Solid recovered fuels - Methods for the determination of the content of elements (Al, Ca, Fe, K, Mg, Na, P, S, Si, Ti, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Sn, Tl, V, Zn) (ISO 3884:2025)

EESTI STANDARDIMIS- JA AKREDITEERIMISKESKUS
ESTONIAN CENTRE FOR STANDARDISATION AND ACCREDITATION

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 3884:2025 sisaldab Euroopa standardi EN ISO 3884:2025 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 3884:2025 consists of the English text of the European standard EN ISO 3884:2025.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 23.04.2025.	Date of Availability of the European standard is 23.04.2025.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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Solid recovered fuels - Methods for the determination of the content of elements (Al, Ca, Fe, K, Mg, Na, P, S, Si, Ti, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Sn, Tl, V, Zn) (ISO 3884:2025)

Combustibles solides de récupération - Méthodes de détermination de la teneur en éléments (Al, Ca, Fe, K, Mg, Na, P, S, Si, Ti, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Sn, Tl, V, Zn) (ISO 3884:2025)

Feste Sekundärbrennstoffe - Verfahren zur Bestimmung des Gehaltes an Elementen (Al, Ca, Fe, K, Mg, Na, P, S, Si, Ti, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Sn, Tl, V, Zn) (ISO 3884:2025)

This European Standard was approved by CEN on 18 April 2025.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN ISO 3884:2025) has been prepared by Technical Committee ISO/TC 300 " Solid recovered materials, including solid recovered fuels " in collaboration with Technical Committee CEN/TC 343 “Solid recovered materials, including solid recovered fuels” the secretariat of which is held by SFS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2025, and conflicting national standards shall be withdrawn at the latest by October 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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Endorsement notice

The text of ISO 3884:2025 has been approved by CEN as EN ISO 3884:2025 without any modification.

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 300, *Solid recovered materials, including solid recovered fuels*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 343, Solid recovered materials, *including solid recovered fuels*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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.

Introduction

Accurate determination of the element content in solid recovered fuels is important for environmental and technical reasons both in the production and combustion stage. Some of the elements determined by the application of one of the methods in this document are included in ISO 21640 [1] while other elements can have environmental implications both for emissions and for the bottom and fly ashes disposal or recovery. Furthermore, the determination of elements such as Al, Ca, Fe, Mg, P, K, Si, Na and Ti can be helpful to predict the melting behaviour and slagging of the ash.

The methods described in this document provide multi-element digestions for a wide range of solid recovered fuels. The elements that are extractable and determined by these procedures can in many instances be described as 'total element contents', although this will be matrix dependent. After digestion, a number of analytical techniques can be used for the accurate determination of major and minor element contents, e.g. inductively coupled plasma with optical or mass detection (ICP-OES, ICP-MS), graphite furnace atomic absorption spectrometry (GF-AAS) and specific direct methods (e.g. for mercury, sulfur).

Alternatively, X-ray fluorescence can be used as a fast method for a qualitative overview of ash forming elements and impurities of solid recovered fuels. After suitable calibration, X-ray fluorescence is very useful for determining major elements or even minor elements (except mercury and beryllium) in solid recovered fuels according to ISO 22940. For calibration of X-ray fluorescence, it is important to use several solid recovered fuel reference materials or solid recovered fuel samples that were carefully characterized after total digestion and measurement by ICP-OES, ICP-MS, GF-AAS or by other techniques such as elemental analysis using combustion technology on sulfur (see ISO 21663 [2]).

After ashing of solid recovered fuels, X-ray fluorescence allows the simultaneous determination of major elements (Al, Ca, Fe, Mg, P, K, Si, Na, Ti) in the ashes after matrix-based calibration (procedures for this are described in ISO 22940 and EN 15309).

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1 Scope

This document specifies methods for the determination of major and minor element concentrations in solid recovered fuels after digestion by the use of different acid mixtures and by addition of a fluxing agent for solid recovered fuel (SRF) ash.

a) Method A: Microwave assisted digestion with hydrochloric, nitric and hydrofluoric acid mixture (6 ml HCl; 2 ml HNO_3; 2 ml HF) followed by boric acid complexation;

b) Method AT: Microwave assisted digestion with hydrochloric, nitric and tetrafluoroboric acid mixture (6 ml HCl; 2 ml HNO_3; 4 ml HBF_4);

c) Method B: Microwave assisted digestion with hydrochloric, nitric and hydrofluoric acid mixture (0,5 ml HCl; 6 ml HNO_3; 1 ml HF) followed by boric acid complexation;

d) Method BT: Microwave assisted digestion with hydrochloric, nitric and tetrafluoroboric acid mixture (0,5 ml HCl; 6 ml HNO_3; 2 ml HBF_4);

e) Method C: Microwave assisted digestion with nitric acid, hydrogen peroxide and hydrofluoric acid mixture (2,5 ml H_2O_2; 5 ml HNO_3; 0,4 ml HF) and optional boric acid complexation;

f) Method CT: Microwave assisted digestion with nitric acid, hydrogen peroxide and tetrafluoroboric acid mixture (2,5 ml H_2O_2; 5 ml HNO_3; 0,8 ml HBF_4);

g) Method D: Digestion of the ashed SRF sample with fluxing agent lithium metaborate in an oven at 1 050 °C.

This document is applicable for the following major and minor/trace elements:

— Major elements: aluminium (Al), calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), sodium (Na), phosphorus (P), sulfur (S), silicon (Si) and titanium (Ti).

— Minor/trace elements: arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), molybdenum (Mo), manganese (Mn), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), tin (Sn), thallium (Tl), vanadium (V) and zinc (Zn).

Method A is applicable for general use for SRF and ashed SRFs, but the amount of the test portion can be very low in case of high concentration of organic matter. Method AT can be used if an alternative to HF is necessary.

Method B with a higher volume of nitric acid is applicable for SRFs with high organic matter (e.g. suitable for high plastic content) that can be difficult to digest with less nitric acid or as a substitute for method A if appropriate equipment is not available. Method BT can be used if an alternative to HF is necessary.

Method C with combination of nitric acid and hydrogen peroxide and addition of hydrofluoric acid is applicable for wood based SRFs (e.g. demolition wood) or when there is a need for comparability to solid biofuel standards. Method CT can be used if an alternative to HF is necessary.

Method D is specifically applicable for determination of major elements in ashed SRF samples.

XRF can be used for the analysis of major elements (Al, Ca, Fe, K, Mg, Na, P, S, Si, Ti) after ashing (815 °C) of the samples and several major and minor/trace elements in SRF can be analysed by XRF after suitable calibration provided that the concentration levels are above instrumental detection limits of the XRF instrumentation and after proper preliminary testing and validation.

Digestion methods with HF and subsequent boric acid complexation or application of method D are applicable for determination of Si and Ti (better digestion efficiency).

Alternative digestion methods can be applied, if their performance is proved to be comparable with those of the methods described in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21637, *Solid recovered fuels — Vocabulary*

ISO 21660-3, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 3: Moisture in general analysis sample*

ISO 22940:2021, *Solid recovered fuels — Determination of elemental composition by X-ray fluorescence*

EN 15309:2007, *Characterization of waste and soil — Determination of elemental composition by X-ray fluorescence*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21637 and the following apply.

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

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

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

3.1
digestion
mineralization of the organic matter of a sample and dissolution of its mineral part, more or less completely, when reacted with a reagent mixture

3.2
microwave unit
whole microwave digestion system (oven and associated equipment)

4 Symbols and abbreviations

A_{db}	ash content at 815 °C on a dry basis (A_DB)
Al	aluminium (AL)
Al_{ash}	aluminium in ashed SRF (ALASH)
Ca	calcium (CA)
Ca_{ash}	calcium in ashed SRF (CAASH)
DM	dry mass (DM)