IEC 62282-8-201

Edition 1.0 2020-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Fuel cell technologies – Part 8-201: Energy storage systems using fuel cell modules in reverse mode – Test procedures for the performance of power-to-power systems

Technologies des piles à combustible – Partie 8-201: Systèmes de stockage de l'énergie utilisant des modules à piles à combustible en mode inversé – Procédures d'essai pour la performance des systèmes électriques à électriques

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INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FUEL CELL TECHNOLOGIES –

Part 8-201: Energy storage systems using fuel cell modules in reverse mode – Test procedures for the performance of power-to-power systems

FOREWORD

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International Standard IEC 62282-8-201 has been prepared by IEC technical committee 105: Fuel cell technologies.

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

FDIS	Report on voting
105/764/FDIS	105/777/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 "http://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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 62282 describes performance evaluation methods for electric energy storage systems using hydrogen that employ electrochemical reactions both for water/steam electrolysis and electric generation.

This document is intended for power to power systems which typically employ a set of electrolyser and fuel cell, or a reversible cell for devices of electric charge and discharge.

A typical targeting application of the electric energy storage systems using hydrogen is in the class of energy intensive electric energy storage. The systems are recognized as critically useful for the relatively long-term power storage operation, such as efficient storage and supply of the renewable power derived electric energy and grid stabilization.

IEC 62282-8 (all parts) 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 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 membranes, including reversible operation*
- IEC 62282-8-103[1]: *Alkaline single cell and stack performance including reversible operation*
- IEC 62282-8-201: *Test procedures for the performance of power-to-power systems*
- IEC 62282-8-202[2]: *Power-to-power systems – Safety*
- IEC 62282-8-300 (all parts)[3]: *Power-to-substance systems*

As a priority dictated by the emerging needs for industry and opportunities for technological development, IEC 62282-8-101, IEC 62282-8-102 and IEC 62282-8-201 have been initiated jointly and firstly. These parts are presented as a package to highlight the need for an integrated approach as regards the system's application (i.e. a solution for energy storage) and its fundamental constituent components (i.e. fuel cells operated in reverse or reversing mode).

IEC 62282-8-103, IEC 62282-8-202 and IEC 62282-8-300 (all parts) are suggested but are left for initiation at a later stage.

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1 Under consideration.

2 Under consideration.

3 Under consideration.

FUEL CELL TECHNOLOGIES –

Part 8-201: Energy storage systems using fuel cell modules in reverse mode – Test procedures for the performance of power-to-power systems

1 Scope

This part of IEC 62282 defines the evaluation methods of typical performances for electric energy storage systems using hydrogen. This is applicable to the systems that use electrochemical reaction devices for both power charge and discharge. This document applies to systems that are designed and used for service and operation in stationary locations (indoor and outdoor).

The conceptual configurations of the electric energy storage systems using hydrogen are shown in Figure 1 and Figure 2. Figure 1 shows the system independently equipped with an electrolyser module and a fuel cell module. Figure 2 shows the system equipped with a reversible cell module. There are an electrolyser, a hydrogen storage and a fuel cell, or a reversible cell, a hydrogen storage and an overall management system (which may include a pressure management) as indispensable components. There may be a battery, an oxygen storage, a heat management system (which may include a heat storage) and a water management system (which may include a water storage) as optional components. The performance measurement is executed in the area surrounded by the outside thick solid line square (system boundary).

NOTE In the context of this document, the term "reversible" does not refer to the thermodynamic meaning of an ideal process. It is common practice in the fuel cell community to call the operation mode of a cell that alternates between fuel cell mode and electrolysis mode "reversible".

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.

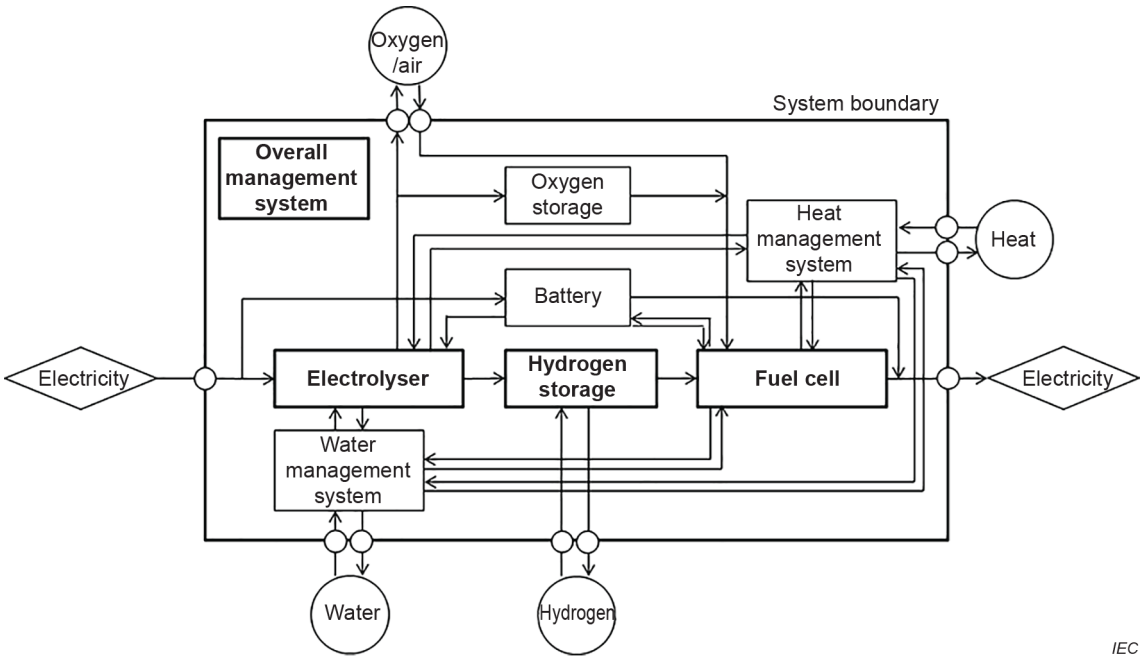

Figure 1 – System configuration of electric energy storage system using hydrogen – Type with electrolyser and fuel cell

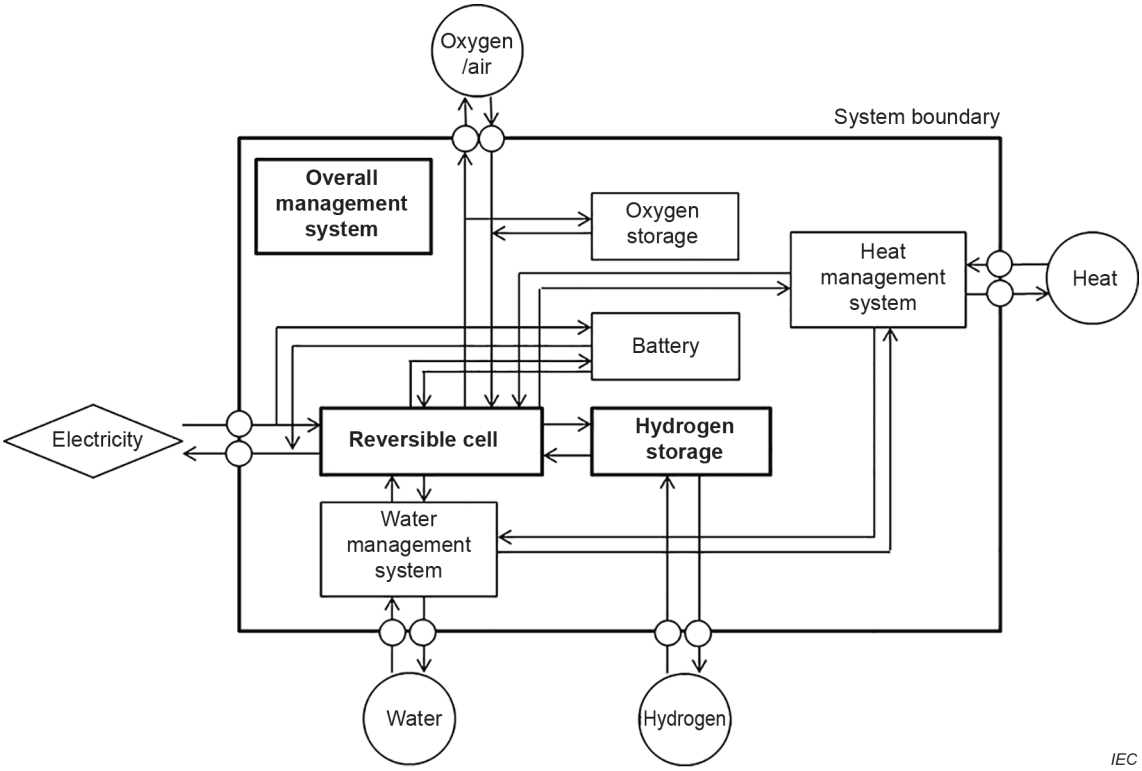

Figure 2 – System configuration of electric energy storage system using hydrogen – Type with reversible cell

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 61427-1, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 1: Photovoltaic off-grid application*

IEC 61427-2, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications*

IEC 62282-3-200, *Fuel cell technologies – Part 3-200: Stationary fuel cell power systems – Performance test methods*

IEC 62282-3-201, *Fuel cell technologies – Part 3-201: Stationary fuel cell power systems – Performance test methods for small fuel cell power systems*

IEC 62282-8-101, *Fuel cell technologies – Part 8-101: Energy storage systems using fuel cell modules in reverse mode – Solid oxide single cell and stack performance including reversible operation*

IEC 62282-8-102, *Fuel cell technologies – Part 8-102: Energy storage systems using fuel cell modules in reverse mode – Test procedures for PEM single cell and stack performance including reversible operation*

IEC 62933-2-1:2017, *Electrical energy storage (EES) systems – Part 2-1: Unit parameters and testing methods – General specification*

ISO/IEC Guide 98-3, *Uncertainly of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 3746, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

ISO 4064-1, *Water meters for cold potable water and hot water – Part 1: Metrological and technical requirements*

ISO 4064-2, *Water meters for cold potable water and hot water – Part 2: Test methods*

ISO 7888, *Water quality – Determination of electrical conductivity*

ISO 9614-1, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*

ISO 11204, *Acoustics – Noise emitted by machinery and equipment – Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections*

ISO 16111, *Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride*

ISO 19880-1, *Gaseous hydrogen – Fuelling stations – Part 1: General requirements*

ISO 19881, *Gaseous hydrogen – Land vehicle fuel containers*

ISO 19882, *Gaseous hydrogen – Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers*

ISO 19884, *Gaseous hydrogen – Cylinders and tubes for stationary storage*

ISO 22734-1, *Hydrogen generators using water electrolysis process – Part 1: Industrial and commercial applications*

ISO 22734-2, *Hydrogen generators using water electrolysis process – Part 2: Residential applications*

3 Terms, definitions and symbols

3.1 Terms and definitions

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:

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

3.1.1
electric energy storage
EES
installation able to store electric energy or which converts electric energy into another form of energy and vice versa, while storing energy

Note 1 to entry: EES can be used also to indicate the activity of an apparatus described in the definition during performing its own functionality.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 62933-1:2018, 3.1, modified – Definition revised and example and note 2 deleted.]

3.1.2
electric energy storage system
EES system
installation with defined electrical boundaries, comprising at least one EES, whose purpose is to extract electric energy from the electric power system, store this energy in some manner and inject electric energy into the electric power system and which includes civil engineering works, energy conversion equipment and related ancillary equipment

Note 1 to entry: The EES system is controlled and coordinated to provide services to the electric power system operators or to the electric power system users.

Note 2 to entry: In some cases, an EES system can require an additional energy source during its discharge, providing more energy to the electric power system than the energy it stores.

Note 3 to entry: This note applies to the French language only.

[SOURCE: IEC 62933-1:2018, 3.2, modified – "grid connected" and "internally" deleted, "whose purpose is to" added and note 3 deleted.]

3.1.3
EES system using hydrogen
EES system comprising at least one EES using hydrogen, whose purpose is to extract electric energy from the electric power system, store this energy as hydrogen and inject electric energy into the electric power system, using hydrogen as a fuel

Note 1 to entry: The conceptual configurations of the EES system using hydrogen are referred to in Clause 1.

3.1.4
battery
device for storing electricity with electricity charge and discharge functions

Note 1 to entry: They are typically employed for absorbing short-term fluctuating electricity input combined with hydrogen storage of an EES system using hydrogen.

3.1.5
electrolyser
electrochemical device that converts water/steam to hydrogen and oxygen by electrolysis reaction

Note 1 to entry: They include alkaline water electrolysis device, polymer electrolyte water electrolysis device, solid oxide electrolysis cell device, and other devices of similar type.

3.1.6
environment
surroundings in which an EES system using hydrogen exists, including air, water, land, natural resources, flora, fauna, humans, and their interrelation

3.1.7
fuel cell
electrochemical device that converts the chemical energy of a fuel and an oxidant to electric energy (DC power), heat and reaction products

Note 1 to entry: The fuel and oxidant are typically stored outside of the fuel cell and transferred into the fuel cell as they are consumed.

[SOURCE: IEC 60050-485:—, 485-08-01]

3.1.8
heat management system
subsystem of the EES system using hydrogen, for controlling the heat storage and flows in the system and its POCs (if applicable)

Note 1 to entry: Typically, heat is utilized among the various system equipment. An example of the mutual heat utilization is where the exothermic reaction heat of the fuel cell is conveyed to an electrolysis cell, in particular a solid oxide electrolysis cell for endothermic consumption.

3.1.9
hydrogen storage
component of the EES system using hydrogen, for storing hydrogen which is produced by water/steam electrolysis in or supplied to the system

Note 1 to entry: There are several kinds of hydrogen storage equipment depending on the hydrogen storage principles. They include low/high-pressure gas, liquid, hydrogen-absorbing alloy (hydrogen absorbed in reversible metal hydride), non-metal hydrides and others.

3.1.10
limit operating conditions
conditions not to be exceeded for operating the system normally and safely

Note 1 to entry: They are recommended by the system manufacturer considering the system characteristics.

3.1.11
net electric energy output
usable electric energy output from the EES system using hydrogen, which is able to serve for the user's purpose, excluding internal and external electric energy dissipation of the system

Note 1 to entry: The internal and external electric dissipation of the system is typically electric energy loss from the equipment operations and connections.

Note 2 to entry: The net electric energy output is the difference between the electric energy outputs and inputs at all POCs.

3.1.12
net electric power
power output of the electric energy storage system and available for external use

Note 1 to entry: The net electric power output is the difference between the electric power outputs and inputs at all POCs.

3.1.13
operating conditions
conditions at which the tested system, more specifically each equipment of the tested system, is operated, as well as physical conditions such as range of ambient temperatures, pressure, radiation levels, humidity and atmosphere are included

3.1.14
operating state
state at which the tested system, more specifically each equipment of the tested system, is operated at specified conditions

3.1.15
overall management system
subsystem of the EES system using hydrogen, served for monitoring and controlling the EES system using hydrogen, by fulfilling all equipment and functions for acquisition, processing, transmission, and display of the necessary process information

Note 1 to entry: The overall management system also includes a subsystem containing an arrangement of hardware, software, and propagation media to allow the transfer of messages from one EES system using hydrogen component/subsystem to another one, including the data interface with external links.

Note 2 to entry: Generally, the control subsystem may be connected to the primary POC (just for data exchange) and it can comprise the communication subsystem and the protection subsystem.

Note 3 to entry: The protection subsystem includes one or more protection equipment, instrument transformer(s), transducers, wiring, tripping circuit(s), auxiliary supply(s). Depending upon the principle(s) of the protection system, it may include one end or all ends of the protected section and, possibly, automatic reclosing equipment.

3.1.16
oxygen storage
one component of the EES system using hydrogen, for storing oxygen, which is produced by water/steam electrolysis in (or supplied to) the system

Note 1 to entry: Oxygen storage is equipped, if needed.

3.1.17
point of connection
POC
point where an EES system using hydrogen is connected to a supply/extraction exterior to the system

Note 1 to entry: Generally, POCs are electricity, heat, water, hydrogen and oxygen/air connection points. They are shown as open circles on the system boundary (thick solid-line square) in Figure 1 and Figure 2.

Note 2 to entry: This note applies to the French language only.

3.1.18
quiescent state
operating state of the EES system, where it is partly or fully charged, and no intended discharging of the stored energy takes place

3.1.19
quiescent state loss rate
sum of energy loss rate and energy consumption rate of EES system during the quiescent state

3.1.20
rated operating conditions
conditions which are applied for standard operation of equipment and/or system

Note 1 to entry: They are recommended by the equipment and/or system manufacturers considering the respective characteristics of the equipment/system.

3.1.21
rated input conditions
conditions specified by the manufacturer, at which the tested system absorbs electric power input at the POC

3.1.22
rated output conditions
conditions specified by the manufacturer, at which the tested system delivers electric power output at the POC

3.1.23
rated test conditions
specific boundary conditions at which the tested system is operated

Note 1 to entry: They shall be agreed between the system manufacturer and customer.

3.1.24
reversible cell
electrochemical device that is able to operate as a fuel cell or as an electrolyser, alternatively

Note 1 to entry: The term "reversible" in this context does not refer to the thermodynamic principle of an ideal process.

3.1.25
roundtrip electrical efficiency
electric energy discharged measured on the primary point of connection (POC) divided by the electric energy absorbed, measured on all the POC (primary and auxiliary), over one EES system standard charging/discharging cycle in specified operating conditions

Note 1 to entry: Efficiency is generally expressed in percentage.

3.1.26
operation history
record of the operating conditions of the system

3.1.27
switchover time
time that is required to switch an EES system using hydrogen from a specified charging phase to a specified discharging phase or vice versa

Note 1 to entry: This can be of relevance in case grid service shall be performed with the system. It comprises the time that is required to go from one operating point in either charging or discharging operation to quiescent state, purging of gas lines if applicable, setting of auxiliary components (valves, heaters, compressors etc.) if applicable and to go to an operating point in the opposite operating phase (discharging or charging).

3.1.28
test state
state of the tested system that is consistent with the objective of the evaluation

Note 1 to entry: More specifically, it means the specific operating state for equipment of the tested system.

3.1.29
tested system
system defined by its boundary to the environment, that is in accordance with the objective of the evaluation

3.1.30
water management system
subsystem of the EES system using hydrogen, for controlling the water and/or steam flows in the system

Note 1 to entry: It includes the controlling mechanisms of water inlet, transport, purifying (if applicable), and drain.

3.2 Symbols

The symbols and their meanings used in this document are given in Table 1, with the appropriate units.