IEC 62282-3-200

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Technologies des piles à combustible –
Partie 3-200: Systèmes à piles à combustible stationnaires – Méthodes d'essai des performances

IEC 62282-3-200:2011

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

This first edition of IEC 62282-3-200 cancels and replaces the first edition of IEC 62282-3-2, published in 2006, and constitutes a technical as well as a structural revision.

The principal changes in this first edition of IEC 62282-3-200 as compared with the first edition of IEC 62282-3-2 aim to harmonize with ASME PTC-50. They are as follows:

– the equations for efficiency calculation are changed from power-base to average power-base, which is obtained by dividing energy by test duration;
– the duration of the test and frequency of reading are changed;
– the efficiency test at partial load is no longer mandatory. Whether or not to conduct the test at partial load should be determined by the parties conducting the tests;

– the flow rate measurement method is modified. Both mass flow rate and volume flow rate are used for calculations of efficiency;

– the thermal energy input and mechanical energy input are incorporated into efficiency calculations.

The development of an independent standard on performance test methods of small stationary fuel cell power systems is currently under way (future IEC 62282-3-201). It will be harmonized with this standard.

The text of this standard is based on the following documents:

FDIS	Report on voting
105/340/FDIS	105/349/RVD

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

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

A list of all the 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication 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 how to measure the performance of stationary fuel cell power systems for residential, commercial, agricultural and industrial applications.

The following fuel cell types have been considered:

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

FUEL CELL TECHNOLOGIES –

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

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;

– electric and thermal efficiency under specified operating conditions;

– environmental characteristics; for example, gas emissions, noise, etc. under specified operating and transient conditions.

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

This standard does not apply to small stationary fuel cell power systems with electric power output of less than 10 kW which will be dealt with in the future IEC 62282-3-201.

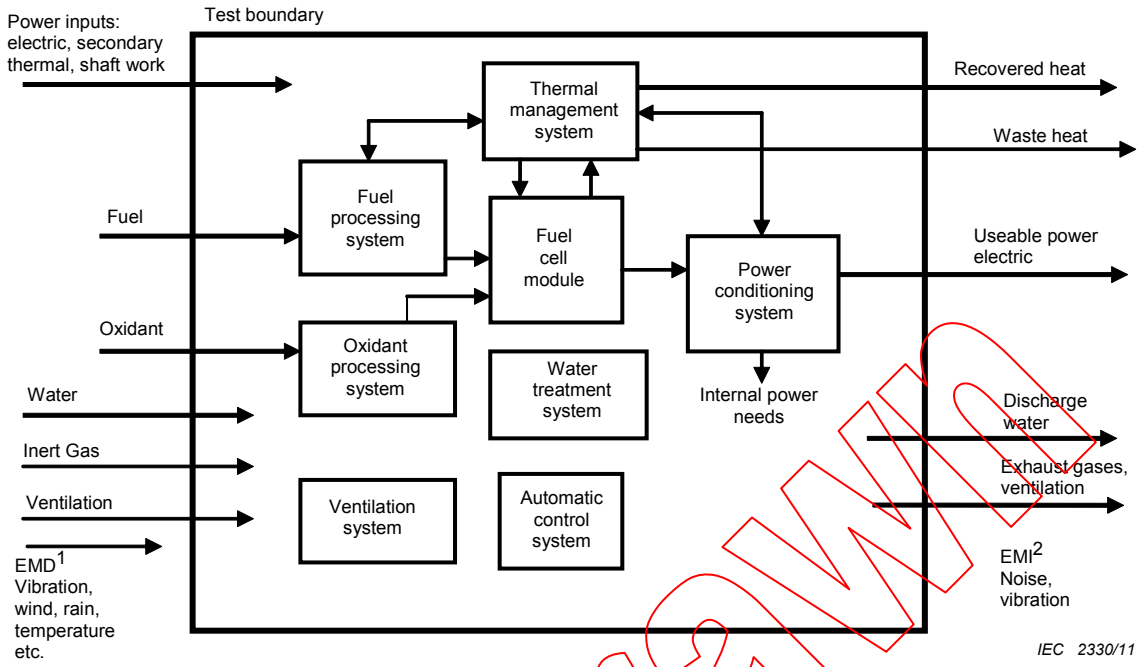
Fuel cell power systems may have different subsystems depending upon types of fuel cell and applications, and they have different streams of material and energy into and out of them. However, a common system diagram and boundary has been defined for evaluation of the fuel cell power system (see Figure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

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

– all energy recovery systems are included within the test boundary;

– all kinds of electric energy storage devices are considered outside the test boundary;

– calculation of the heating value of the input fuel (such as natural gas, propane gas and pure hydrogen gas, etc.) is based on the conditions of the fuel at the boundary of the fuel cell power system.



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.

1 EMD : electromagnetic disturbance

2 EMI : electromagnetic interference

Figure 1 – Fuel cell power system diagram

2 Normative references

The following referenced documents are indispensable for the application 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 equipment – Expression of performance*

IEC 60688, *Electrical measuring transducers for converting a.c. 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 61000-4-13, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*

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 (AC) – General requirements, tests and test conditions – Part 11: Metering equipment*

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

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

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*

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 6060, *Water quality – Determination of the chemical oxygen demand*

ISO 6326 (all parts), *Natural gas − Determination of sulfur compounds*

ISO 6974 (all parts), *Natural gas − Determination of composition with defined uncertainty by gas chromatography*

ISO 6975 (all parts), *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 – Performance characteristics of automated measuring methods*

ISO 8217, *Petroleum products – Fuel (class F) – Specifications of marine fuels*

ISO 9000, *Quality management systems – Fundamentals and vocabulary*

ISO 9096, *Stationary source emissions – Manual determination of mass concentration of particulate matter*

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

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

ISO 10523, *Water quality – Determination of pH*

ISO 10707, *Water quality – Evaluation in an aqueous medium of the "ultimate" aerobic biodegradability of organic compounds – Method by analysis of biochemical oxygen demand (closed bottle test)*

ISO 10780, *Stationary source emissions – Measurement of velocity and volume flowrate of gas streams in ducts*

ISO 10849, *Stationary source emissions – Determination of the mass concentration of nitrogen oxides – 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 14687, *Hydrogen fuel – Product specification*

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

ISO 16622, *Meteorology – Sonic anemometer/thermometers – Acceptance test methods for mean wind measurements*

ASTM D4809-00, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)*

ASTM F2602-08e1, *Standard Test Method for Determining the Molar Mass of Chitosan and Chitosan Salts by Size Exclusion Chromatography with Multi-angle Light Scattering Detection* (SEC-MALS)

ASME PTC 50, *Performance Test Code 50 – Fuel Cell Power Systems Performance*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
audible noise level
sound pressure level produced by a fuel cell power system measured at a specified distance in all operation modes

NOTE Expressed in decibels (dB) and measured as described in this standard.

3.1.2
auxiliary electric input power
electric power for a parasitic load (3.1.18) supplied from outside the system

3.1.3
background noise level
sound pressure level of ambient noise at the measurement point

NOTE This measurement is taken as described in this standard with the fuel cell power system in the cold state.

3.1.4
background vibration level
mechanical oscillations caused by the environment that affect vibration level readings

NOTE Background vibration is measured with the fuel cell power system in the cold state.

3.1.5
cold state
condition of a fuel cell power system at ambient temperature with no power input or output

3.1.6
discharge water
water that is discharged from the fuel cell power system

3.1.7
electric efficiency (of a fuel cell power system)
ratio of the net electric-power produced by a fuel cell power system to the total energy flow supplied to the fuel cell power system

NOTE Any electric power that is supplied to a parasitic load of a fuel cell power system from an external source is deducted from the electric power output of the fuel cell power system.

3.1.8
emission characteristics
concentrations of total sulfur oxides (SO_x), total nitrogen oxides (NO_x), carbon dioxide (CO_2), carbon monoxide (CO), total hydrocarbon compounds and particulate in the exhaust gas

NOTE Measured at the point of discharge to the environment as described in this standard.

3.1.9
fuel cell module
assembly incorporating one or more fuel cell stacks and other main and, if applicable, additional components, which is intended to be integrated into a power plant or a vehicle

NOTE A fuel cell module is comprised of 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 and/or control. Additionally, a fuel cell module may comprise: means for conveying additional fluids (e.g. cooling media, inert gas), means for detecting normal and/or abnormal operating conditions, enclosures or pressure vessels and module ventilation systems.

3.1.10
fuel cell power system
generator system that uses one or more fuel cell module(s) to generate electric power and heat

NOTE A fuel cell power system is composed of all or some of the following subsystems: one or more fuel cell modules, a fuel processing system, a power conditioning system, a thermal management system, and other subsystems as needed. A generic fuel cell power system is shown in Figure 1.

3.1.11
fuel input
amount of natural gas, hydrogen, methanol, liquid petroleum gas, propane, butane, or other material containing chemical energy consumed by the fuel cell power system during specified operating conditions

3.1.12
heat recovery efficiency (of a fuel cell power system)
ratio of the average recovered thermal power to the average total power input

3.1.13
interface point
measurement point at the boundary of a fuel cell power system at which material and/or energy either enters or leaves

NOTE This boundary is intentionally selected to accurately measure the performance of the system. If necessary, the boundary or the interface points of the fuel cell power system (Figure 1) to be assessed should be determined by agreement among the parties.

3.1.14
minimum power
minimum net power output at which a fuel cell power system is able to operate continuously in a stable manner

3.1.15
operating temperature
temperature at which fuel cell power system operates and is specified with a measuring point by the manufacturer

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

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

3.1.18
parasitic load
power consumed by auxiliary machines and equipments such as balance of plant (BOP) necessary to operate a fuel cell power system

3.1.19
power response time
duration between the instant of initiating a change of electric or thermal power output and when the electric or thermal output power attains the steady state set value within tolerance

3.1.20
90 % power response time
duration between the instant of initiating a change of electric or thermal power output and when the electric or thermal output power attains 90 % of the desired value

3.1.21
pressure
pressure of gas or liquid measured in the fuel cell power system