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Fuel cell technologies – Part 7-1: Test methods – Single cell performance tests for polymer electrolyte fuel cells (PEFC)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FUEL CELL TECHNOLOGIES –

Part 7-1: Test methods – Single cell performance tests for polymer electrolyte fuel cells (PEFC)

FOREWORD

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Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62282-7-1, which is a Technical Specification, has been prepared by IEC technical committee 105: Fuel cell technologies.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

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

a) addition of new tests, mainly regarding transportation applications; and,
b) restructuring of the format: basic and applied performance test methods.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
105/568/DTS	105/621/RVC

Full information on the voting for the approval of this technical specification 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 of 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 website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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 standard single-cell test methods for polymer electrolyte fuel cells (PEFCs). This document provides consistent and repeatable methods to test the performance of single cells. This document should be used by component manufacturers or stack manufacturers who assemble components in order to evaluate the performance of cell components, including membrane-electrode assemblies (MEAs) and flow plates. This document is also available for fuel suppliers to determine the maximum allowable impurities in fuels.

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

FUEL CELL TECHNOLOGIES –

Part 7-1: Test methods – Single cell performance tests for polymer electrolyte fuel cells (PEFC)

1 Scope

This document covers cell assemblies, test station setup, measuring instruments and measuring methods, performance test methods, and test reports for PEFC single cells.

This document is used for evaluating:

a) the performance of membrane electrode assemblies (MEAs) for PEFCs in a single cell configuration;

b) materials or structures of PEFCs in a single cell configuration; or,

c) the influence of impurities in fuel and/or in air on the fuel cell performance.

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.

ISO 14687-2, *Hydrogen fuel – Product specification – Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles*

3 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
anode
electrode (3.8) at which the oxidation of fuel (3.11) takes place

3.2
catalyst
substance that accelerates (increases the rate of) a reaction without being consumed itself

Note 1 to entry: The catalyst lowers the activation energy of the reaction, allowing for an increase in the reaction rate.

3.3
catalyst-coated membrane
CCM
<in a PEFC (3.24)> membrane whose surfaces are coated with a catalyst layer (3.4) to form the reaction zone of the electrode (3.8)

Note 1 to entry: See also membrane electrode assembly (MEA) (3.19).

3.4
catalyst layer
porous region adjacent to either side of the membrane containing the catalyst (3.2), typically with ionic and electronic conductivity

Note 1 to entry: The catalyst layer comprises the spatial region where the electrochemical reactions may take place.

3.5
cathode
electrode (3.8) at which oxidant (3.22) reduction takes place

3.6
clamping plate
pressure plate
frame used to compress the cell components together to maintain electrical conductivity and sealing

3.7
current collector
conductive material in a fuel cell (3.12) that collects electrons from the anode (3.1) side or conducts electrons to the cathode (3.5) side

3.8
electrode
electronic conductor (or semi-conductor) through which an electric current enters or leaves the electrochemical cell as the result of an electrochemical reaction

Note 1 to entry: An electrode may be either an anode (3.1) or a cathode (3.5).

[SOURCE: IEC TS 62282-1:2013, 3.33]

3.9
electrolyte
liquid or solid substance containing mobile ions that render it ionically conductive

Note 1 to entry: The electrolyte is the main distinctive feature of the different fuel cell technologies (e.g. a liquid, polymer, molten salt, solid oxide) and determines the usable operating temperature range.

[SOURCE: IEC 60050-482:2004, 482-02-29, modified — the note has been modified]

3.10
flow plate
conductive plate made of metal, a material such as graphite, or a conductive polymer that may be a carbon-filled composite, which is incorporated with flow channels for fuel (3.11) or an oxidant (3.22) gas feed and has an electrical contact with an electrode (3.8)

3.11
fuel
hydrogen or hydrogen-containing gas that reacts at the anode (3.1)

3.12
fuel cell
electrochemical device that converts the chemical energy of a fuel (3.11) and an oxidant (3.22) to electrical 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/TS 62282-1:2013, 3.43]

3.13
gas diffusion electrode
GDE
component on the anode (3.1) or cathode (3.5) side comprising all electronic conductive elements of the electrode (3.8), i.e. gas diffusion layer (3.14) and catalyst layer (3.4)

3.14
gas diffusion layer
GDL
porous substrate placed between the catalyst layer (3.4) and the flow plate (3.10) to serve as electric contact and allow the access of reactants to the catalyst layer and the removal of reaction products

Note 1 to entry: The gas diffusion layer is also called a porous transport layer (PTL).

[SOURCE: IEC TS 62282-1:2013, 3.57, modified — "flow plate" replaces "bipolar plate" and note modified.]

3.15
gasket
sealing component which prevents the reactant gas from leaking out of a cell

3.16
internal resistance
ohmic resistance inside a fuel cell (3.12), measured between current collectors (3.7), caused by the electronic and ionic resistances of the different components (electrodes (3.8), electrolyte (3.9), flow plates (3.10) and current collectors)

Note 1 to entry: The term ohmic refers to the fact that the relation between voltage drop and current is linear and obeys Ohm's Law.

[SOURCE: IEC TS 62282-1:2013, 3.66, modified — "flow plates" replaces "bipolar plates"]

3.17
limiting current density
maximum current density that can be attained by the cell under a given set of test conditions where the cell voltage sharply decreases to near zero

3.18
maximum current density
highest current density allowed for a short time as specified by the manufacturer

3.19
membrane electrode assembly
MEA
component of a fuel cell (3.12), usually PEFC (3.24), consisting of an electrolyte membrane with gas diffusion electrodes (3.13) on either side

[SOURCE: IEC TS 62282-1:2013, 3.73, modified — "DMFC" deleted]

3.20
minimum cell voltage
lowest permitted cell voltage specified by the manufacturer

3.21
open circuit voltage
OCV
voltage across the terminals of a fuel cell (3.12) with fuel (3.11) and an oxidant (3.22) present and in the absence of external current flow

Note 1 to entry: The open circuit voltage is expressed in V.

Note 2 to entry: Also known as "no-load voltage".

[SOURCE: IEC TS 62282-1:2013, 3.117.2]

3.22
oxidant
oxygen or oxygen-containing gas (e.g. air) that reacts at the cathode (3.5)

3.23
polymer electrolyte
polymer material containing mobile ions that render it ionically conductive

3.24
polymer electrolyte fuel cell
PEFC
fuel cell (3.12) that employs a polymer with ionic exchange capability as the electrolyte (3.9)

Note 1 to entry: The polymer electrolyte fuel cell is also called a proton exchange membrane fuel cell (PEMFC) and solid polymer fuel cell (SPFC).

[SOURCE: IEC TS 62282-1:2013, 3.43.7]

3.25
power
energy per unit time, calculated from the voltage multiplied by the current

3.26
power density
measure calculated by dividing the power by the geometric electrode area

Note 1 to entry: Power density is expressed in W/cm^2.

3.27
rated current density
maximum current density specified by the manufacturer of the MEA (3.19) or single cell (3.29) for continuous operation

3.28
rated voltage
minimum cell voltage specified by the manufacturer of the MEA (3.19) or single cell (3.29) for continuous operation

3.29
single cell
cell typically consisting of an anode flow plate (3.10), MEA (3.19), cathode flow plate (3.10) and sealing gaskets (3.15)

Note 1 to entry: See Annex B for additional information.

3.30
single cell test
test of the fuel cell (3.12) performance based on a single cell (3.29)

[SOURCE: IEC TS 62282-1:2013, 3.112.5]