PD IEC/TS 62282-1:2013

BSI Standards Publication

Fuel cell technologies

Part 1: Terminology

National foreword

This Published Document is the UK implementation of IEC/TS 62282-1:2013. It supersedes DD IEC/TS 62282-1:2010 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/105, Fuel cell technologies.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2013

ISBN 978 0 580 83340 3
ICS 27.070

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 November 2013.

Amendments/corrigenda issued since publication

Date	Text affected

IEC/TS 62282-1

Edition 3.0 2013-11

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

Fuel cell technologies –
Part 1: Terminology

Technologies des piles à combustible –
Partie 1: Terminologie

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX W

ICS 27.070

ISBN 978-2-83221-190-8

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FUEL CELL TECHNOLOGIES –

Part 1: Terminology

FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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

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

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

The first edition of IEC/TS 62282-1:2005 was intended as a resource for the working groups of TC 105 and users of the TC 105 standards series; therefore, it only included terms and definitions used in the other IEC 62282 standards to provide consistency among those documents.

This third edition, as was the second edition, is a general fuel cell glossary, including all terms unique to fuel cell technologies; it has:

a) added four new terms; 3.20, 3.43.1, 3.58 and 3.86.2;
b) made editorial changes to thirty terms; 3.1, 3.4.2.3, 3.4.4, 3.14, 3.28, 3.33.1, 3.42.1, 3.42.2, 3.42.3, 3.45, 3.48, 3.49, 3.52, 3.57, 3.66, 3.67, 3.69.2, 3.77.6, 3.82.2, 3.83, 3.84, 3.86.3, 3.86.4, 3.90, 3.94, 3.100, 3.108.4, 3.110.1, 3.110.4 and 3.115.5; and
c) removed the term "heat rate".

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
105/450/DTS	105/471/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 publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62282 series, published under the general title *Full 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;

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

FUEL CELL TECHNOLOGIES –

Part 1: Terminology

1 Scope

This part of IEC 62282 provides uniform terminology in the forms of diagrams, definitions and equations related to fuel cell technologies in all applications including but not limited to stationary power, transportation, portable power and micro power applications.

Not found here are words and phrases, which can be found in standard dictionaries, engineering references or the IEC 60050 series.

NOTE The first edition of IEC 62282 was intended as a resource for the working groups and users of the IEC 62282 series of fuel cell standards. This third edition, as well as the second edition, has been expanded into a general fuel cell glossary.

2 Diagrams of generalized fuel cell systems

2.1 Diagrams

Fuel cell power system

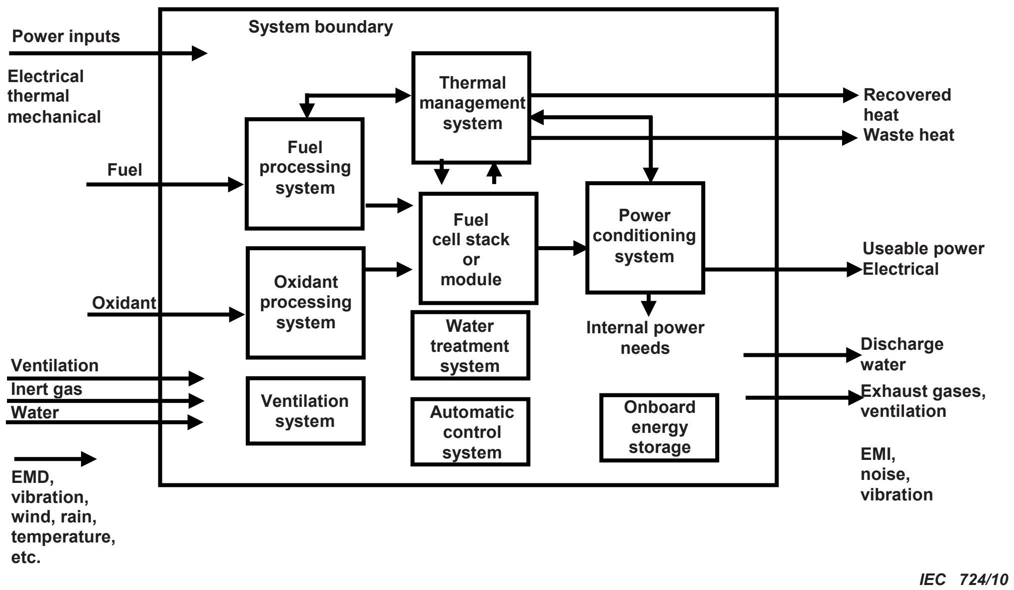

Figure 1 – Stationary fuel cell power systems (3.49.3)

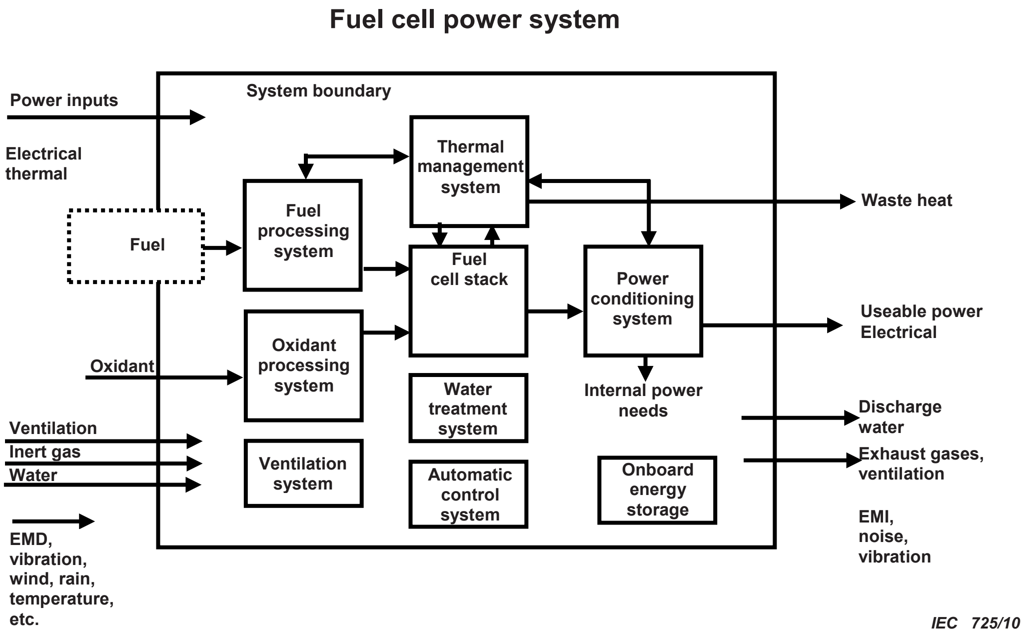

Figure 2 – Portable fuel cell power systems (3.49.2)

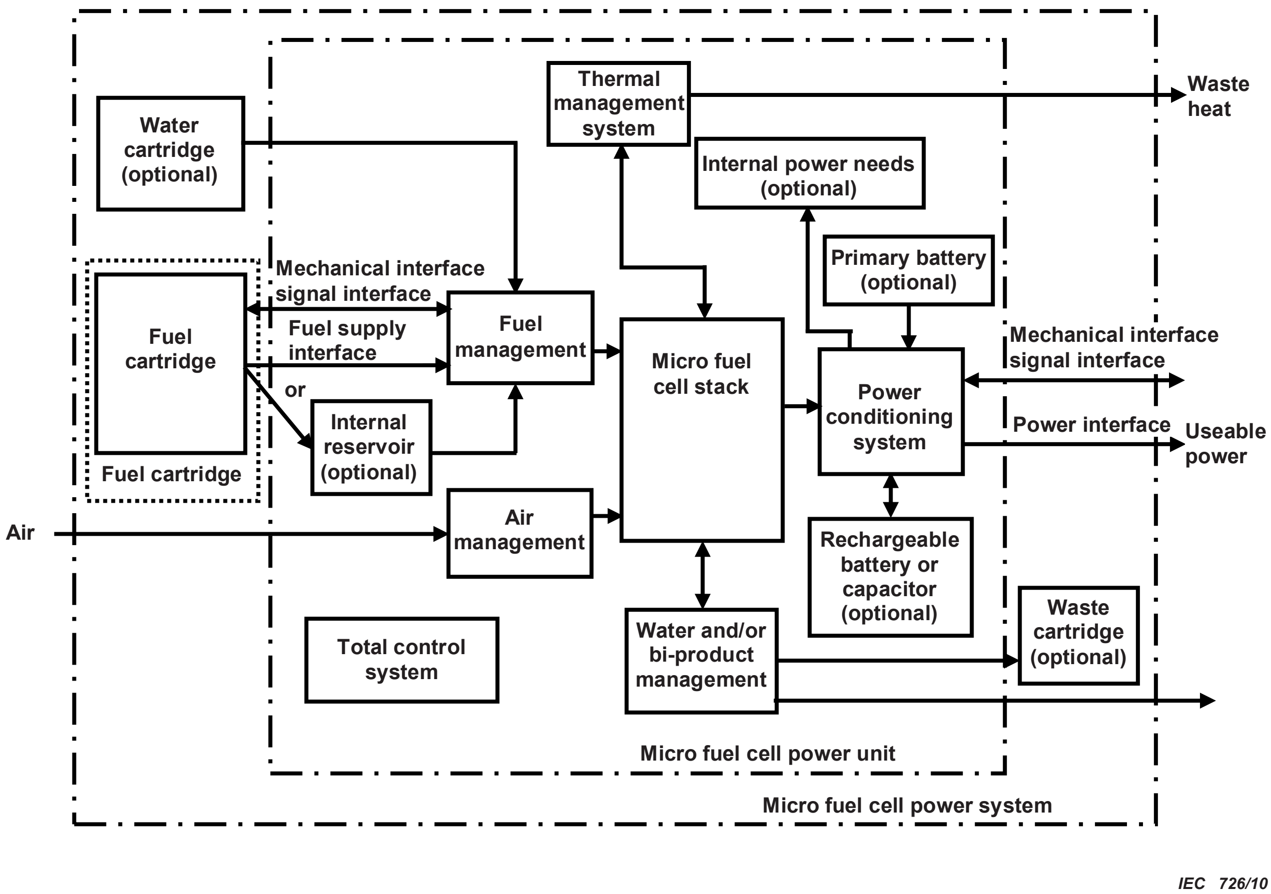

Figure 3 – Micro fuel cell power systems (3.49.1)

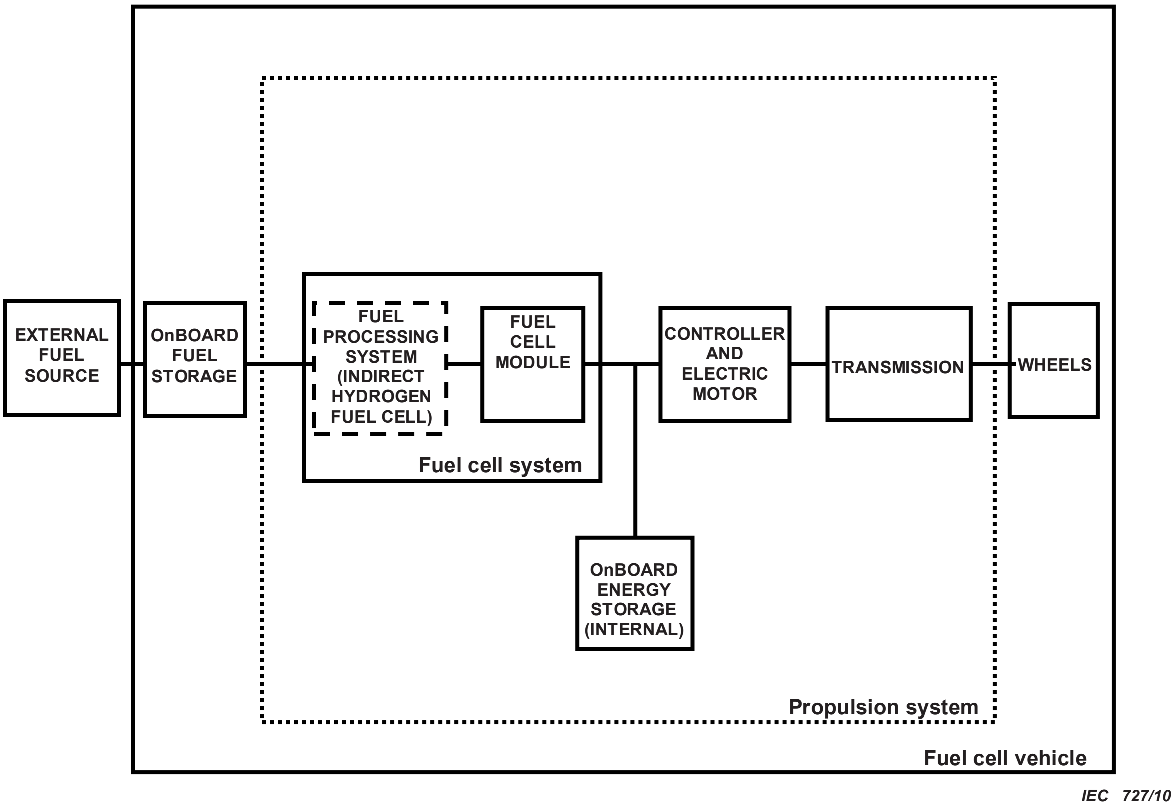

Figure 4 – Fuel cell vehicles (3.51)

2.2 Definition of diagram functions

The overall design of the power systems anticipated by this part of IEC 62282 are formed by an assembly of integrated systems, as necessary, intended to perform designated functions, as follows:

- Automatic control system – System that is composed of sensors, actuators, valves, switches and logic components that maintain the fuel cell power system (3.49) parameters within the manufacturer's specified limits without manual intervention.
- Fuel cell module – Equipment assembly of one or more fuel cell stacks (3.50) which electrochemically converts chemical energy to electric energy and thermal energy intended to be integrated into a vehicle or power generation system.
- Fuel cell stack – Equipment assembly of cells, separators, cooling plates, manifolds (3.70) and a supporting structure that electrochemically converts, typically, hydrogen rich gas and air reactants to DC power, heat and other reaction products.
- Fuel processing system – System of chemical and/or physical processing equipment plus associated heat exchangers and controls required to prepare, and if necessary, pressurize, the fuel for utilization within a fuel cell power system (3.49).
- Onboard energy storage – System of internal electric energy storage devices intended to aid or complement the fuel cell module (3.48) in providing power to internal or external loads.
- Oxidant processing system – System that meters, conditions, processes and may pressurize the incoming supply of oxidant for use within the fuel cell power system (3.49).
- Power conditioning system – Equipment that is used to adapt the electrical energy produced by the fuel cell stack(s) (3.50) to application requirements as specified by the manufacturer.

- Thermal management system – System that provides heating or cooling and heat rejection to maintain the fuel cell power system (3.49) in the operating temperature range, and may provide for the recovery of excess heat and assist in heating the power train during start-up.
- Ventilation system – System that provides air through forced or natural means to the fuel cell power system's (3.49) enclosure.
- Water treatment system – System that provides all of the necessary treatment of the recovered or added water for use within the fuel cell power system (3.49).

For micro fuel cell power systems

- Fuel cartridge – Removable article that contains and supplies fuel to the micro fuel cell power unit (3.74) or internal reservoir, not to be refilled by the user. Possible variations include:
  - attached – having its own enclosure that connects to the device powered by the micro fuel cell power system (3.49.1);
  - exterior – having its own enclosure that forms a portion of the enclosure of the device powered by the micro fuel cell power system (3.49.1);
  - insert – having its own enclosure and is installed within the enclosure of the device powered by the micro fuel cell power system (3.49.1);
  - satellite – intended to be connected to and removed from the micro fuel cell power unit (3.74) to transfer fuel to the internal reservoir inside micro fuel cell power unit.
- Micro fuel cell power unit – Micro fuel cell power system (3.49.1) excluding its fuel cartridge

Other terms used in the diagrams, include the following:

- Discharge water – Water discharged from the fuel cell power system (3.49) including wastewater and condensate.
- EMD (electromagnetic disturbance) – Any electromagnetic phenomenon that may degrade the performance of a device, equipment or system, or adversely affect living or inert matter (IEC 60050-161:1990, 161-01-05).
- EMI (electromagnetic interference) – Degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance. (IEC 60050-161:1990, 161-01-06).
- Recovered heat – Thermal energy that has been recovered for useful purposes.
- Waste heat – Thermal energy released and not recovered.

3 Terms, definitions and abbreviations

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

3.1
air bleed
introduction of small levels of air (around 5 %) into the fuel stream, upstream of the fuel inlet to the fuel cell (3.43) or within the anode (3.2) compartment

Note 1 to entry: The purpose of air bleed is to mitigate poisoning by species such as carbon monoxide by catalytic oxidation of the poison within the anode (3.2) compartment of the fuel cell (3.43).

3.2
anode
electrode (3.33) at which the oxidation of the fuel takes place

[SOURCE: IEC 60050-482:2004, 482-02-27, modified]

3.3
active layer
See catalyst layer (3.14).

3.4
area

3.4.1
cell area
geometric area of the bipolar plate (3.9) perpendicular to the direction of current flow

Note 1 to entry: The cell area is expressed in m^2.

3.4.2
electrode area

3.4.2.1
active area
geometric area of the electrode (3.33) perpendicular to the direction of the current flow

Note 1 to entry: The active area is expressed in m^2.

Note 2 to entry: The active area, also called effective area is used in the calculation of the cell current density (3.27).

3.4.2.2
effective area
See active area (3.4.2.1).

3.4.2.3
electrochemical surface area
area of the electrochemically accessible electrocatalyst (3.31) surface

Note 1 to entry: The electrochemical surface area is expressed as the product of the surface per unit volume (m^2/m^3) and the volume of the electrode.

Note 2 to entry: The electrochemical surface area is expressed in m^2.

3.4.3
membrane electrode assembly (MEA) area
geometric area of the entire MEA (3.73) perpendicular to the direction of net current flow, including active area (3.4.2.1), and uncatalysed areas of the membrane

Note 1 to entry: The membrane electrode assembly (MEA) area is expressed in m^2.

3.4.4
specific surface area
electrochemical surface area (3.4.2.3) per unit mass (or volume) of the catalyst (3.11)

Note 1 to entry: The specific surface area corresponds to the area of an electrocatalyst (3.31) accessible to reactants due to its open porous structure, per unit mass (or volume) of the catalyst (3.11).

Note 2 to entry: The specific surface area is expressed in m^2/g, m^2/m^3.

3.5
availability factor
ratio of the up-duration to the period of time under consideration

[SOURCE: IEC 60050-603:1986, 603-05-09]

3.6
axial load
compressive load applied to the end plates (3.40) of a fuel cell stack (3.50) to assure contact and/or gas tightness

Note 1 to entry: The axial load is expressed in Pa.

3.7
balance of plant
BOP
supporting/auxiliary components based on the power source or site-specific requirements and integrated into a comprehensive power system package

Note 1 to entry: In general, all components besides the fuel cell stack (3.50) or fuel cell module (3.48) and the fuel processing system are called balance of plant components.

3.8
base load operation
See full load operation (3.77.4).

3.9
bipolar plate
conductive plate separating individual cells in a stack, acting as current collector (3.26) and providing mechanical support for the electrodes (3.33) or membrane electrode assembly (3.73)

Note 1 to entry: The bipolar plate usually incorporates flow fields on either side for the distribution of reactants (fuel and oxidant) and removal of products, and may also contain conduits for heat transfer. The bipolar plate provides a physical barrier to avoid mixing of oxidant, fuel and coolant fluids. The bipolar plate is also known as the bipolar separating plate.

3.10
bus bar
See stack terminal (3.105).

3.11
catalyst
substance that accelerates (increases the rate of) a reaction without being consumed itself

See also electrocatalyst (3.31).

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

3.12
catalyst coated membrane
CCM
(in a PEFC (3.43.7)) membrane whose surfaces are coated with a catalyst layer (3.14) to form the reaction zone of the electrode (3.33)

See also membrane electrode assembly (MEA) (3.73).

3.13
catalyst coated substrate
CCS
substrate whose surface is coated with a catalyst layer (3.14)

3.14
catalyst layer
surface adjacent to either side of the membrane containing the electrocatalyst (3.31), typically with ionic and electronic conductivity

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

3.15
catalyst loading
amount of catalyst (3.11) incorporated in the fuel cell (3.43) per unit active area (3.4.2.1), specified either per anode (3.2) or cathode (3.18) separately, or combined anode and cathode loading

Note 1 to entry: The catalyst loading is expressed in g/m^2.

3.16
catalyst poisoning
inhibition of the catalyst (3.11) properties by substances (poisons)

Note 1 to entry: Electrocatalyst (3.31) poisoning causes degradation of the fuel cell (3.43) performance.

3.17
catalyst sintering
binding together of catalyst (3.11) particles due to chemical and/or physical processes

3.18
cathode
electrode (3.33) at which the reduction of the oxidant takes place

[SOURCE: IEC 60050-482:2004, 482-02-28, modified]

3.19
cell(s)

3.19.1
planar cell
fuel cell (3.43) formed in a flat structure

3.19.2
single cell
basic unit of a fuel cell (3.43) consisting of a set of an anode (3.2) and a cathode (3.18) separated by electrolyte (3.34)

3.19.3
tubular cell
fuel cells (3.43) with a cylindrical structure that allows fuel and oxidant to flow on the inner or outer surface of the tube

Note 1 to entry: Different cross section types can be used (e.g. circular, elliptical).

3.20
clamping plate
See end plate (3.40).

3.21
compression end plate
See end plate (3.40).

3.22
conditioning
(related to cells/stacks) preliminary step that is required to properly operate a fuel cell (3.43) and that is realized following a protocol specified by the manufacturer

Note 1 to entry: The conditioning may include reversible and/or irreversible processes depending on the cell technology.

3.23
cross leakage
See crossover (3.24).

3.24
crossover
leakage between the fuel side and the oxidant side, of a fuel cell (3.43), in either direction, generally through the electrolyte (3.34)

Note 1 to entry: Crossover is also called cross leakage.

3.25
current

3.25.1
leakage current
electric current in an unwanted conductive path other than a short-circuit

Note 1 to entry: The leakage current is expressed in A.

[SOURCE: IEC 60050-151:2001, 151-15-49]

3.25.2
rated current
maximum continuous electric current as specified by the manufacturer, at which the fuel cell power system (3.49) has been designed to operate

Note 1 to entry: The rated current is expressed in A.

3.26
current collector
conductive material in a fuel cell (3.43) that collects electrons from the anode (3.2) side or conducts electrons to the cathode (3.18) side

3.27
current density
current per unit active area (3.4.2.1)

Note 1 to entry: The current density is expressed in A/m^2 or A/cm^2.

3.28
degradation rate
rate at which a cell's performance deteriorates over time

Note 1 to entry: The degradation rate can be used to measure both recoverable and permanent losses in cell performance.

The typical unit of measure is volts (DC) per unit time or % of initial value (volt DC) per a fixed time, at rated current.

3.29
desulfurizer
reactor to remove sulfur components contained in raw fuel (3.89)

Note 1 to entry: Adsorbent desulfurizer, catalytic hydro-desulfurizer, etc.

3.30
efficiency
ratio of output useful energy flows to input energy flows of a device

Note 1 to entry: The energy flows can be measured by measuring the relevant in and output values over one single defined time interval, and can, therefore, be understood as mean value of the respective flows.

3.30.1
electrical efficiency
ratio of the net electrical power (3.85.3) produced by a fuel cell power system (3.49) to the total enthalpy flow supplied to the fuel cell power system

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

3.30.2
exergetic efficiency
ratio of the net electrical power (3.85.3) produced by a fuel cell power system (3.49) and the total exergy flow supplied to the fuel cell system assuming gaseous reaction products

3.30.3
heat recovery efficiency
ratio of recovered heat flow of a fuel cell power system (3.49) and the total enthalpy flow supplied to the fuel cell power system

Note 1 to entry: The supplied total (including reaction enthalpy) enthalpy flow of the raw fuel (3.89) should be related to lower heating value (LHV) for a better comparison with other types of energy conversion systems.

3.30.4
overall energy or total thermal efficiency
ratio of total useable energy flow (net electrical power (3.85.3) and recovered heat flow) to the total enthalpy flow supplied to the fuel cell power system (3.49)

Note 1 to entry: The supplied total (including reaction enthalpy) enthalpy flow of the raw fuel (3.89) should be related to lower heating value (LHV) for a better comparison with other types of energy conversion systems.

3.30.5
overall exergy efficiency
ratio of the sum of net electrical power (3.85.3) and total useable exergy flow of recovered heat related to the total exergy flow supplied to the fuel cell power system (3.49)

Note 1 to entry: The supplied total exergy flow of the raw fuel (3.89) (including reaction) should be related to a gaseous product for a better comparison with other types of energy conversion systems.

3.31
electrocatalyst
substance that accelerates (increases the rate of) an electrochemical reaction

See also catalyst (3.11).

Note 1 to entry: In a fuel cell (3.43), electrocatalysts are placed in the active (3.3) or catalyst layer (3.14).

3.32
electrocatalyst support
component of an electrode (3.33) that is the support of the electrocatalyst (3.31), and serves as the conductive medium

3.33
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 (3.2) or cathode (3.18).

3.33.1
gas diffusion electrode
type of electrode (3.33) specifically designed for gaseous reactants and/or products

Note 1 to entry: A gas diffusion electrode usually comprises one or more porous layers, like the gas diffusion layer (3.57) and the catalyst layer (3.14).

3.33.2
ribbed electrode
electrode (3.33) provided with grooves on the electrode substrate for gas passage

3.34
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 (3.43) technologies (e.g. a liquid, polymer, molten salt, solid oxide) and determines the useful operating temperature range.

[SOURCE: IEC 60050-111:1996, 111-15-02]

3.35
electrolyte leakage
undesired escape of liquid electrolyte (3.34) from a fuel cell stack (3.50)

3.36
electrolyte loss
any decrease with respect to the initial electrolyte (3.34) inventory of a fuel cell (3.43)

Note 1 to entry: The electrolyte (3.34) losses may originate by different processes such as evaporation, leakage, migration and consumption in metallic component corrosion.

3.37
electrolyte matrix
insulating gas-tight cell component with a properly tailored pore structure that retains the liquid electrolyte (3.34)

Note 1 to entry: The pore structure has to be adjusted with respect to those of the adjacent electrodes (3.33) to assure a complete filling (3.41).

3.38
electrolyte migration
potential driven effect experienced by external manifolded MCFC (3.43.5) stacks

Note 1 to entry: The electrolyte (3.34) tends to migrate from the positive end of the stack to the negative end. The migration occurs through the gaskets placed between the external manifolds (3.70) and the stack edges.

3.39
electrolyte reservoir
component of liquid electrolyte fuel cells (3.43) (e.g. MCFC (3.43.5) and PAFC (3.43.6)) that stores liquid electrolyte (3.34) for the purpose of replenishing electrolyte losses (3.36) over the cell life (3.69.2)

3.40
end plate
component located on either end of the fuel cell stack (3.50) in the direction of current flow, serving to transmit the required compression to the stacked cells

Note 1 to entry: The end plate may comprise ports, ducts, manifolds (3.70), or clamping plates for the supply of fluids (reactants, coolant) to the fuel cell stack (3.50). It may also be known as stack end frame or compression end plate.

3.41
filling (level)
fraction of the total open pore volume of a fuel cell (3.43) porous component (e.g. electrode (3.33) or electrolyte matrix (3.37)) that is occupied by a liquid electrolyte (3.34)

3.42
flow configuration of stack or module

3.42.1
co-flow
fluid flow in same parallel directions through adjacent parts of an apparatus, as in a heat exchanger or in a fuel cell (3.43)

3.42.2
counter flow
fluid flow in opposite parallel directions through adjacent parts of an apparatus, as in a heat exchanger or in a fuel cell (3.43)

3.42.3
cross flow
fluid flow going across another flow at an angle essentially perpendicular to one another through adjacent parts of an apparatus, as in a heat exchanger or a fuel cell (3.43)

3.42.4
dead end flow
cell or stack configuration, characterized by the lack of a fuel and/or oxidant outlet port

Note 1 to entry: In dead end operation, almost 100 % of the reactant fed to the cell or stack is consumed. A small fraction of reactants may be vented out from fuel cell power systems (3.49) that require periodic purging of the electrode (3.33) compartment(s).

3.43
fuel cell
electrochemical device that converts the chemical energy of a fuel and an oxidant 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 60050-482:2004, 482-01-05, modified]

3.43.1
air breathing fuel cell
fuel cell (3.43) that uses ambient air as oxidant only forced by natural ventilation (3.116.2)

3.43.2
alkaline fuel cell
fuel cell (3.43) that employs an alkaline electrolyte (3.34)

3.43.3
direct fuel cell
fuel cell (3.43) in which the raw fuel (3.89) supplied to the fuel cell power system (3.49) and the fuel supplied to the anodes (3.2) is the same

3.43.4
direct methanol fuel cell
DMFC
direct fuel cell (3.43.3) in which the fuel is methanol (CH_3OH), in gaseous or liquid form

Note 1 to entry: The methanol is oxidized directly at the anode (3.2) with no reformation to hydrogen. The electrolyte (3.34) is typically a proton exchange membrane.

3.43.5
molten carbonate fuel cell
MCFC
fuel cell (3.43) that employs molten carbonate as the electrolyte (3.34)

Note 1 to entry: Usually, either molten lithium/potassium or lithium/sodium carbonate salts are used as the electrolyte (3.34).

3.43.6
phosphoric acid fuel cell
PAFC
fuel cell (3.43) that employs aqueous solution of phosphoric acid (H_3PO_4) as the electrolyte (3.34)

3.43.7
polymer electrolyte fuel cell
PEFC
fuel cell (3.43) that employs a polymer with ionic exchange capability as the electrolyte (3.34)

Note 1 to entry: The polymer electrolyte fuel cell is also called a proton exchange membrane fuel cell (PEMFC) (3.43.8) and solid polymer fuel cell (SPFC).

3.43.8
proton exchange membrane fuel cell
PEMFC
See polymer electrolyte fuel cell (PEFC) (3.43.7).

3.43.9
regenerative fuel cell
electrochemical cell able to produce electrical energy from a fuel and an oxidant, and to produce the fuel and oxidant in an electrolysis process from electrical energy

3.43.10
solid oxide fuel cell
SOFC
fuel cell (3.43) that employs an ion-conducting oxide as the electrolyte (3.34)

3.43.11
solid polymer fuel cell
SPFC
See polymer electrolyte fuel cell (3.43.7).

3.44
fuel cell/battery hybrid system
fuel cell power system (3.49) combined with a battery, for delivering useful electric power

Note 1 to entry: The fuel cell power system (3.49) can deliver electric power, charge the battery, or both. The system can deliver and accept electric energy.

3.45
fuel cell/gas turbine system
power system based on the integration of a fuel cell (3.43), usually MCFC (3.43.5) or SOFC (3.43.10), and a gas turbine

Note 1 to entry: The system operates by using the fuel cell’s thermal energy and residual fuel to drive a gas turbine. Also known as a fuel cell/gas turbine hybrid system.

3.46
fuel cell gas turbine hybrid system
See fuel cell/gas turbine system (3.45).

3.47
fuel cell cogeneration system
fuel cell power system (3.49) that is intended to supply both electrical power and heat to an external user

3.48
fuel cell module
assembly incorporating one or more fuel cell stacks (3.50) and, if applicable, additional components, which is intended to be integrated into a power system or a vehicle

Note 1 to entry: A fuel cell module is comprised of the following main components: one or more fuel cell stack(s) (3.50), piping system for conveying fuels, oxidants and exhausts, electrical 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, and the required electronic components for module operation and power conditioning.

3.49
fuel cell power system
generator system that uses one or more fuel cell module(s) (3.48) 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 Clause 2.

3.49.1
micro fuel cell power system
micro fuel cell power unit (3.74) and associated fuel cartridges that is wearable or easily carried by hand

3.49.2
portable fuel cell power system
fuel cell power system (3.49) that is not intended to be permanently fastened or otherwise secured in a specific location

3.49.3
stationary fuel cell power system
fuel cell power system (3.49) that is connected and fixed in place

3.50
fuel cell stack
assembly of cells, separators, cooling plates, manifolds (3.70) and a supporting structure that electrochemically converts, typically, hydrogen rich gas and air reactants to DC power, heat and other reaction products

3.51
fuel cell vehicle
electric vehicle using a fuel cell power system (3.49) to feed an electric motor for propulsion

3.52
fuel utilization
ratio of the fuel that is electrochemically converted to generate the fuel cell current to the total amount of the fuel entering the fuel cell

3.53
fuelling coupler
interface that connects a fuel cell vehicle (3.51) and a fuel supply service station

Note 1 to entry: The fuelling coupler may also supply cooling water and communication information relating to fuel supply. The fuel coupler consists of the fuelling nozzle and the fuelling receptacle.

3.54
gas clean-up
removal of contaminants from gaseous feed streams by a physical or chemical process

3.55
gas diffusion anode
See gas diffusion electrode (3.33.1).

3.56
gas diffusion cathode
See gas diffusion electrode (3.33.1).

3.57
gas diffusion layer
GDL
porous substrate placed between the catalyst layer (3.14) and the bipolar plate (3.9) 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 a component of a gas diffusion electrode (3.33.1), and may also be called a porous transport layer (PTL).

3.58
gas distribution plate
See bipolar plate (3.9).

3.59
gas leakage
sum of all gases leaving the fuel cell module (3.48) except the intended exhaust gases

3.60
gas purge
protective operation to remove gases and/or liquids, such as fuel, hydrogen, air or water, from a fuel cell power system (3.49)

3.61
gas seal
airtight mechanism that prevents the reaction gas from leaking out of a prescribed flow path

Note 1 to entry: The gas seal may be dry or wet, depending on the fuel cell (3.43) type.

3.62
humidification
process of introducing water into the fuel cell (3.43) with the fuel and/or oxidant reactant gas stream(s)

3.63
humidifier
equipment for adding water to the fuel and/or oxidant gas stream(s)

3.64
interconnector
conductive and gastight component connecting single cells (3.19.2) in a fuel cell stack (3.50)

3.65
interface point
measurement point at the boundary of a fuel cell power system (3.49) 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 (3.49) to be assessed should be determined by agreement of the parties.

3.66
internal resistance
ohmic resistance inside a fuel cell (3.43), measured between current collectors (3.26), caused by the electronic and ionic resistances of the different components (electrodes, electrolyte, bipolar plates and current collectors)

See ohmic polarization (3.82.2).

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.

3.67
IR loss
ohmic polarization
See ohmic polarization (3.82.2) and internal resistance (3.66).

3.68
land (related to flow field)
protruding structure in the flow field that is in contact with the gas diffusion layer (3.57) and thereby providing electronic contact and, consequently, pathways for electron flow

3.69
life

3.69.1
catalyst life (reformer)
duration of the time interval between the instant of initial start-up of a fuel cell power system (3.49) and the initial instant when the concentration of non-reformed fuel at the reformer (3.92) outlet exceeds the manufacturers allowable design value, while the fuel cell power system is operating at its ratings

3.69.2
cell or stack life
duration of the time interval under operating conditions between the first start up and until the fuel cell voltage, at defined conditions, drops below the specified minimum acceptable voltage

Note 1 to entry: The minimum acceptable voltage value should be determined by agreement of the parties taking into account the specific use.

3.70
manifold
conduit(s) which supplies fluid to or collects it from the fuel cell (3.43) or the fuel cell stack (3.50)

Note 1 to entry: External manifold design refers to a stacking (3.106) of cells where the gas mixtures are supplied from a central source to large fuel and oxidant inlets covering adjacent sides of the stack and sealed with properly designed gaskets. The exhaust gases are collected on the opposite sides with similar systems.

Note 2 to entry: Internal manifold design refers to a system of ducts inside the stack and penetrating the bipolar plates (3.9) that distributes the gas flows among the cells.

3.71
mass activity
See specific activity (3.102).

3.72
mass transport (or concentration) loss
See concentration polarization (3.82.3).

3.73
membrane electrode assembly
MEA
component of a fuel cell (3.43), usually PEFC (3.43.7), DMFC (3.43.4), consisting of an electrolyte membrane with gas diffusion electrodes (3.33.1) on either side

3.74
micro fuel cell power unit
fuel cell (3.43) based electric generator providing a DC output voltage (3.117.3) that does not exceed 60 V and a continuous net electrical power (3.85.3) that does not exceed 240 VA

Note 1 to entry: The micro fuel cell power unit does not include a fuel cartridge.

3.75
no load voltage
See open circuit voltage (3.117.2).

3.76
non-repeat parts
all the components of a fuel cell stack (3.50) that are not part of the repeated cell unit, e.g. the stack end plates (3.40)

3.77
operation

3.77.1
constant current operation
mode when the fuel cell power system (3.49) is operated at a constant current

3.77.2
constant power operation
mode when the fuel cell power system (3.49) is operated at a constant output power within the extents of its power generation capacity

3.77.3
constant voltage operation
mode when the fuel cell power system (3.49) is operated at a constant output voltage (3.117.3)

3.77.4
full load operation
mode when the fuel cell power system (3.49) is operated at its rated power (3.85.4)

3.77.5
grid-connected operation
mode when the fuel cell power system (3.49) is operated while connected to a utility grid

3.77.6
grid-independent or isolated operation
mode when the fuel cell power system (3.49) is isolated from any utility power grid and individually operated

3.77.7
load following operation
mode when the fuel cell power system (3.49) is primarily controlled by either the fluctuation of the electrical power load or the heat flow demand

3.77.8
pre-generation operation
See pre-generation state (3.110.4).

3.78
oxidant utilization
ratio of the amount of oxidant that electrochemically reacts to generate the electric current of the fuel cell (3.43) to the total amount of oxidant entering the cell

Note 1 to entry: $[(O_{2\ in} - O_{2\ out})/O_{2\ in}]$ where $O_{2\ in}$ and $O_{2\ out}$ mean O_2 flow rate at the inlet and outlet, respectively.

3.79
parasitic load
power consumed by auxiliary machines and equipment such as balance of plant (BOP) (3.7) necessary to operate a fuel cell power system (3.49)

Note 1 to entry: Examples are blowers, pumps, heaters, sensors. The parasitic load can strongly depend on the system power output and ambient conditions.

3.80
partial oxidation
See partial oxidation reforming (3.93.3).

3.81
poisoning
See catalyst poisoning (3.16).

3.82
(fuel cell) polarization
departure of the output voltage (3.117.3) of a fuel cell (3.43) from the thermodynamic value as a consequence of irreversible processes within the components of the fuel cell

Note 1 to entry: Polarization gives rise to efficiency (3.30) loss and increases with faradaic current passing through the cell.

3.82.1
activation polarization
polarization caused by slow electrode kinetics

3.82.2
ohmic polarization
polarization caused by the resistance to the flow of ions in the electrolyte (3.34) and of electrons in the electrodes (3.33), bipolar plates (3.9), and current collectors (3.26)

Note 1 to entry: The term ohmic refers to the fact that the voltage drop follows Ohm's Law, i.e. it is proportional to the current with an ohmic resistance (called internal resistance (3.66) of the cell) as the proportionality constant.

3.82.3
concentration polarization
polarization caused by slow diffusion to the reaction sites in the electrode (3.33) and/or slow diffusion of products from the electrodes of the fuel cell (3.43)

Note 1 to entry: This polarization type is more important at high current densities and may result in a sharp decrease in the cell voltage.

3.83
polarization curve
typically a plot of the output voltage (3.117.3) of a fuel cell (3.43) as a function of output current at defined reactant conditions

Note 1 to entry: The polarization curve is expressed in V versus A/cm^2.

3.84
porosity
ratio of the volume of pores to the total volume of an electrode (3.33) material or of an electrolyte matrix (3.37)

Note 1 to entry: The porosity features, such as overall open porosity, pore shape, size and size distribution, are key properties of fuel cell active components and significantly influence the performances.

3.85
power

3.85.1
gross power
DC outlet power of a fuel cell stack (3.50)

Note 1 to entry: The gross power is expressed in W.

3.85.2
minimum power
minimum net electrical power (3.85.3) at which a fuel cell power system (3.49) is able to operate continuously in a stable manner

Note 1 to entry: The minimum power is expressed in W.

3.85.3
net electrical power
power generated by the fuel cell power system (3.49) available for external use

Note 1 to entry: The net electrical power is expressed in W.

Note 2 to entry: Net electrical power is the difference between the gross power (3.85.1) and the power consumed by auxiliaries.

3.85.4
rated power
maximum continuous electric output power that a fuel cell power system (3.49) is designed to achieve under normal operating conditions specified by the manufacturer

Note 1 to entry: The rated power is expressed in W.

3.85.5
specific power
ratio of the rated power (3.85.4) to the mass, volume or area of a fuel cell power system (3.49)

Note 1 to entry: The specific power is expressed in kW/kg, kW/m^3, W/cm^2.

3.86
pressure

Note 1 to entry: ISO recommends using absolute pressure. If gauge pressure is used, it should be so noted.

3.86.1
differential cell pressure
difference in pressure across the electrolyte (3.34) as measured from one electrode (3.33) to the other

Note 1 to entry: The differential cell pressure is expressed in Pa.

3.86.2
maximum allowable differential working pressure
maximum differential pressure between the anode and cathode side, specified by the manufacturer, which the fuel cell can withstand without any damage or permanent loss of functional properties

Note 1 to entry: The maximum allowable differential working pressure is expressed in Pa.

3.86.3
maximum allowable working pressure
maximum gauge pressure at which a fuel cell (3.43) or fuel cell power system (3.49) may be operated

Note 1 to entry: The maximum allowable working pressure is expressed in Pa.

Note 2 to entry: The maximum allowable working pressure is the pressure used in determining the setting of pressure limiting/relieving devices installed to protect a component or system from accidental over-pressurizing.

3.86.4
maximum operating pressure
maximum gauge pressure, specified in pressure by the manufacturer of a component or system, at which it is designed to operate continuously

Note 1 to entry: The maximum operating pressure is expressed in Pa.

Note 2 to entry: Includes all normal operation, both steady state (3.110.5) and transient.

3.87
porous transport layer
PTL
See gas diffusion layer (GDL) (3.57).

3.88
purge
See gas purge (3.60).

3.89
raw fuel
fuel supplied to a fuel cell power system (3.49) from an external source

3.90
reactant recirculation
capture of excess reactant downstream and its re-introduction into the reactant flow upstream of the fuel cell (3.43)

3.91
reformate gas
hydrogen rich gas that is converted from raw fuel (3.89) via a fuel reforming system

3.92
reformer
reactor to produce a hydrogen rich gas mixture from a raw fuel (3.89)

Note 1 to entry: There are several types of reformers such as plate type, single tube type, multi tube type, multi-dual tube type, and multi-tube annular type.

3.92.1
catalytic combustion type reformer
reformer (3.92) using heat produced by catalytic combustion

3.92.2
direct fired type reformer
reformer (3.92) heated by both flame and catalytic combustion

3.93
reforming
process of producing a hydrogen-rich gas mixture from a raw fuel (3.89) for eventual use in a fuel cell (3.43)

3.93.1
external reforming
reforming reaction that takes place prior to entering the fuel cell stack (3.50) structure

3.93.2
internal reforming
reforming reaction that takes place within the fuel cell stack (3.50) structure

Note 1 to entry: The reforming section may be separated, but adjacent to the fuel cell anode (3.2) (indirect internal), or may be the anode itself (direct internal).

3.93.3
partial oxidation reforming
POX
exothermic fuel reaction where the fuel is partially oxidized to carbon monoxide and hydrogen rather than fully oxidized to carbon dioxide and water

3.93.4
steam reforming
SR
process for reacting a raw fuel (3.89), such as natural gas, in the presence of steam to produce hydrogen as a product

3.94
repeat part
component type of any fuel cell (3.43) entity, which appears again in every single cell (3.19.2) of a fuel cell stack (3.50)

See also non-repeat part (3.76).

Note 1 to entry: Examples of a repeat part include: active component (anode (3.2), electrolyte (3.34), cathode (3.18), bipolar plate (3.9), gas distribution and current collector (3.26).

3.95
roughness factor
ratio of the electrochemical surface area (3.4.2.3) to the active area (3.4.2.1) of the electrode (3.33)

3.96
safeguarding
control system actions, based on process parameters, taken to avoid conditions that might be hazardous to personnel or might result in damage to the fuel cell (3.43) or its surroundings

3.97
separator plate
See bipolar plate (3.9).

3.98
series connection
connection of cells in a cathode (3.18) to anode (3.2) pattern such that individual cell voltages are additive

3.99
shift converter
reactor that converts, by water gas shift reaction, carbon monoxide produced by steam reforming (3.93.4) into carbon dioxide and hydrogen

Note 1 to entry: The reaction works downstream of the reformer (3.92).

3.100
short stack
fuel cell stack (3.50) with number of cells significantly smaller than the designed stack with rated power (3.85.4), but with number of cells high enough to represent the scaled characteristics of the full stack

See also substack (3.111).

3.101
shutdown
sequence of operations, specified by the manufacturer, that occurs to transition a fuel cell power system (3.49) from operational state (3.110.2) to passive (3.110.3), pre-generation (3.110.4), or cold state (3.110.1)

Note 1 to entry: Different procedures may characterize scheduled shutdowns (3.101.3) and emergency shutdowns (3.101.1).

3.101.1
emergency shutdown
control system actions, based on process parameters, taken to stop the fuel cell power system (3.49) and all its reactions immediately to avoid equipment damage and/or personnel hazards

3.101.2
normal shutdown
See scheduled shutdown (3.101.3).

3.101.3
scheduled shutdown
shutdown (3.101) of a fuel cell power system (3.49) for routine matters

Note 1 to entry: The scheduled shutdown is also called normal shutdown.

3.102
(mass) specific activity
current delivered by a fuel cell (3.43), at a given voltage, referred to the mass of electrocatalyst (3.31) in the electrodes (3.33)

Note 1 to entry: The specific activity may also be referred to the electrochemical surface area (3.4.2.3), or volume of the catalyst layer (3.14). These can be referred to as area specific activity or volume specific activity, respectively.

Note 2 to entry: The specific activity is expressed in A/g (A/cm^2, A/cm^3).

3.103
stack
See fuel cell stack (3.50).

3.104
stack end frame
See end plate (3.40).

3.105
stack terminal
output terminal at which electric power is supplied from the fuel cell stack (3.50)

Note 1 to entry: Also called bus bar.

3.106
stacking
process of placing individual fuel cells (3.43) adjacent to one another to form a fuel cell stack (3.50)

See series connection (3.98).

Note 1 to entry: Normally, the individual fuel cells (3.43) are connected in series.

3.107
standard conditions
test or operating conditions that have been predetermined to be the basis of the test in order to have reproducible, comparable sets of test data

Note 1 to entry: Typical conditions to be standardized refer to fuel and oxidant parameters, like compositions, flow rates, temperature, pressure and humidity, as well as to the fuel cell (3.43), like temperature.

3.108
start

3.108.1
black start
start-up through a dedicated auxiliary power source that is totally independent of external systems

3.108.2
cold start
start-up when the temperature of the fuel cell power system (3.49) is at ambient temperature

3.108.3
hot start
start-up when the temperature of the fuel cell power system (3.49) is within the fuel cell (3.43) equipment's normal operating temperature range

3.108.4
warm start
start-up when the temperature of the fuel cell power system (3.49) is higher than ambient temperature but lower than its normal operating temperature range

3.109
start-up energy
sum of the electric, thermal and/or chemical (fuel) energy required by a fuel cell power system (3.49) during the start-up time (3.115.5)

3.110
state

3.110.1
cold state
state of a fuel cell power system (3.49) at ambient temperature with no power input or output

3.110.2
operational state
state of a fuel cell power system (3.49) with substantial electrical active output power available

3.110.3
passive state
state for the fuel cell power system (3.49) when the fuel and oxidant systems have been purged with steam, air or nitrogen or per manufacturer's instructions

3.110.4
pre-generation state
state of a fuel cell power system (3.49) being at sufficient operating temperature and in such an operational mode, with zero electrical output power, that the fuel cell power system is capable of being promptly switched to an operational state (3.110.2) with substantial electrical active output power

3.110.5
steady state
state of a physical system in which the relevant characteristics remain constant with time

[SOURCE: IEC 60050-101:1998, 101-14-01]

3.110.6
storage state
state of a fuel cell power system (3.49) being non-operational and possibly requiring, under conditions specified by the manufacturer, the input of thermal and/or electric energy and/or an inert atmosphere in order to prevent deterioration of the components

3.111
substack
typically a group of stacked fuel cells (3.43) that make up the base repetitive unit number of cells per full stack

See short stack (3.100).

Note 1 to entry: Substacks may form an intermediate step in manufacturing and may be used to test new stack concepts prior to scale-up to full size stacks.

3.112
test

3.112.1
acceptance test
contractual test to prove to the customer that the item meets certain conditions of its specification

[SOURCE: IEC 60050-151:2001, 151-16-23]

3.112.2
freeze-thaw test
test to study the behavior of a fuel cell (3.43) as its temperature changes from below water freezing point to above freezing, and/or conversely

3.112.3
process and control test
test of a fuel cell power system (3.49) that is carried out before operation and usually without the fuel cell stack(s) (3.50) to verify the integrity of component performance and control function

3.112.4
routine test
conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050-151:2001, 151-16-17]

3.112.5
single cell test
test of the fuel cell (3.43) performance based on one single cell (3.19.2)

Note 1 to entry: The test is typically a laboratory scale test in which several variables can be adjusted in order to obtain data over a wide range of conditions, such as temperature, current density (3.27), fuel and oxidant flow rates, etc. The outcome of a single cell test may be a polarization curve (3.83), a voltage stability plot, or other data related to fuel cell (3.43) performance.

3.112.6
stack test
test of the fuel cell (3.43) performance based on a stack (3.50)

Note 1 to entry: The test involves variables that may be related to individual cells (temperature, voltage) or the whole stack (such as temperature, current density (3.27), fuel and oxidant flow rates, etc.) to be adjusted in order to obtain data over a wide range of conditions. The outcome of a stack test may be a polarization curve (3.83), single cell (3.19.2) voltages stability plot, or other data related to fuel cell (3.43) performance.

3.112.7
type test
conformity test made on one or more items representative of the production

[SOURCE: IEC 60050-151:2001, 151-16-16]

3.113
thermal stability
stable temperature, isothermal conditions

3.114
three-phase boundary
microstructural spatial region within the electrode (3.33) with coexisting ionic and electronic conductivity, within which electrolyte (3.34), electrode and reactant (fuel or oxidant) states coexist so the reactions of the fuel cell (3.43) may take place

3.115
time

3.115.1
generating time
accumulative duration of the time intervals which a fuel cell power system (3.49) generates electric power

Note 1 to entry: The time includes both the time that the power system supplies electricity to the grid and the time that the generating power is consumed for parasitic load (3.79) only.

3.115.2
hot time
accumulated duration of the time intervals which the fuel cells (3.43) of a fuel cell power system (3.49) spend in the normal operating temperature range, independently of the actual power

3.115.3
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 (3.110.5) set value within tolerance

3.115.4
shutdown time
duration between the instant when the load is removed and the instant when the shutdown (3.101) is completed as specified by the manufacturer

3.115.5
start-up time

a) for fuel cell power systems that do not require external energy to maintain a storage state (3.110.6), duration required for transitioning from cold state (3.110.1) to net electrical power (3.85.3) output; and
b) for fuel cell power systems that require external power to maintain a storage state (3.110.6), duration required for transitioning from storage state to net electrical power (3.85.3) output

3.116
ventilation

3.116.1
forced ventilation
movement of air and its replacement with fresh air by mechanical means

3.116.2
natural ventilation
movement of air and its replacement with fresh air due to the effects of wind and/or temperature gradients

3.117
voltage

3.117.1
minimum voltage
lowest voltage that a fuel cell module (3.48) is able to produce continuously at its rated power (3.85.4) or during maximum permissible overload conditions, whichever voltage is lower

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

3.117.2
open-circuit voltage
OCV
voltage across the terminals of a fuel cell (3.43) with fuel and oxidant 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".

3.117.3
output voltage
voltage between the output terminals under operating conditions

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

3.118
waste water
excess water that is removed from the fuel cell power system (3.49) and that does not constitute part of the thermal recovery system

3.119
water gas shift converter
See shift converter (3.99).

3.120
water separator
equipment that condenses and separates water vapour in the gas discharged from the fuel cell (3.43)

3.121
wet seal
gas seal method that prevents reactant gas of a fuel cell (3.43) from leaking out by surface tension of electrolyte (3.34)

Abbreviations

BOP	balance of plant
CCM	catalyst coated membrane
CCS	catalyst coated substrate
DMFC	direct methanol fuel cell
EMD	electromagnetic disturbance
EMI	electromagnetic interference
GDL	gas diffusion layer
LVH	lower heating value
MCFC	molten carbonate fuel cell
MEA	membrane electrode assembly
OVC	open-circuit voltage
PAFC	phosphoric acid fuel cell
PEFC	polymer electrolyte fuel cell
PEMFC	proton exchange membrane fuel cell
POX	partial oxidation reforming
PTL	porous transport layer
SOFC	solid polymer fuel cell

SPFC	solid polymer fuel cell
SR	steam reforming

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