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Solid recovered fuels — Guidance for the specification of solid recovered fuels (SRF) for selected uses

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO-specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 300, *Solid recovered materials, including solid recovered fuels*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Waste-to-energy is a broad term that covers much more than waste incineration. It includes various treatment processes that have different environmental impacts but also offer potential for the progress desired towards a low-carbon and circular economy. Processes that convert waste into solid fuels and generate electricity and/or thermal energy from it can play an increasing role in achieving such goals.

Traditionally, solid fuels recovered from waste have been used as an integrative fuel in incineration or co-incineration plants treating a mix of wastes, so as to improve the energy performance of the plant. There are also some dedicated SRF-EfW plants (e.g. incineration plants and industrial combustion plants recovering thermal and/or electrical energy from the solid recovered fuel alone).

An increasing role as substitutive fuel has occurred over time to allow a reduction of fossil fuel consumption and the impact on climate change and greenhouse gas emission of industrial activities with a high energy consumption. In recent years, the use of solid recovered fuels has expanded to other interesting and promising fields, such as gasification or combined gasification and pyrolysis. Waste gasification and co-incineration of the resulting syngas in a combustion plant, co-processing to power and material recovery in cement kilns and waste incineration in dedicated facilities can be highlighted as best proven techniques to increase the energy efficiency of waste-to-energy processes and optimize their contribution to national and global climate and energy goals.

All the above-mentioned waste-to-energy processes rank differently in the waste hierarchy and have different needs for fuel quality to ensure better plant management as well as compliance with requirements set by national and supranational legislation.

Quite an extensive family of solid fuels can be recovered from waste, with different physico-chemical properties and a quality that is not always well defined. Those produced from non-hazardous waste, classified as SRF (Solid Recovered Fuel), are specifically of interest in this document. The term SRF itself identifies a family of fuels that can differ in origin (input waste streams), composition and quality.

Many barriers still hamper the extensive development of SRFs. As discussed later, a continuing confusion in terminology can be highlighted. Solid fuels recovered from non-hazardous waste are identified in different countries by different terms (e.g. CSS, CDR, CDR-Q, RPF, SBS, CSR,), shipped with different waste codes, and an ambiguous use of the terms RDF and SRF still occurs. SRF is largely produced and traded as waste, different countries labelling it with different waste codes based on local waste legislation. An end-of-waste of SRF is allowed in some countries (e.g. Austria, Italy) if the fuels produced comply with specific and mandatory requirements legally set.

Solid recovered fuels are intended to be classified and specified according to ISO/TC 300 standards. Fuel specification is also the subject of national guidelines, in places addressed to specific end uses of the fuel (e.g. in cement kilns), and of local voluntary commitments on fuel properties between the producer and the end user aimed at ensuring that the latter meets its own technological, economic and environmental needs.

Generic (all solid waste) or specific (SRF) quality requirements are set by national or local regulators (e.g. administrative bodies authorized to issue plant permits), mainly to ensure that waste-to-energy plants at least meet the requirements for environmental and human protection and to regulate the role of waste-to energy plants within the national/regional waste management systems as a whole.

There are still acceptance problems in several countries that need to overcome, for example by reliable data, a high level of information and transparency.

To foster the application of SRFs in existing and new fields and to overcome existing barriers, it is therefore strategically essential for all interested stakeholders to define what quality requirements the SRF meets based on homogeneous, unambiguous and well-accepted criteria.

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Solid recovered fuels — Guidance for the specification of solid recovered fuels (SRF) for selected uses

1 Scope

This document addresses the provision of background references that are helpful in defining a more detailed specification for SRF according to its specific end use for energy conversion (EfW plants) and to support the SRF market. The aim is to enable all the interested stakeholders – producers, end users, legislators, local authority bodies and standardization bodies – to guarantee that the SRF complies fully with technical, environmental and economic requirements and to facilitate its social acceptability when utilized for energy conversion.

This document is intended to provide references for the specification of SRF produced from non-hazardous waste streams and traded to EfW plants as waste. The quality of such SRF is specified through values for relevant fuel properties, appropriate to the subsequent end uses that have an expected growth or an established/well consolidated role in heat and power generation in waste-to-energy systems:

— coal co-combustion in cement kilns,

— gasification,

— coal co-combustion in power plants.

The SRF can also be used in other end-use applications but these are not addressed in this document.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
BAT
best available technique
term used within the European Union for the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole

Note 1 to entry: “Techniques” includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

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Note 2 to entry: "Available techniques" means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.

Note 3 to entry: "Best" means most effective in achieving a high general level of protection of the environment as a whole.

[SOURCE: Directive 2010/75/EU, Art. 3 (10)]

3.1.2
BAT reference document
term used within the European Union for a document, resulting from the exchange of information drawn up for defined activities, that describes, in particular, applied techniques, present emission and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques

Note 1 to entry: "BAT conclusions" means a document containing the parts of a BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.

Note 2 to entry: "Emission levels associated with the best available techniques" means the range of emission levels obtained under normal operating conditions using a best available technique or a combination of best available techniques, as described in BAT conclusions, expressed as an average over a given period of time, under specified reference conditions.

Note 3 to entry: "Emerging technique" means a novel technique for an industrial activity that, if commercially developed, could provide either a higher general level of protection of the environment or at least the same level of protection of the environment and higher cost savings than existing best available techniques.

[SOURCE: Directive 2010/75/EU, Art. 3 (11)]

3.1.3
classification of solid recovered fuels
categorization of *solid recovered fuels* (3.1.18) into classes by focusing on the key properties net calorific value, chlorine and mercury, that are defined by boundary values

Note 1 to entry: The classes are defined by boundary values for the chosen fuel characteristics to be used for trading as well as for the information of permitting authorities and other interested parties.

[SOURCE: ISO 21637, 3.12, modified — Note 1 to entry is added.]

3.1.4
co-incineration plants
term used within the European Union for any stationary or mobile technical unit whose main purpose is the generation of energy or production of material products and which uses *waste* (3.1.19) as a regular or additional fuel or in which waste is thermally treated for the purpose of disposal through the incineration by oxidation of waste as well as other thermal treatment processes, such as pyrolysis, gasification or plasma process, if the substances resulting from the treatment are subsequently incinerated

[SOURCE: Directive 2010/75/EU, Art. 3 (41)]

3.1.5
combustion plant
term used within the European Union for any technical apparatus in which fuels are oxidized in order to use the heat thus generated

[SOURCE: Directive 2010/75/EU, Art. 3 (25)]

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3.1.6
composition of solid recovered fuels
breakdown of *solid recovered fuels* (3.1.18) by types of components

Note 1 to entry: This is typically expressed as a percentage of the mass fraction component in the fuel on an as received basis (m % ar).

Note 2 to entry: Examples of components - wood, paper, board, textiles, plastics, rubber.

[SOURCE: ISO 21637, 3.14]

3.1.7
dedicated SRF- EfW plants
any technical unit in which the energy conversion is from the *solid recovered fuel* (3.1.18*)* alone

3.1.8
EfW plants
energy from waste plants like municipal waste incineration (MWI), mono- and co-combustion plants including cement kilns

3.1.9
energy conversion
use of the calorific value of the *solid recovered fuel* (3.1.18) for energy purposes alone or with other fuels

Note 1 to entry: Solid recovered fuels may be an intermediary energy carrier and used directly or indirectly for the energy conversion such as in multi-stage production and use of synthetic gas. Examples of energy conversion processes are incineration, co-incineration, combustion, co-combustion, gasification and pyrolysis, in which energy is used for supplying heat, cooling and/or electric power.

[SOURCE: ISO 21637, 3.27]

3.1.10
energy purposes
use of the calorific value within industrial processes or for the supply of heat and electrical power

Note 1 to entry: For industrial processes, the use of solid recovered fuel may contribute to the energy source within the process of producing specific materials, such as cement clinker, bricks and lime.

[SOURCE: ISO 21637, 3.29]

3.1.11
EoW
end-of-waste
term used within the European Union for status of a specified substance or object that ceases to be a *waste* (3.1.19) when it has undergone a recovery, including recycling, operation and complies with specific criteria, to be developed in accordance with the following conditions: (a) the substance or object is commonly used for specific purposes; (b) a market or demand exists for such a substance or object; (c) the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; (d) the use of the substance or object will not lead to overall adverse environmental or human health impacts

[SOURCE: Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste, art. 6]

3.1.12
gasification plant
any stationary or mobile technical unit whose purpose is converting feedstock fuels into a syngas (synthesis gas) for different final uses

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3.1.13
hazardous waste
waste (3.1.19) which has proprieties that may be harmful to human health or the environment

Note 1 to entry: These wastes are categorized by waste streams and hazardous characteristics. The hazardous characteristics relevant to solid wastes are: explosives substances; flammable solids; wastes liable to spontaneous combustion; wastes which, in contact with water emit flammable gases; wastes which oxidizing; organic peroxides; acute poisoning and infectious substances.

Note 2 to entry: Further identification of the waste's status can be determined using the Annex I and Annex III tables of the Basel Convention on the control of transboundarym of hazardous wastes and their disposal.

Note 3 to entry: Additional categories of hazardous waste to those in the Basel Convention Annex I and Annex III may be established by stakeholders to the agreement or at a national level.

[SOURCE: ISO 21637, 3.35, modified — Example and Notes 4 and 5 to entry were removed.]

3.1.14
incineration plant
term used within the European Union for any stationary or mobile technical unit and equipment dedicated to the thermal treatment of *waste* (3.1.19), with or without recovery of the combustion heat generated, through the incineration by oxidation of waste as well as other thermal treatment processes, such as pyrolysis, gasification or plasma process, if the substances resulting from the treatment are subsequently incinerated

Note 1 to entry: According to the US Environmental Protection Agency, incinerators are any furnace used in the process of combusting solid waste for the purpose of reducing the volume of the waste by removing combustible matter. A solid waste incineration unit is defined as a distinct operating unit of any facility which combusts any solid waste material from commercial or industrial establishments or the general public (including single and multiple residence, hotels and motels). The term does not include: a) materials recovery facilities (including primary or secondary smelters) which combust waste for the primary purpose of recovering metals; b) qualifying small power production facilities or or qualifying cogeneration facilities which burn homogeneous waste (such as units which burn tires or used oil, but not including refuse-derived fuel) for the production of electric energy or in the case of qualifying cogeneration facilities which burn homogeneous waste for the production of electric energy and steam or forms of useful energy (such as heat) which are used for industrial, commercial, heating or cooling purposes; c) air curtain incinerators provided that such incinerators only burn wood wastes, yard wastes, and clean lumber.

[SOURCE: Directive 2010/75/EU (40); US Environmental Protection Agency. Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Commercial and Industrial Solid Waste Incineration Units; [Technical Amendments] Federal Register / Vol. 83, No. 116 / Friday, June 15, 2018 / Proposed Rules 3.17]

3.1.15
MSW
Municipal Solid Waste
waste (3.1.19) collected and treated by or for municipalities

Note 1 to entry: It typically covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste.

3.1.16
non-hazardous waste
waste (3.1.19) that is other than *hazardous waste* (3.1.13)

3.1.17
specification of solid recovered fuels
list of properties that characterize *solid recovered fuels* (3.1.18)

[SOURCE: ISO 21637, 3.76]

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3.1.18
SRF
Solid Recovered Fuel
solid fuel for energy purposes according to ISO 21640, derived from *non-hazardous wastes* (3.1.18)

Note 1 to entry: According to EN 15359, SRF are solid fuels prepared from non-hazardous waste s meeting the classification and specification requirements laid down in this European Standard. "Prepared" means processed, homogenized and upgraded to a quality that can be traded amongst producers and users.

Note 2 to entry: Whether the input material is hazardous or non-hazardous is determined through national laws and Directives or by categorization of the fuel through the Annexes in the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.*

[SOURCE: ISO 21637, 3.75, modified – Original Notes 1-2 to entry were replaced by a new Note 1.]

3.1.19
waste
substances or objects which are discarded or are intended to be discarded

Note 1 to entry: The provisions of national laws can apply.

Note 2 to entry: The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal provides the user with the ability to determine whether a material is deemed to be a hazardous waste or non-hazardous waste. By following the Convention's requirements and Annexes, along with national laws, operators have a clear understanding of the distinction between the different categories of waste.

[SOURCE: Basel Convention on the control of transboundary movements of hazardous wastes and their disposal, 2019]

3.2 Symbols and abbreviated terms

BAT	Best Available Technique
CDW	Construction and Demolition Waste
ICW	Industrial and Commercial Waste
H	Hazardous Waste
NH	Non-Hazardous Waste
MSW[a]	Municipal Solid Waste
EoW	End-of-Waste
RDF[b]	Refuse Derived Fuel
SRF[c]	Solid Recovered Fuel
ar	as received
d	dry basis
BD	bulk density, kg/m^3
DM	dry matter, % in mass
NCV	net calorific value, MJ/kg; kcal/kg
M	moisture content, $q_{p,\,net}$, % in mass

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A	ash content, % in mass
TC	total carbon content, % in mass

[a] Municipal solid waste is a *waste* (3.1.18) collected and treated by or for municipalities. It typically covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste.

[b] RDF differs from SRF (*solid recovered fuel* as defined in 3.1.17) in that it is not in compliance with standardized classification and specification requirements. RDF includes high calorific fractions, which are coarser fractions from waste streams that contain materials with a high calorific value that have not been processed as extensively as fractions for power plants running on secondary fuels such as SRF.

[c] As defined in 3.1.17.

4 Compilation, structure and use of data

Background references and data provided in this document have been collected from:

— national/international legislation, standards, guidelines and statistics on waste management;

— sectoral statistics reported in documents or websites (e.g. Global Cement; AITEC, Italian Cement Technical and Economical Association; VDZ, German Cement Works Association; Japan Cement Association; European Recovered Fuel Organisation; German Quality Assurance Association for Solid Recovered Fuels and Recycled Wood (BGS e. V.; Japan RPF Association);

— reference documents on the best available techniques;

— public documents of national producers/end users;

— a review of literature studies;

— international databases (e.g. the ECN Phyllis Database);

— responses sent to questionnaires. Four online surveys were promoted in 2017 by the ISO TC 300/WG2 to collect background information on:

  — profiles of the SRF-RDF produced. Responses (25) were provided from European (88 %: Germany, Italy, Sweden, Spain, Finland) and Japanese (12 %) producers;

  — market, production and use of SRF-RDF. Only a few responses were collected (5) that refer to European countries (Spain, France, Italy, Austria);

  — legislation, standards and guidelines that have an impact on SRF-RDF. Responses (11) were provided by European stakeholders (60%: Germany, France, Italy, Denmark and Serbia) and Asia (40 %, Japan);

  — needs for the classification and specification of SRF-RDF. Responses (15) were provided by stakeholders (end users, producers, authorities, mirror committees) of European countries only (Sweden, Spain, Italy, France, Austria and Germany);

— personal communications (e.g. Italian producers/end users of SRF; Japanese producers of RPF).

Background references on the main characteristics of the end-user plants of interest are provided in Annex C, while the collected background references on provisions in national legislations, standards, plant permits, guidelines, voluntary agreements, results of statistical assessments for typical values, reference data for properties of the produced SRF/RDF, are reported in Annexes A, B and D.

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