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Fuel cell technologies -
Part 3-200: Stationary fuel cell power systems - Performance test methods

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Fuel cell technologies - Part 3-200: Stationary fuel cell power systems - Performance test methods

FOREWORD

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IEC 62282-3-200 has been prepared by IEC technical committee 105: Fuel cell technologies. It is an International Standard.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) revision of the Introduction, Scope and Clause 3;
b) revision of the symbols in Table 1;
c) revision of Figure 2 (symbol diagram);
d) revision of measurement methods (8.3);
e) revision of the efficiency test (10.2);

f) revision of the electric power and thermal power response characteristics test (10.3);

g) revision of the start-up and shutdown characteristics test (10.4);

h) revision of Annex C.

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

Draft	Report on voting
105/1124/FDIS	105/1134/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- withdrawn, or
- revised.

INTRODUCTION

This part of IEC 62282 describes how to measure the performance of stationary fuel cell power systems for residential, commercial, agricultural and industrial applications.

This document describes type tests and their test methods only. In this document, no routine tests are required or identified, and no performance targets are set.

A related but independent standard IEC 62282-3-201 on the performance test methods of small stationary fuel cell power systems has been aligned with this document.

1 Scope

This part of IEC 62282 covers operational and environmental aspects of the stationary fuel cell power systems performance. The test methods apply as follows:

– power output under specified operating and transient conditions;
– electrical and heat recovery efficiency under specified operating conditions;
– environmental characteristics, for example, exhaust gas emissions, noise, under specified operating and transient conditions.

This document applies to all kinds of stationary fuel cell technologies, such as:

– alkaline fuel cells (AFC);
– phosphoric acid fuel cells (PAFC);
– polymer electrolyte fuel cells (PEFC);
– molten carbonate fuel cells (MCFC);
– solid oxide fuel cells (SOFC).

This document does not provide coverage for electromagnetic compatibility (EMC).

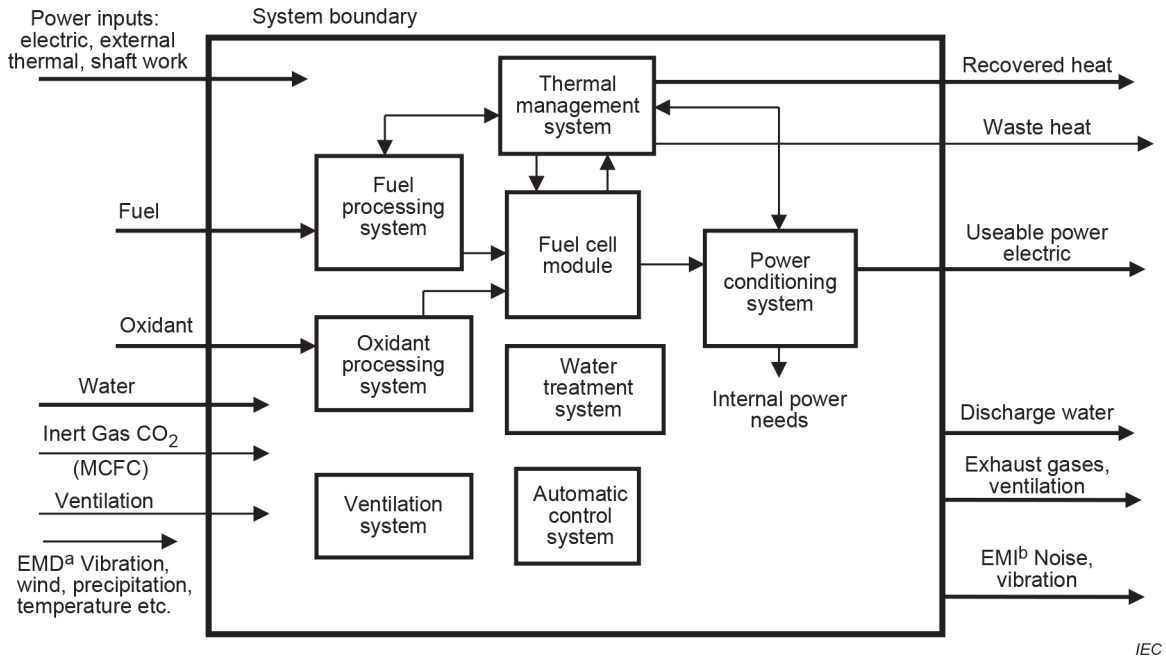
This document does not apply to small stationary fuel cell power systems with rated electric power output of less than 10 kW which are dealt with in IEC 62282-3-201.

Fuel cell power systems can have different subsystems depending upon types of fuel cell and applications, and they have different streams of material and energy into and out of them. However, a common system diagram and boundary has been defined for evaluation of the fuel cell power system (see Figure 1).

The following conditions are considered in order to determine the system boundary of the fuel cell power system:

– all energy recovery systems are included within the system boundary;
– all kinds of electric energy storage devices are considered outside the system boundary;
– calculation of the heating value of the input fuel (such as natural gas, propane gas and pure hydrogen gas) is based on the conditions of the fuel at the boundary of the fuel cell power system.

The document does not provide safety requirements for the testing of stationary fuel cell power systems. Details on safe operation of the tested system can be obtained from the manufacturers instructions.



Key

Fuel cell power system including subsystems. The interface is defined as a conceptual or functional one instead of hardware such as a power package.

Subsystems: fuel cell module, fuel processor, etc. These subsystem configurations depend on the kind of fuel, type of fuel cell or system.

The interface points in the boundary to be measured for calculation data.

[a] EMD electromagnetic disturbance

[b] EMI electromagnetic interference

Figure 1 – Fuel cell power system diagram

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 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60359, *Electrical and electronic measurement equipment - Expression of performance*

IEC 60688, *Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals*

IEC 61000-4-7, *Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC 61028, *Electrical measuring instruments - X-Y recorders*

IEC 61143 (all parts), *Electrical measuring instruments - X-t recorders*

IEC 61672-1, *Electroacoustics - Sound level meters - Part 1: Specifications*

IEC 61672-2, *Electroacoustics - Sound level meters - Part 2: Pattern evaluation tests*

IEC 62052-11, *Electricity metering equipment - General requirements, tests and test conditions - Part 11: Metering equipment*

IEC 62053-22, *Electricity metering equipment - Particular requirements - Part 22: Static meters for AC active energy (classes 0,1S, 0,2S and 0,5S)*

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

ISO 3648, *Aviation fuels - Estimation of net specific energy*

ISO 3744, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane*

ISO 4677-1, *Atmospheres for conditioning and testing - Determination of relative humidity – Part 1: Aspirated psychrometer method*

ISO 4677-2, *Atmospheres for conditioning and testing - Determination of relative humidity – Part 2: Whirling psychrometer method*[1]

ISO 5167 (all parts), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

ISO 5348, *Mechanical vibration and shock - Mechanical mounting of accelerometers*

ISO 5815-2, *Water quality - Determination of biochemical oxygen demand after n days (BODn) - Part 2: Method for undiluted samples*

ISO 6060, *Water quality - Determination of the chemical oxygen demand*

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 7934, *Stationary source emissions - Determination of the mass concentration of sulfur dioxide - Hydrogen peroxide/barium perchlorate/Thorin method*

ISO 7935, *Stationary source emissions - Determination of the mass concentration of sulfur dioxide in flue gases - Performance characteristics of automated measuring systems*

ISO 8217:2024, *Products from petroleum, synthetic and renewable sources - Fuels (class F) - Specifications of marine fuels*

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

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[1] This publication was withdrawn.

ISO 10396, *Stationary source emissions - Sampling for the automated determination of gas emission concentrations for permanently-installed monitoring systems*

ISO 10523, *Water quality - Determination of pH*

ISO 11626, *Natural gas - Determination of sulfur compounds - Determination of hydrogen sulfide content by UV absorption method*

ISO 10849, *Stationary source emissions - Determination of the mass concentration of nitrogen oxides in flue gas - Performance characteristics of automated measuring systems*

ISO 11042-1, *Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation*

ISO 11042-2, *Gas turbines - Exhaust gas emission - Part 2: Automated emission monitoring*

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

ISO 11564, *Stationary source emissions - Determination of the mass concentration of nitrogen oxides - Naphthylethylenediamine photometric method*

ISO 11632, *Stationary source emissions - Determination of mass concentration of sulfur dioxide - Ion chromatography method*

ISO 14687, *Hydrogen fuel - Product specification*

ISO/TR 15916, *Basic considerations for the safety of hydrogen systems*

ISO 16622, *Meteorology - Sonic anemometers/thermometers - Acceptance test methods for mean wind measurements*

ISO 16960, *Natural gas - Determination of sulfur compounds - Determination of total sulfur by oxidative microcoulometry method*

ISO 19739, *Natural gas - Determination of sulfur compounds using gas chromatography*

ISO 20729, *Natural gas - Determination of sulfur compounds - Determination of total sulfur content by ultraviolet fluorescence method*

ASTM D4809, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)*

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 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
auxiliary electric power input
electric power for auxiliary machines and equipment supplied from outside the system boundary

3.1.2
background noise level
sound pressure level of ambient noise at the measurement point

Note 1 to entry: This measurement is taken as described in this document with the fuel cell power system in the cold state.

3.1.3
background vibration level
mechanical oscillations level caused by the environment that affect vibration level readings

Note 1 to entry: In this document, background vibration is measured with the fuel cell power system in the cold state.

3.1.4
cold state
state of a fuel cell power system, which is entirely at ambient temperature with no power input or output, ready for start-up

Note 1 to entry: Power input to a control device for monitoring the fuel cell power system during cold state is not taken into consideration.

[SOURCE: IEC 60050-485:2020, 485-21-01, modified – "which is entirely" and "ready for start-up" added; Note 1 to entry added.]

3.1.5
discharge water
water discharged from the fuel cell power system including waste water and condensate

3.1.6
electrical efficiency
ratio of the average net electric power output produced by a fuel cell power system to the average total power input supplied to the fuel cell power system

Note 1 to entry: Lower heating value (LHV) is assumed unless otherwise stated.

Note 2 to entry: Any electric power that is supplied to auxiliary machines and equipment of a fuel cell power system from an external source is deducted from the electric power output of the fuel cell power system.

[SOURCE: IEC 60050-485:2020, 485-10-02, modified – "electrical" instead of "electric" in the preferred term; "average net electric power output" instead of "net electric power"; "average total power input" instead of "total enthalpy flow"; “Note 2 to entry added.]

3.1.7
external thermal energy
additional thermal energy input from outside the system boundary

Note 1 to entry: External thermal energy can be supplied e.g. by make-up water or process condensate return.

3.1.8
fuel cell module
assembly incorporating one or more fuel cell stacks and, if applicable, additional components, that is intended to be integrated into a power system

Note 1 to entry: A fuel cell module comprises the following main components: one or more fuel cell stack(s), a piping system for conveying fuels, oxidants and exhausts, electric connections for the power delivered by the stack(s), and means for monitoring, control or both. Additionally, a fuel cell module can comprise: means for conveying additional fluids (e.g. cooling media, inert gas, CO_2 (MCFC)), means for detecting normal and abnormal operating conditions, enclosures or pressure vessels and module ventilation systems, and the required electronic components for module operation and power conditioning.

[SOURCE: IEC 60050-485:2020, 485-09-03, modified – In the definition "or a vehicle" deleted and in the Note to entry, "CO_2 (MCFC)" added.]

3.1.9
fuel cell power system
generator system that uses one or more fuel cell modules to generate electric power and heat

Note 1 to entry: A fuel cell power system is composed of all or some of the systems shown in Figure 1.

[SOURCE: IEC 60050-485:2020, 485-09-01, modified – Note 1 to entry added.]

3.1.10
fuel input
amount of natural gas, hydrogen, methanol, liquid petroleum gas, propane, butane, or other substance containing chemical energy introduced to the fuel cell power system during specified operating conditions

3.1.11
heat recovery efficiency
ratio of the average recovered thermal power output of a fuel cell power system to the average total power input supplied to the fuel cell power system

[SOURCE: IEC 60050-485:2020, 485-10-04, modified – "average recovered thermal power output" instead of "recovered heat flow"; "average total power input" instead of "total enthalpy flow"; Note 1 to entry deleted.]

3.1.12
interface point
measurement point at the boundary of a fuel cell power system at which material or energy, or both, either enters or leaves

Note 1 to entry: This boundary is intentionally selected to accurately measure the performance of the system including all normal operation, both steady state and transient. If necessary, the boundary or the interface points of the fuel cell power system (Figure 1) to be assessed should be determined by agreement between the parties.

[SOURCE: IEC 60050-485:2020, 485-09-12, modified – In Note 1 to entry, reference to Figure 1 added and Note 2 to entry deleted.]

3.1.13
minimum power
lowest net electric power output at which a fuel cell power system is able to operate continuously in a stable manner

[SOURCE: IEC 60050-485:2020, 485-14-02, modified – "output" added, Note 1 to entry deleted.]

3.1.14
noise level
sound pressure level produced by a fuel cell power system

Note 1 to entry: Noise level is expressed in decibels (dB) and measured at a specified distance and in all operation modes as described in this document.

3.1.15
operating temperature
temperature at which the fuel cell power system operates and with its determination specified by the manufacturer

Note 1 to entry: The temperature can be either measured at a specific measuring point or determined from the measurement at several specific points.

3.1.16
overall energy efficiency
ratio of total useable power output (net electrical power and recovered thermal power) to the average total power input supplied to the fuel cell power system

Note 1 to entry: The supplied total power input of the fuel should be related to the lower heating value (LHV) for a better comparison with other types of energy conversion systems.

Note 2 to entry: Refer to 4.3 regarding reporting based on LHV or HHV.

[SOURCE: IEC 60050-485:2020, 485-10-05, modified – Second preferred term "total thermal efficiency" deleted; in the definition,"power output" instead of "energy flow"; "thermal power" instead of "heat flow"; "average total power input" instead of "total enthalpy flow"; in Note 1 to entry, "total power input" instead of "total (including reaction enthalpy) enthalpy flow" and Note 2 to entry added.]

3.1.17
oxidant input
amount of oxidant (air) input into the inside of the fuel cell module during specified operating conditions

Note 1 to entry: The oxidant is usually air, but other oxidants (e.g. oxygen) can be used.

3.1.18
power response time
duration between the instant of initiating a change of electric or thermal power output and when the electric or thermal power output attains the set value within tolerance

3.1.19
90 % power response time
duration between the instant of initiating a change of electric or thermal power output and when the electric or thermal power output attains 90 % of the desired value within tolerance

3.1.20
pre-generation state
state of a fuel cell power system at a sufficient operating temperature and in such an operational mode, with zero electric power output, that the fuel cell power system is capable of being promptly switched to an operational state with a substantial net electric power output

[SOURCE: IEC 60050-485:2020, 485-21-04, modified – second preferred term "pre-generation operation" deleted and in the definition, "net" added before “electric”]

3.1.21
purge gas consumption
amount of inert gas or dilution gas supplied to the fuel cell power system during specific conditions to make it ready for operation or shutdown