SLOVENSKI STANDARD
SIST EN IEC 62282-8-301:2023

01-september-2023

Tehnologije gorivnih celic - 8-301. del: Sistemi za shranjevanje energije, ki uporabljajo module regenerativnih gorivnih celic - Elektroenergetski sistemi za proizvodnjo metana, ki temeljijo na členih s trdim oksidnim elektrolitom, vključno z obrnjenim delovanjem - Metode za preskušanje zmogljivosti (IEC 62282-8-301:2023)

Fuel cell technologies - Part 8-301: Energy storage systems using fuel cell modules in reverse mode - Power to methane energy systems based on solid oxide cells including reversible operation - Performance test methods (IEC 62282-8-301:2023)

Tehnologije gorivnih celic - 8-301. del: Sistemi za shranjevanje energije, ki uporabljajo module regenerativnih gorivnih celic – Elektroenergetski sistemi za proizvodnjo metana, ki temeljijo na členih s trdim oksidnim elektrolitom - Metode za preskušanje zmogljivosti (IEC 62282-8-301:2023)

Technologies des piles à combustible - Partie 8-301: Systèmes de stockage de l’énergie utilisant des modules à piles à combustible en mode inversé - Systèmes de conversion de l’énergie en méthane à base de piles à oxyde solide, comprenant le fonctionnement réversible - Méthodes d’essai des performances (IEC 62282-8-301:2023)

Ta slovenski standard je istoveten z: **EN IEC 62282-8-301:2023**

ICS:

27.070	Gorilne celice	Fuel cells

SIST EN IEC 62282-8-301:2023 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62282-8-301

July 2023

ICS 27.070

English Version

Fuel cell technologies - Part 8-301: Energy storage systems using fuel cell modules in reverse mode - Power-to-methane energy systems based on solid oxide cells including reversible operation - Performance test methods (IEC 62282-8-301:2023)

Technologies des piles à combustible - Partie 8-301: Systèmes de stockage de l'énergie utilisant des modules à piles à combustible en mode inversé - Systèmes de conversion de l'énergie en méthane à base de piles à oxyde solide, comprenant le fonctionnement réversible - Méthodes d'essai des performances (IEC 62282-8-301:2023)

Brennstoffzellentechnologien - Teil 8-301: Energiespeichersysteme mit Brennstoffzellenmodulen im reversiblen Betrieb - Power-to-Methane-Energiesysteme auf Basis von Festoxidzellen einschließlich reversiblem Betrieb - Leistungskennwerteprüfverfahren (IEC 62282-8-301:2023)

This European Standard was approved by CENELEC on 2023-06-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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

European foreword

The text of document 105/968/FDIS, future edition 1 of IEC 62282-8-301, prepared by IEC/TC 105 "Fuel cell technologies" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62282-8-301:2023.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2024-03-27
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-06-27

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

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 62282-8-301:2023 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standard indicated:

IEC 62282-3-200 NOTE Approved as EN 62282-3-200

ISO 6976 NOTE Approved as EN ISO 6976

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cencenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60584-1	-	Thermocouples - Part 1: EMF specifications and tolerances	EN 60584-1	-
IEC 60584-3	-	Thermocouples - Part 3: Extension and compensating cables - Tolerances and identification system	EN IEC 60584-3	-
IEC 61515	-	Mineral insulated metal-sheathed thermocouple cables and thermocouples	EN 61515	-
IEC 62282-7-2	2021	Fuel cell technologies - Part 7-2: Test methods - Single cell and stack performance tests for solid oxide fuel cells (SOFCs)	EN IEC 62282-7-2	2021
IEC 62282-8-101	2020	Fuel cell technologies - Part 8-101: Energy storage systems using fuel cell modules in reverse mode - Test procedures for the performance of solid oxide single cells and stacks, including reversible operation	EN IEC 62282-8-101	2020
ISO 5167-1	-	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements	EN ISO 5167-1	-
ISO 5168	-	Measurement of fluid flow - Procedures for the evaluation of uncertainties	-	-
ISO 6141	-	Gas analysis - Contents of certificates for calibration gas mixtures	EN ISO 6141	-
ISO 6142-1	-	Gas analysis - Preparation of calibration gas mixtures - Part 1: Gravimetric method for Class I mixtures	EN ISO 6142-1	-
ISO 6143	-	Gas analysis - Comparison methods for determining and checking the composition of calibration gas mixtures	EN ISO 6143	-

ISO 6145-7	-	Gas analysis - Preparation of calibration gas mixtures using dynamic methods - Part 7: Thermal mass-flow controllers	EN ISO 6145-7	-
ISO 6974	series	Natural gas - Determination of composition and associated uncertainty by gas chromatography	EN ISO 6974	series
ISO 6975	-	Natural gas - Extended analysis - Gas-chromatographic method	EN ISO 6975	-
ISO 7066-2	-	Assessment of uncertainty in the calibration and use of flow measurement devices - Part 2: Non-linear calibration relationships	-	-
ISO 8573-1	-	Compressed air - Part 1: Contaminants and purity classes	-	-
ISO 8756	-	Air quality - handling of temperature, pressure and humidity data	-	-
ISO 10101	series	Natural gas - Determination of water by the Karl Fischer method	EN ISO 10101	series
ISO 11541	-	Natural gas - Determination of water content at high pressure	EN ISO 11541	-

IEC 62282-8-301

Edition 1.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fuel cell technologies – Part 8-301: Energy storage systems using fuel cell modules in reverse mode – Power-to-methane energy systems based on solid oxide cells including reversible operation – Performance test methods

Technologies des piles à combustible – Partie 8-301: Systèmes de stockage de l'énergie utilisant des modules à piles à combustible en mode inversé – Systèmes de conversion de l'énergie en méthane à base de piles à oxyde solide, comprenant le fonctionnement réversible – Méthodes d'essai des performances

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 27.070

ISBN 978-2-8322-6860-5

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

FUEL CELL TECHNOLOGIES –

Part 8-301: Energy storage systems using fuel cell modules in reverse mode – Power-to-methane energy systems based on solid oxide cells including reversible operation – Performance test methods

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62282-8-301 has been prepared by IEC technical committee 105: Fuel cell technologies. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
105/968/FDIS	105/983/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62282 series, published under the general title *Fuel cell technologies*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This part of IEC 62282 describes performance evaluation methods for electric energy conversion systems based on power-to-methane systems using solid oxide cells (SOCs) and methanation reactors.

A typical application of the power-to-methane systems is an electrolytic production of methane as the energy carrier suitable for a large-scale, long-term storage and transportation.

The combustion heat of methane per mol is about three times larger than that of hydrogen. Methane is easily liquefied, which makes it suitable for storage and transportation via existing infrastructures for natural gas (tanks, pipelines, tankers, or trucks) as well as for being easily utilized by conventional equipment. Also, the use of "green methane" (produced by renewable electricity) or "carbon neutral methane" in place of "fossil methane" is a promising option in the near future.

The IEC 62282-8 series aims to develop performance test methods for power storage and buffering systems based on electrochemical modules (combining electrolysis and fuel cells, in particular reversible cells), taking into consideration both options of re-electrification and substance (and heat) production for the sustainable integration of renewable energy sources.

Under the general title "Energy storage systems using fuel cell modules in reverse mode", the IEC 62282-8 series consists of the following parts:

- IEC 62282-8-101: Test procedures for the performance of solid oxide single cells and stacks, including reversible operation
- IEC 62282-8-102: Test procedures for the performance of single cells and stacks with proton exchange membrane, including reversible operation
- IEC 62282-8-103[1]: Alkaline single cell and stack performance including reversible operation
- IEC 62282-8-201[2]: Test procedures for the performance of power-to-power systems
- IEC 62282-8-202[3]: Power-to-power systems – Safety
- IEC 62282-8-3xy (all parts): Power-to-substance systems

As a priority dictated by the emerging needs for industry and the opportunities for technological development, IEC 62282-8-101, IEC 62282-8-102 and IEC 62282-8-201 were initiated jointly.

This document is the first of the IEC 62282-8-3xy series.

[1] Under consideration.

[2] Second edition under preparation. Stage at the time of publication: IEC CDV 62282-8-201:2023.

[3] Under consideration.

FUEL CELL TECHNOLOGIES –

Part 8-301: Energy storage systems using fuel cell modules in reverse mode – Power-to-methane energy systems based on solid oxide cells including reversible operation – Performance test methods

1 Scope

This part of IEC 62282 specifies performance test methods of power-to-methane systems based on solid oxide cells (SOCs). Water, CO_2, and electricity are supplied to the system to produce methane and oxygen.

This document is not intended to be applied to solid oxide fuel cell (SOFC) cell/stack assembly units for power generation purposes only, since these are covered in IEC 62282-7-2. In addition, the test methods for SOC cell/stack assembly units including reversible operation (without any methanation reactor) are already described in IEC 62282-8-101. Users can substitute the selected test methods of this document with the equivalent test methods given in IEC 62282-8-101 (solid oxide electrolysis cell (SOEC) to produce H_2 only as well as SOFC operation mode and reversible mode) and in IEC 62282-7-2 (SOFC mode only).

This document covers two types of processes as shown in Figure 1:

- Case 1: Steam and CO_2 are introduced into the SOC (co-electrolysis process), and the product gas (mainly, H_2 + CO) is supplied to a methanation reactor (catalytic reactor);
- Case 2: Steam is introduced into the SOC to generate H_2, which is supplied into a methanation reactor with CO_2.

Besides these two cases, the methanation catalyst can be integrated within the SOC, but this case is not within the scope of this document. This document provides, for testing systems, information on instruments and specifies measurement methods to test the performance of SOC cell/stack assembly units and of the methanation reactor for energy conversion purposes. To produce CH_4 from water and CO_2, the SOC is operated in electrolysis mode (solid oxide electrolysis cell (SOEC)). The SOC can be operated either in fuel cell mode (SOFC) or in reversible operation mode or both. In this document, the system is considered not to have components which store electricity, fluids, or heat.

This document is intended to be used for data exchanges in commercial transactions between the system manufacturers and customers. Users of this document can selectively execute test items suitable for their purposes from those described in this document.

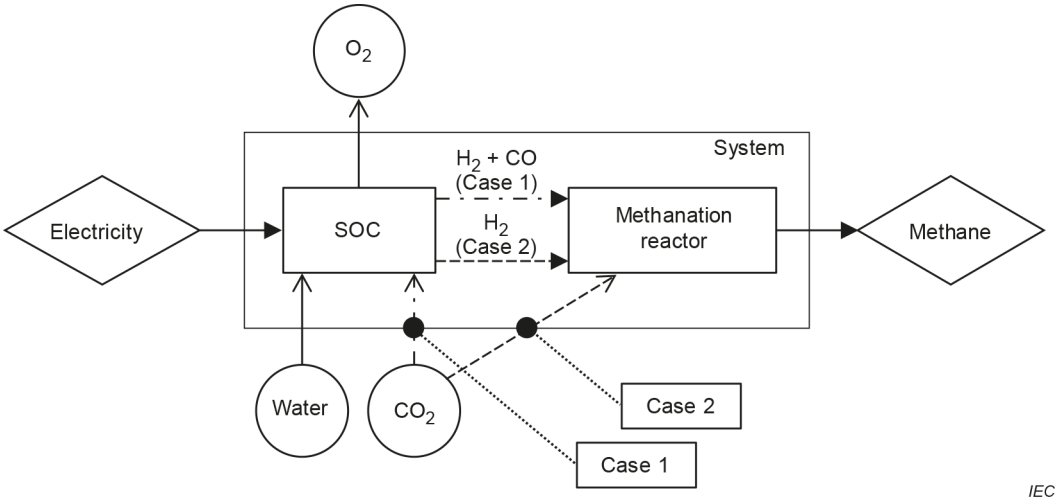

Figure 1 – Process schematic of the scope of IEC 62282-8-301

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.

IEC 60584-1, *Thermocouples – Part 1: EMF specifications and tolerances*

IEC 60584-3, *Thermocouples – Part 3: Extension and compensating cables – Tolerances and identification system*

IEC 61515, *Mineral insulated metal-sheathed thermocouple cables and thermocouples*

IEC 62282-7-2:2021, *Fuel cell technologies – Part 7-2: Test methods – Single cell and stack performance tests for solid oxide fuel cells (SOFC)*

IEC 62282-8-101:2020, *Fuel cell technologies – Part 8-101: Energy storage systems using fuel cell modules in reverse mode – Test procedures for the performance of solid oxide single cells and stacks, including reversible operation*

ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 1: General principles and requirements*

ISO 5168, *Measurement of fluid flow – Procedures for the evaluation of uncertainties*

ISO 6141, *Gas analysis – Contents of certificates for calibration gas mixtures*

ISO 6142-1, *Gas analysis – Preparation of calibration gas mixtures – Part 1: Gravimetric method for Class I mixtures*

ISO 6143, *Gas analysis – Comparison methods for determining and checking the composition of calibration gas mixtures*

ISO 6145-7, *Gas analysis – Preparation of calibration gas mixtures using dynamic methods – Part 7: Thermal mass-flow controllers*

ISO 6974 (all parts), *Natural gas – Determination of composition and associated uncertainty by gas chromatography*

ISO 6975, *Natural gas – Extended analysis – Gas-chromatographic method*

ISO 7066-2, *Assessment of uncertainty in the calibration and use of flow measurement devices – Part 2: Non-linear calibration relationships*

ISO 8573-1, *Compressed air – Part 1: Contaminants and purity classes*

ISO 8756, *Air quality – Handling of temperature, pressure and humidity data*

ISO 10101 (all parts), *Natural gas – Determination of water by the Karl Fischer method*

ISO 11541, *Natural gas – Determination of water content at high pressure*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

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

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
active electrode area
effective electrode area
geometric area of the electrode where the electrochemical reaction takes place

Note 1 to entry: Usually this corresponds to the smaller of the two areas of negative electrode or positive electrode.

Note 2 to entry: Area perpendicular to the ionic current flow, usually expressed in m^2 or cm^2.

[SOURCE: IEC 62282-8-101:2020, 3.1.1]

3.1.2
additional gas
gas added to the product gas from the negative electrode for the reaction in the methanation reactor

Note 1 to entry: For Case 2 in Figure 1, the additional gas is CO_2.

Note 2 to entry: For Case 1 in Figure 1 (co-electrolysis mode), CO_2 or H_2 or both can be added to convert the product gas from the negative electrode into CH_4 efficiently.

3.1.3
area-specific resistance
ASR
internal resistivity of any component of a cell or a stack, including the change of potential due to the electrochemical reaction

Note 1 to entry: It is normalized by the active electrode area and is expressed in $\Omega \cdot m^2$ or $\Omega \cdot cm^2$.

[SOURCE: IEC 62282-8-101:2020, 3.1.2]

3.1.4
catalyst
substance that accelerates a reaction without being consumed itself

[SOURCE: IEC 60050-485:2020, 485-01-01, modified – "electrochemical reaction" has been replaced by "reaction" and Note 1 and Note 2 have been deleted.]

3.1.5
cell
single cell
basic unit of a solid oxide cell

[SOURCE: IEC 62282-8-101:2020, 3.1.7, modified – "cell" has become a preferred term.]

3.1.6
cold state
state of a power-to-methane system at ambient temperature with no power input or output

Note 1 to entry: The cold state can come after the storage state during cooling-down of the system.

[SOURCE: IEC 60050-485:2020, 485-21-01, modified – "fuel cell power system" has been replaced by "power-to-methane system" and the Note to entry has been added.]

3.1.7
compression force
axial load
compressive load applied to the single cell or to the end plates of a planar SOC stack to ensure electric contact and gas tightness

Note 1 to entry: The compression force is in practice expressed in N.

[SOURCE: IEC 62282-8-101:2020, 3.1.7, modified – The preferred term "axial load" has become an admitted term and the admitted term "compression force" has become a preferred term.]

3.1.8
conditioning
preliminary step of treatment that is required to properly operate a SOC and is usually realized by following a protocol specified by the manufacturer

[SOURCE: IEC 62282-8-101:2020, 3.1.8, modified – The Note 1 to entry has been deleted.]

3.1.9
conversion of CO_2 into CH_4
catalytic conversion percentage of carbon dioxide into methane in the methanation reactor

3.1.10
conversion of H_2 into CH_4
catalytic conversion percentage of hydrogen into methane in the methanation reactor

3.1.11
current density
electric current per unit active area of the electrode

Note 1 to entry: The current density is expressed in A/m^2 or A/cm^2.

[SOURCE: IEC 60050-485:2020, 485-12-01, modified – "of the electrode" has been added and the domain has been deleted.]