IEC 62282-3-201

Edition 1.0 2013-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Technologies des piles à combustible – Partie 3-201: Systèmes à piles à combustible stationnaires – Méthodes d'essai des performances pour petits systèmes à piles à combustible

IEC 62282-3-201:2013

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FUEL CELL TECHNOLOGIES –

Part 3-201: Stationary fuel cell power systems – Performance test methods for small fuel cell power systems

FOREWORD

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International Standard IEC 62282-3-201 has been prepared by IEC technical committee 105: Fuel cell technologies.

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

FDIS	Report on voting
105/444/FDIS	105/454/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 parts of the IEC 62282 series, 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- withdrawn,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 provides consistent and repeatable test methods for the electric/thermal and environmental performance of small stationary fuel cell power systems.

This international standard limits its scope to small (below 10 kW electric power output) stationary fuel cell power systems and provides test methods specifically designed for them in detail. It is based on IEC 62282-3-200, that generally describes performance test methods that are common to all types of fuel cells.

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

This standard is to be used by manufacturers of small stationary fuel cell power systems and/or those who evaluate the performance of their systems for certification purposes.

Users of this standard may selectively execute test items that are suitable for their purposes from those described in this standard. This standard is not intended to exclude any other methods.

FUEL CELL TECHNOLOGIES –

Part 3-201: Stationary fuel cell power systems – Performance test methods for small fuel cell power systems

1 Scope

This part of IEC 62282 provides test methods for the electric/thermal and environmental performance of small stationary fuel cell power systems that meet the following criteria:

- output: nominal electric power output of less than 10 kW;
- output mode: grid-connected/independent operation or stand-alone operation with single-phase AC output or 3-phase AC output not exceeding 1 000 V, or DC output not exceeding 1 500 V;

  NOTE The limit to 1 000 V comes from the definition for "low voltage" given in IEV 601-01-26.
- operating pressure: maximum allowable working pressure of less than 0,1 MPa (gauge) for the fuel and oxidant passages;
- fuel: gaseous fuel (natural gas, liquefied petroleum gas, propane, butane, hydrogen, etc.) or liquid fuel (kerosene, methanol, etc.);
- oxidant: air.

This standard covers fuel cell power systems whose primary purpose is the production of electric power and whose secondary purpose may be the utilization of by-product heat. Accordingly, fuel cell power systems for which the use of heat is primary and the use of by-product electric power is secondary are outside the scope of this standard.

All systems with integrated batteries are covered by this standard. This includes systems where batteries are recharged internally or recharged from an external source.

This standard does not cover additional auxiliary heat generators that produce thermal energy.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 5815 (all parts), *Water quality – Determination of biochemical oxygen demand after n days (BODn)*

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

ISO 6798, *Reciprocating internal combustion engines – Measurement of emitted airborne noise – Engineering method and survey method*

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

ISO 10523, *Water quality – Determination of pH*

ASTM F2602, *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)*

3 Terms and definitions

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

3.1
noise level
sound pressure level produced by the fuel cell power system measured at a specified distance in all operation modes

Note 1 to entry: Expressed as decibels (dB) and measured as described in 15.2.

3.2
background noise level
sound pressure level of ambient noise at the measurement point

Note 1 to entry: This measurement is taken as described in 15.2 with the fuel cell power system in the cold state.

3.3
battery
electrochemical energy storage device that provides energy input to support parasitic loads and/or provides electric energy output

Note 1 to entry: Back-up batteries for control software memory and similar applications are not included.

3.4
cold state
condition of a fuel cell power system at ambient temperature with no power input or output, ready for start-up

[SOURCE: IEC/TS 62282-1:2010, definition 3.110.1, modified – addition of "ready for start-up"]

3.5
discharge rate
mass of discharged exhaust gas component per unit of time

3.6
discharge water
water that is discharged from the fuel cell power system

Note 1 to entry: Discharge water does not constitute part of a thermal recovery system.

3.7
electric efficiency
ratio of the average net electric power output of a fuel cell power system at a given duration to the average fuel power fed to the same fuel cell power system at the same duration

[SOURCE: IEC/TS 62282-1:2010, definition 3.30.1 modified – original definition has been modified and the NOTE dropped]

3.8
electric energy input
integrated value of electric power input at the electric input terminal

3.9
electric energy output
integrated value of electric power output at the electric output terminal

3.10
electric power input
electric power input at the electric input terminal of the fuel cell power system

3.11
electric power output
electric power output at the electric output terminal of the fuel cell power system

3.12
fuel cell power system
generator system that uses a fuel cell module(s) to generate electric power and heat

3.13
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 while it is working at the specified operating conditions

3.14
fuel power input
fuel energy input per unit of time

3.15
heat recovery efficiency
ratio of the average thermal power recovered at a given duration from a fuel cell power system to the average fuel power fed to the same fuel cell power system at the same duration

[SOURCE: IEC/TS 62282-1:2010, definition 3.30.3, modified – original definition has been revised and the NOTE dropped]

3.16
heat recovery fluid
fluid circulating between the fuel cell power system and a heat sink for recovering the thermal energy output

3.17
inert purge gas
inert gas or dilution gas, not containing chemical energy, supplied to the fuel cell power system during specific conditions to make it ready for operation or shutdown

Note 1 to entry: Dilution gas containing chemical energy shall be considered as fuel.

3.18
integrated fuel input
volume or mass of fuel consumed by the fuel cell power system under specified operating conditions

3.19
interface point
measurement point at the boundary of a fuel cell power system at which material and/or energy either enters or leaves

Note 1 to entry: 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 2) to be assessed should be determined by agreement of the parties.

[SOURCE: IEC/TS 62282-1:2010, definition 3.65]

3.20
mass concentration
concentration of mass of exhaust gas component per unit of volume

3.21
minimum electric power output
minimum net power output, at which a fuel cell power system is able to operate continuously at a steady state

3.22
net electric power
value calculated by subtracting the electric power input from the electric power output

3.23
nominal electric power
electric power output at the electric output terminal of the fuel cell power system under normal operating conditions, stated by the manufacture

[SOURCE: IEC/TS 62282-1:2010, definition 3.85.4, modified – original term and definition has been revised and the NOTE dropped]

3.24
overall energy efficiency
sum of the electric efficiency and heat recovery efficiency

3.25
parasitic load
power consumed by auxiliary machines and equipment such as balance of plant (BOP) necessary to operate a fuel cell power system

3.26
recovered heat (of a fuel cell power system)
thermal energy recovered from the fuel cell power system

Note 1 to entry: The recovered heat is measured by determining the temperatures and flow rates of heat recovery fluid (water, steam, air or oil, etc.), entering and leaving the thermal energy recovery subsystem at the interface point of the fuel cell power system.

3.27
recovered thermal power
recovered thermal energy per unit of time

3.28
shutdown energy
sum of electric and/or chemical (fuel) energy required during the shutdown time

3.29
shutdown time
duration between the moment when a shutdown action is initiated at nominal electric power output to the moment when the cold state or storage state, as specified by the manufacturer, is attained

[SOURCE: IEC/TS 62282-1:2010, definition 3.115.4, modified – original definition has been revised]

3.30

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

[SOURCE: IEC/TS 62282-1:2010, definition 3.110.4, modified]

3.31
start-up energy
a) for fuel cell power systems without battery, electric and/or chemical (fuel) energy required for transitioning from cold state or storage state to net electric power output; and

b) for fuel cell power systems with battery, electric and/or chemical (fuel) energy required for recharging the battery, which is discharged to supply nominal electric power output at start-up, to a known nominal state of charge

3.32
start-up time
a) for fuel cell power systems that do not require external energy to maintain storage state, duration required for transitioning from cold state to positive net electric power output; and

b) for fuel cell power systems that require external energy to maintain storage state, duration required for transitioning from storage state to positive net electric power output

[SOURCE: IEC/TS 62282-1:2010, definition 3.115.5, modified – original definition has been revised]

3.33
stationary fuel cell power system
fuel cell power system that is connected and fixed in place

[SOURCE: IEC/TS 62282-1:2010, definition 3.49.3]

3.34
storage state
condition of a fuel cell power system that is non-operational and possibly requiring, under conditions specified by the manufacturer, the input of thermal or electric energy in order to prevent deterioration of the components and/or energize the control systems and other components, and is ready for start-up

[SOURCE: IEC/TS 62282-1:2010, definition 3.110.6, modified – original definition has been revised]

3.35
test run
time interval in which data points required for the computation of test results are recorded

Note 1 to entry: Recorded results are computed based on these data points.

3.36
thermal storage unit
unit that stores heat recovered from the fuel cell power system in the thermal storage medium and supplies the heat with heat carrier externally as needed

Note 1 to entry: It is composed of a thermal storage tank, a heat exchanger and a heat carrier supply system.

Note 2 to entry: A typical thermal storage medium is water.

3.37
waste heat
thermal energy released and not recovered

3.38
water consumption
water supplied (outside the test boundary) to the power system other than initial fill

4 Symbols

The symbols and their meanings used in this part of IEC 62282 are given in Table 1 for electric/thermal performance and Table 2 for environmental performance, with the appropriate units.

Table 1 – Symbols and their meanings for electric/thermal performance

Symbol	Definition	Unit
q_{vf}	Average volumetric flow rate of fuel under the test conditions	m^3/s
q_{vf0}	Average volumetric flow rate of fuel under reference conditions	m^3/s
q_{iv}	Integrated volumetric flow over the test duration	m^3
q_{vr}	Average volumetric flow rate of heat recovery fluid	m^3/s
q_{ivHR}	Integrated flow volume of heat recovery fluid	m^3
q_{vHR}	Average volumetric flow rate of heat recovery fluid at outlet over the test period	m^3/s
M_0	Reference molar volume of ideal gas (2,364 5 × 10^{-2} m^3/mol) (at the reference temperature for this standard, t_0 = 288,15 K)	m^3/mol
q_{mf}	Average mass flow rate of fuel under the test conditions	kg/s
q_{mHR}	Average mass flow rate of heat recovery fluid at outlet over the test period	kg/s
q_{imf}	Integrated mass flow of fuel over the test duration	kg
q_{imHR}	Integrated mass flow of heat recovery fluid	kg
M_{mf}	Molar mass of fuel	g/mol
M	Corrected water mass	kg
P_n	Average net electric power output	kW
P_{nom}	Nominal electric power output	kW
$P_{instore}$	Average electric power input in storage state	kW
P_{min}	Minimum electric power output	kW
PV_d	Decrease rate of electric power output	W/s
PV_u	Increase rate of electric power output	W/s
P_d	Electric power output change range between P_{nom} and P_{min}	W
p_0	Reference pressure (101,325 kPa(abs))	kPa(abs)
p_f	Average fuel pressure during test duration	kPa(abs)
t_0	Reference temperature (288,15 K)	K
t_f	Average fuel temperature during test duration	K