"Energy exploitation of Solid Recovered Fuels (SRF) with high biogenic content - standardisation options"

Hellenic Solid Waste Management Association,
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Emmanuel Kakaras, Panagiotis Grammelis, Michalis Agraniotis

📞 +30 210 7723604, Fax : +30 210 7723663,
E-mail : ekak@central.ntua.gr
Contents

- EU Legislative framework and current situation on waste treatment
- Solid Recovered Fuels (SRF):
  - Definitions
  - Characterisation
  - Standardisation
  - Classes
- Biogenic content of SRF
- SRF market situation and legislation
- Conclusions
EU legislation in waste treatment - targets

- Reduction of the biodegradable part disposed off to landfills (31/1999 EC)
  Target: Until end of 2011: 65% reduction of biodegradable quantities landfilled compared with 1995

- Increase of packaging waste recycling.
  Target until end of 2011: recycling of at least 55% w/w of packaging waste

- RES promotion including the organic fraction of solid waste (28/2009 EC)
Modern management options of mixed Municipal Solid Waste (excluding landfilling):

a) MBT (Mechanical Biological Treatment) and production of RDF or/and compost
b) Direct mass burn incineration of MSW

- Energy recovery in both cases: indispensable practice
- No competitiveness between the two technologies
- Applied in several countries of Central Europe, where increased percentages of recycling and low percentages of land filling are apparent

Waste management practices in Europe, Source: EEA, Data 2009
Solid recovered fuels

The term RDF (Refuse Derived Fuels) is generic and includes all recovered fuels.

**Definition – Solid Recovered Fuels (SRF)**

“Fuels derived from fractions of non-hazardous waste and high calorific value for energy use in industry”

SRF classification according to 3 parameters:
- Calorific value – economical indicator
- Cl – technological indicator
- Hg – environmental indicator

Typical composition of SRF from MSW: 43% Paper/cardboard, 16% Soft plastic, 8% Hard plastic, 12% Composites, 11% Cloth, 3% Wood, 2% Lather, 5% Λοιπά.
Solid Recovered Fuels: production methods

Main steps of SRF production

- Screening
- Size reduction
- Ferrous and non-ferrous metal separation
- Classification based on conventional mechanical methods like air or centrifugal or ballistic classification
- Classification based on novel optical methods like Near Infrared Spectroscopy (NIR)
- Thermal or biological drying
- Compacting, pelletising

Separation systems with optical methods:
They are based in identification of materials by infrared radiation spectrum technology (Near Infrared Technology, NIR)

(Source: www.titech.com)
For the characterization of the recovered fuel as “SRF”, certain requirements of standard CEN/TC 343 must be met.

Additional standardization according to national standards (e.g. German standard RAL-GZ 724) improves the competitiveness and marketability of the fuel.

Required procedure for the characterisation of a waste recovered fuel as SRF.
Solid Recovered Fuels: Standardization

Structure of quality management system for the SRF

Aim and specific objectives of work group CEN/TC 343

TC 343 Working groups

WG1: Terminology and quality management
WG2: Fuel classification and specification
WG3: Sampling and Determination of the biomass content of SRF
WG4: Physical, mechanical tests
WG5: Chemical tests
# Solid Recovered Fuels: Obligatory & non-obligatory analysis (TS 15359)

## SRF class and origin

<table>
<thead>
<tr>
<th>Class code</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
</tr>
</tbody>
</table>

## Physical parameters

<table>
<thead>
<tr>
<th>Particle form</th>
<th>Particle size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>d</td>
</tr>
</tbody>
</table>

## Test method

<table>
<thead>
<tr>
<th>Unit</th>
<th>Value</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typical</td>
<td>Limit</td>
</tr>
</tbody>
</table>

## Chemical parameters

<table>
<thead>
<tr>
<th>Unit</th>
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<tr>
<td></td>
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<td>Limit</td>
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</table>

## Obligatory to specify

<table>
<thead>
<tr>
<th>Fuel preparation</th>
<th>Biomass content</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
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</tbody>
</table>

## Non-obligatory to specify

<table>
<thead>
<tr>
<th>Composition</th>
<th>Wood</th>
<th>Paper</th>
<th>Plastic</th>
<th>Rubber</th>
<th>Textile</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>Dry basis</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>As received</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

## Specification of Other:

<table>
<thead>
<tr>
<th>Physical parameters</th>
<th>Unit</th>
<th>Value</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typical</td>
<td>Limit</td>
<td>prCEN/TS XXX</td>
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</table>

## Chemical parameters

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<td>Typical</td>
<td>Limit</td>
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</table>

## Obligatory to specify

<table>
<thead>
<tr>
<th>SRF origin and preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
</tr>
</tbody>
</table>

## Non-obligatory to specify

<table>
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</thead>
<tbody>
<tr>
<td>a</td>
</tr>
</tbody>
</table>

## Chemical parameters

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</thead>
<tbody>
<tr>
<td></td>
<td>Typical</td>
<td>Limit</td>
</tr>
</tbody>
</table>

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a According to this prEN, Annex B
b According to prCEN/TS 15440
c The typical value is the mean value for the physical properties and the properties of the elements except for the heavy metals and trace elements, in which case the median value should be used, for SRF over an agreed or specified period of time. The limit value (maximum, minimum or 80th percentile, in case the median has been used as typical value) will be agreed upon and defined by the user and producer, and refers to a consignment.
## SRF classification according to TS 15359

<table>
<thead>
<tr>
<th>Fuel Parameter</th>
<th>Statistical measure</th>
<th>Units</th>
<th>Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net calorific Value ($H_u$)</td>
<td>Mean value</td>
<td>MJ/kg (ar)</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Chlorine (Cl)</td>
<td>Mean value</td>
<td>% (d)</td>
<td>≤ 0,2 ≤ 0,6 ≤ 1,0 ≤ 1,5 ≤ 3</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>Median 80th percentile</td>
<td>mg/MJ (ar)</td>
<td>≤ 0,02 ≤ 0,03 ≤ 0,08 ≤ 0,15 ≤ 0,50</td>
</tr>
<tr>
<td></td>
<td>mg/MJ (ar)</td>
<td></td>
<td>≤ 0,04 ≤ 0,06 ≤ 0,16 ≤ 0,30 ≤ 1,00</td>
</tr>
</tbody>
</table>
National quality assurance schemes for SRF: The German RAL GZ 724

- Required measurements for the awarding of the RAL quality sign
  - moisture
  - ash
  - NCV
  - Cl
  - Heavy metals

- In contrast to the European Technical Specifications under development, the German RAL determines maximum values in heavy metal concentration in SRF

- Other national quality assurance schemes:
  - Finland: SFS 5875
  - Italy: UNI 9903
  - Switzerland: guideline for co-incineration in cement kilns (BUWAG, 2005)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Einheit</th>
<th>Medianwert</th>
<th>„80. Perzentil“ Wert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>mg/kg TS</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Quecksilber</td>
<td>mg/kg TS</td>
<td>0,6</td>
<td>1,2</td>
</tr>
<tr>
<td>Thallium</td>
<td>mg/kg TS</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Arsen</td>
<td>mg/kg TS</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Kobalt</td>
<td>mg/kg TS</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/kg TS</td>
<td>25(1)</td>
<td>80(1)</td>
</tr>
<tr>
<td>Antimon</td>
<td>mg/kg TS</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>Blei</td>
<td>mg/kg TS</td>
<td>70(2)</td>
<td>190(2)</td>
</tr>
<tr>
<td>Chrom</td>
<td>mg/kg TS</td>
<td>40(2)</td>
<td>125(2)</td>
</tr>
<tr>
<td>Kupfer</td>
<td>mg/kg TS</td>
<td>200(2)</td>
<td>400(2)</td>
</tr>
<tr>
<td>Mangan</td>
<td>mg/kg TS</td>
<td>50(2)</td>
<td>250(2)</td>
</tr>
<tr>
<td>Vanadium</td>
<td>mg/kg TS</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Zinn</td>
<td>mg/kg TS</td>
<td>30</td>
<td>70</td>
</tr>
</tbody>
</table>

1) Die o. g. Schwermetallehalte sind gültig ab einem Heizwert \( H_{TS} \) von = 16 MJ/kg für heizwertreiche Fraktionen aus Siedlungsabfällen und ab einem Heizwert \( H_{TS} \) von = 20 MJ/kg für produktionsspezifische Abfälle. Bei Unterschreitung dieser Heizwerte sind die o. g. Werte entsprechend linear abzusetzen, eine Erhöhung ist nicht zugelassen.

2) Für Sekundärbrennstoff aus produktionsspezifischen Abfällen

3) Für Sekundärbrennstoff aus den heizwertreichen Fraktionen von Siedlungsabfällen

4) Überschreitungen aufgrund von Inhomogenitäten im Einzelfall zulässig

Maximum heavy metal concentrations of SRF according to German RAL GZ 724
Typical trace element concentrations standardized to heat value **lignite (blue)** and **SRF (red)** in mg/kJ

Source: Neovis GmbH
Biogenic content: Derives from paper/cardboard

Determination methods (TS 15440):

1. Manual sorting
   - Classification into categories (biogenic, not biogenic, inert)
   - Determination through the mass fraction
     → Appropriate only for particles over 10mm, time consuming

2. Selective Dissolution Method (SDM)
   - Dissolution with nitric acid, hydrogen peroxide
   - Calculation of the biogenic fraction based on mass – energy or carbon share
     → Most commonly used. Critical points: the analysis of fixed C and the dissolution step

3. \(^{14}\text{C} – \) method
   - Relation of renewable / non renewable share through the determination of the \(^{14}\text{C} \) isotope in the carbon
   - Different technologies applicable (AMS, BI, LSC)
     → Limited amount of laboratories has the capacity to
Three different figures considering biogenic content determination may be provided

- Biogenic carbon
- Biomass content (mass based)
- Biomass energy content (based on NCV)

The determination of the value to be used in the renewable share calculation (ETS, feed-in tariff) is subject to legislative regulation
Biogenic content of SRF

Biogenic content of Greek RDF produced at the MBT plant of A. Liosia

Biogenic content of different recovered fuels

SRF 1: SRF from commercial waste
SRF 2: high calorific fraction from MWS
SRF 3: fraction from used material
SRF 4: fraction from new material

Source: Quovadis project
Solid Recovered Fuels
Potential advantages by SRF co-utilisation, concerns

Advantages of SRF co-utilisation in industrial processes

- Fossil fuel savings
- Alternative waste management option to msw incineration (Figure)
- 50-70%wt biogenic content in SRF $\rightarrow$ reduction of CO$_2$ emissions
- Utilization of existing capacities (cement kilns, power plants) for SRF co-incineration $\rightarrow$ low investment costs, beneficial economies of scale

![Figure: Energy specific CO$_2$ emissions of different fossil fuels and of two SRF qualities, Source: Remondis AG](image)

Concerns

- Concerns over possible discrepancies between the controls applied on dedicated incineration and co-incineration plants
- Fuel quality control, possible pollutants in SRF (Cl, Heavy Metals)
- Necessary public acceptance and confidence

Need for SRF standardization and classification
European SRF market situation

Total SRF potential in EU 27 = 70 Mt; coming from municipal, industrial, and demolition & construction sources and including, plastics, paper, cardboard, textiles, wood, high calorific fraction from MBT

• About 12 Mt was energy recovered or 17%
• National recovery rates differed between 2% and 35%
• Even regional differences, within a member state, can be observed
• The processing took place in energy intensive industries; like cement, paper, metal and chemical industries
• The countries with the highest recovery rates: Denmark, Germany, Netherlands, Sweden
• The countries with the lowest recovery rates: Bulgaria, Greece, Romania, Poland

Source: Prognos, EU Atlas Secondary Raw Materials and Eurostat
Evolution of the MSW treatment price in Germany, the Netherlands and Belgium

MSW incineration capacity in countries of Central Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Incineration capacity (t)</th>
<th>population</th>
<th>kg Cap./inh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>24.500.000</td>
<td>82.500.000</td>
<td>297</td>
</tr>
<tr>
<td>Netherlands</td>
<td>8.000.000</td>
<td>16.500.000</td>
<td>485</td>
</tr>
<tr>
<td>Belgium</td>
<td>3.280.000</td>
<td>10.500.000</td>
<td>312</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3.500.000</td>
<td>7.200.000</td>
<td>486</td>
</tr>
</tbody>
</table>

Evolution of the MSW treatment price in Germany, the Netherlands and Belgium

Source: Bert Straetmans, May 2010, Workshop Helsinki
Co – incineration of recovered fuels in coal firing stations: Case study Germany

- After the capacity shortage in the German market in years following 2005, the situation is stabilised through the operation of new RDF incinerator plants and the further extension of the co-firing practice in coal fired plants and cement plants.
Μεμονωμένες μονάδες καύσης RDF / SRF

Μονάδα στο βιομηχανικό πάρκο Hoechst, πλησίον της Φρανκφούρτης

- Δυναμικότητα 700.000 t/a RDF
- Εισερχόμενη θερμική ισχύς 270 MW\textsubscript{th}
- Παραγόμενη ηλεκτρική ισχύς 86 MW\textsubscript{el}
- Τεχνολογία καύσης: ρευστοποιημένη κλίνη

Μονάδα στην πόλη Rostock

- Δυναμικότητα 170.000 t/a RDF
- Εισερχόμενη θερμική ισχύς 87 MW\textsubscript{th}
- Παραγόμενη ηλεκτρική ισχύς 18 MW\textsubscript{el}
- Τεχνολογία καύσης: υδρόψυκτη εσχάρα
SRF Gasification

• **Poly-Stabilat (FP7)**
  – Location: Osnabruck, DE
  – Technology: FB Gasification of RDF/SRF
  – Fuel input: 750 kg/h,
  – Output: 500 kWel

• **Energy Waste (LIFE+)**
  – Location: Athens (EPANA), GR
  – Technology: FB Gasification of RDF/SRF
  – Pilot scale unit
1. Fuel handling
2. FB gasifier
3. Gas cooling
4. Gas filter
5. Gas fired boiler

Waste Gasification & Gas Cleaning for Firing in Separate Boiler

(Metso Power)
Recovered fuels co-utilisation potential in Greece

- Several new recycling plants are built in the last years for packaging waste
- New technologies are adopted (NIR) providing high quality recovered material
- Quality assurance, characterisation of the produced fuel as SRF and classification is required towards the improvement of the marketability of the fuels
Legislative issues

• New regulation for the licensing of RES plants: released by RAE on 6-04-2011, currently under public consultation

• Following regulations are proposed for incinerator plants of waste recovered fuels

→ The plant will follow the permit procedure of a common CHP plant and not of a RES plant, if the biogenic content in the recovered fuel is lower than 100% (!)

→ No mixing of this 100% biogenic fuel with other waste recovered fuels is allowed, in order to keep the RES permission
Critical points that should be discussed

• Typical biogenic content of recovered fuels: 40-60%

• Higher biogenic content: only in waste wood, saw dust, not in the high calorific fraction of MSW

• Necessity for the definition of the biogenic fraction for every recovered fuels type

• Necessity to define a feed-in-tariff for the determined biogenic fraction. The electricity produced from the non biogenic fraction should be charged based on the regular electricity price (SMP)
Conclusions

- Solid Recovered Fuels (SRF) are certified secondary fuels based on the European standards under development.
- Energy exploitation of recovered fuels is an alternative waste treatment practice.
- Waste derived fuels from derived MSW possess a considerable biogenic fraction.
- The energy exploitation of waste recovered fuels with a high biogenic content results in considerable CO₂ emission savings.
- A clarification on the biogenic fraction of waste recovered fuels shall be made in the new Greek regulation (currently under public consultation).