separating the "unwanted" stream that would go into the RDF, the stream that was separated were the plastics that would be then called RDF. Therefore the new stream created would be rich in plastics that would give Higher Heating Value and lower Moisture content. However the amounts of RDF that would be produced would be significantly lower. In the following table (table 8) the analysis of a sample of RDF produced by negative sorting is presented along with values of positive sorting RDF lots.

Table 8: Negative sorting sample analyses

		RDF sample –Negative Sorting	RDF 9 - March 2012 Positive Sorting	RDF 10 – April 2012 Positive Sorting	RDF 11 – May 2012 Positive Sorting
Proximate analysis	Moisture (% wt.)	15,52	17,56	11,42	11,58
	Ash (% wt. dry)	10,14	8,40	7,77	7,51
	Volatiles (% wt. dry)	82,35	85,18	86,10	88,56
	Fixed Carbon (% wt. dry)	7,51	6,41	6,13	3,93
Ultimate analysis	C (% wt.) d.a.f	55,71	67,25	66,39	69,73
	H (% wt.) d.a.f	7,40	11,40	10,79	11,44
	N (% wt.) d.a.f	0,49	0,41	0,27	0,55
	S (% wt.) d.a.f	n.d.	0,62	0,56	0,59
	O (% wt.) d.a.f	36,28	19,46	21,10	16,79
	Cl (% wt.) d.a.f	0,12	0,85	0,89	0,89
Higher Heating Value analysis	Gross Calorific Value (kJ/kg)	28.937	28.891	30.825	31.675
	Net Calorific Value (kJ/kg) (dry)	27.486	26.613	28.654	29.367
	Net Calorific Value (kJ/kg) (as reveived)	22.841	21.510	25.102	25.683

*n.d.: not detected

From the optical “Negative” sorting setup, the sample that derives has low moisture which is comparable to the positive sorting setup samples. However it has a higher concentration in ash and fixed carbon. This factor, along with the lower volatiles concentration leads to the conclusion of higher paper concentration present in the “negative” sorting setup sample. This leads to lower net calorific value, since paper has a lower NCV than plastic.

3.7 Proposals for RDF improvement

In order to manage the optimization of the produced RDF quality, one must have a detailed description regarding the end-user requirement standards. First of all one should specify the type of end-use scheme in order to balance the quality and quantity of the Refuse Derived Fuel produced for usage. As studied and presented in the previous chapters of this deliverable, each setup has its pros and cons.

By managing to remove with the most efficient way, a certain stream that ends up in RDF, it is manageable to successfully create a fuel of the required specifications. However this lead to the increase or decrease of another parameter that is equally important for the fuel. Certain examples are given in the following bullets:

a) In order to reduce the ash content in the produced RDF, it was found that it is better to have higher plastics quantity present than paper and more specifically only certain types of plastics that have low ash content
b) In order to reduce the moisture content in the produced RDF, it was found that it is better to have higher plastics quantity present than paper. Plastic has significantly lower absorptive potential, thus finally carrying less water and being more stable in weather changes
c) In order increase the net calorific value in the produced RDF, it was found that it is better to have higher plastics quantity present than paper. Plastic has higher NCV comparing to paper and in combination with lower moisture content, a small increase in plastics concentration leads to a significant increase in NCV
d) In order to decrease the chlorine content which is a technological indicator in the produced RDF, it was found that it is better to have higher paper concentration than plastics.
e) In order to increase the biogenic content in the produced RDF, it was found that it is better to have higher paper concentration than plastics. Biogenic content is very important in terms of reducing CO_2 emissions. What is more, in Greece as well as in other EU states there is a subsidy for RDF usage that depends on the biogenic content.
f) Regarding matters of H/C ratio which indicates the ease for ignition it is preferable to have higher plastic content than paper.

However any of the aforementioned alterations in the production setup come at a cost. And this cost is the RDF quantity produced, as well as the useless part that will be left unused. By removing streams that would normally end in the produced RDF, the final mass produced will be lowered and different treatment methods should be applied for the leftovers.

4 Conclusions

- Classification of EPANAs' RDF according to EN 15359:2011 is 4, 2, 1
- All the samples derived from positive sorting setup have significantly lower moisture content than the ones derived from normal setup. The moisture reduction means that fewer RDF components that can absorb moisture are in the produced RDF. In other words the reduction of paper led to the reduction in the moisture and ash content. As a consequence due to the increase of plastics concentration, an increase to the volatiles content is observed.
- The positive sorting samples show higher chlorine concentration. This fact coupled with proximate analysis, confirms a higher plastic content present comparing to normal setup samples.
- The H/C ratio, which represents the fuel quality, is higher in positive sorting lots. According to literature, the higher the ratio, the lower is the ignition temperature.
- Positive sorting lots have a significantly higher calorific value in each comparative lot gathered. This is supposed to occur due to the higher concentration in plastics that is found in positive sorting lots. The increase in net calorific value ranges from 66.9 % to 98.3% in raw basis and from 41.4 % to 57.9% in dry basis.
- From the optical "Negative" sorting setup, the sample that derives has low moisture which is comparable to the positive sorting setup samples. However it has a higher concentration in ash and fixed carbon. This factor, along with the lower volatiles concentration leads to the conclusion of higher paper concentration present in the "negative" sorting setup sample. This leads to lower net calorific value, since paper has a lower NCV than plastic.

5 References

[1] EN 15359:2011: Solid recovered fuels - Specifications and classes

[2] EN 15442:2011: Solid recovered fuels - Methods for sampling

[3] Edward Furimsky, Effect of H/C ratio on coal ignition, Fuel Processing Technology, Volume 19, Issue 2, September 1988, Pages 203-210

[4] EN 15400:2011: Solid recovered fuels - Determination of calorific value