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Title:
Fuel cell technologies - Part 1: Terminology

(Titre) :

Introductory note

International Electrotechnical Commission

Technical Committee 105 – Fuel Cell Technologies

Terminology

Technical Report

IEC TC105-1

(Format to be consistent with IEC documents)

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Fuel Cell Technologies

Terminology

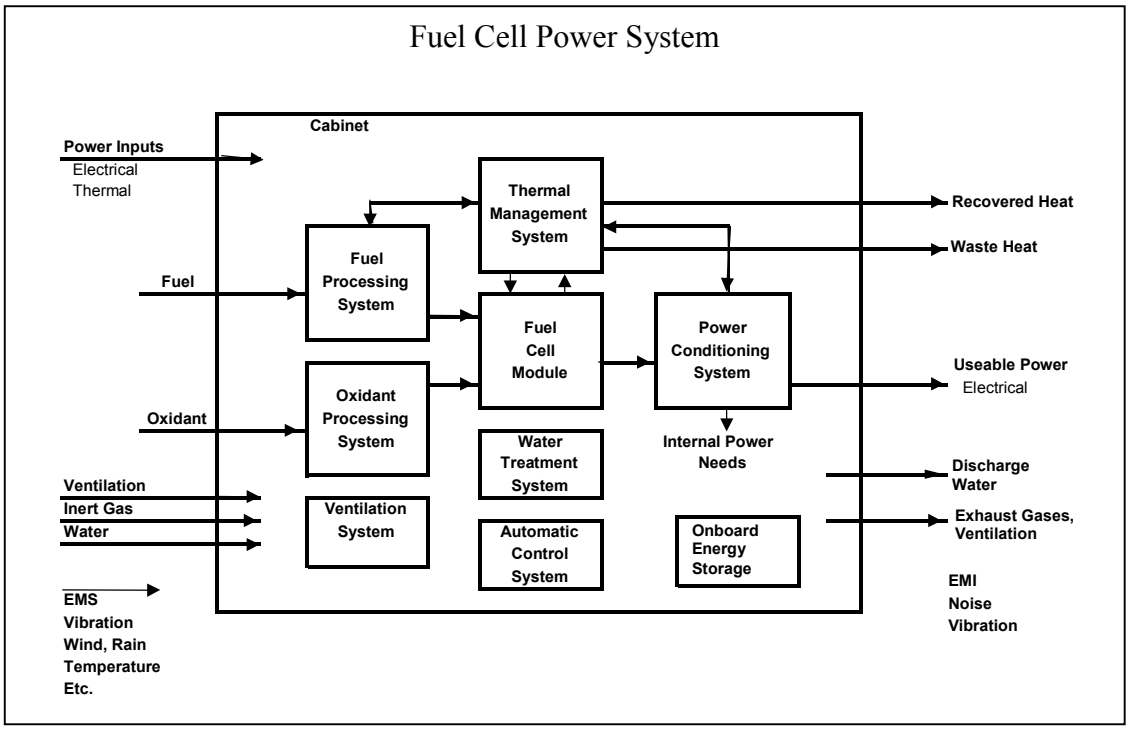
1 INTRODUCTION

1.1 Scope. This report 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 and portable power applications. Not found here are words and phases which can be found in standard dictionaries, engineering references or IEC's Multilingual Dictionary on Electricity, Electronics and Telecommunications.

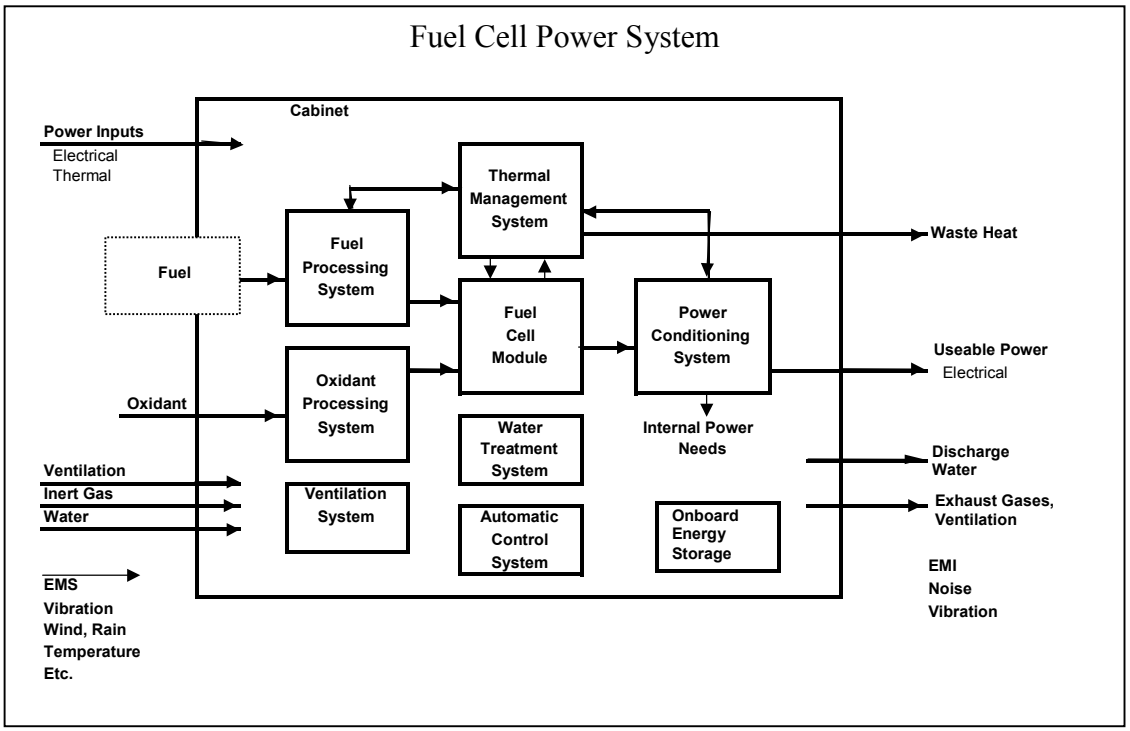
1.2 Purpose. This report is intended as a resource for the Working Groups and users of the TC105 series of fuel cell standards.

2 DIAGRAMS OF GENERALIZED FUEL CELL SYSTEMS

2.1 Stationary Fuel Cell Power Systems



2.2 Portable Fuel Cell Power Systems



3 TERMS AND DEFINITIONS

3.1 acceptance test

contractual test to prove to the customer that the item meets certain conditions of its specifications

3.2 allowable working pressure

maximum pressure, specified in gage pressure by the manufacturer, of a component or system to which it has been certified to according to the relevant code or directives
Note- Reliefs are set to protect at (or below) this value.

3.3 alkaline fuel cell

fuel cell that employs aqueous solution of alkali as the electrolyte
Note- Generally, aqueous solution of potassium hydroxide is used as the electrolyte.

3.4 ambient temperature

temperature of the medium surrounding a device, equipment or installation which may affect the performance of the device, equipment or installation

3.5 anode

electrode capable of emitting positive charge carriers to and/or receiving negative charge carriers from the medium of lower conductivity

3.6 automatic control system

assembly of sensors, actuators, valves, switches and logic components that maintains the *fuel cell power system* parameters within the manufacturers specified limits without manual intervention

3.7 background noise

sound pressure level, expressed in decibels(dBA), generated by the surroundings of a plant and measured at a specified measurement point when the plant is in the shutdown state

3.8 cathode

electrode capable of emitting negative charge carriers to and/or receiving positive charge carriers from the medium of lower conductivity

3.9 cold state

operational state of the *fuel cell power system* when it has neither power input nor output and is at ambient temperature

3.10 dynamic transient response of power output

dynamic response of the *fuel cell power system* output to load change

3.11 electrical efficiency

ratio of the electrical energy output to the energy input as calorific value of fuel supplied (low heating value) into the *fuel cell power system* under specified stable operating conditions
Note- Where electric power is supplied from an external source for a parasitic load, this energy is deducted from the electrical energy output of the generator.

3.12 electrical leakage (see leakage current)

3.13 electrolyte leakage

escape of liquid electrolyte from a *fuel cell module*

3.14 electromagnetic compatibility (EMC)

ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

3.15 electromagnetic disturbance

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

3.16 electromagnetic interference (EMI)

degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

3.17 electromagnetic emission level (of a disturbing source)

level of a given electromagnetic disturbance emitted from a particular device, equipment or system

3.18 emission characteristics

concentration of total sulfur oxides (SO_x), total nitrogen oxides (NO_x), total carbon dioxides (CO_2), total carbon monoxide (CO), total hydrocarbon compounds and particulates in the exhaust gas produced by the combustion in a reformer or other subsystems of the *fuel cell power system*, measured at the point of discharge to the environment

3.19 estimated individual noise value

value obtained by subtracting the measured background noise level from that measured on an instrument

3.20 fuel cell

electrochemical device that converts the chemical energy of a fuel and oxidant, both externally supplied, to electrical energy and by-products including heat

3.21 fuel cell module

assembly, enclosed in pressure vessels, if necessary, and consisting of one or more *fuel cell stacks* and of the devices serving for connecting stack or stacks to supporting systems

3.22 fuel cell power system

generator system that uses a fuel cell module to convert the chemical energy of reactants (a fuel and an oxidant) by an electrochemical process to electric energy (direct current or alternate current electricity) and thermal energy
Note- The system is composed of all or some of the systems shown in **2.1**.

3.23 fuel cell stack

assembly of cells, separators, cooling plates, manifolds and a supporting structure that electrochemically coverts fuel and an oxidant to dc power, heat, water and other byproducts

3.24 fuel processing system

chemical processing equipment plus associated heat exchangers and controls required to convert input fuel to a composition suitable for the *fuel cell stacks*

3.25 full load current

maximum continuous load current as specified by the manufacturer, at which the *fuel cell module* has been designed to operate

3.26 gas crossover (fuel)

unintended gas transfer from the fuel side and the oxidant side, or vice versa

3.27 gas leakage

aggregate unintended stream of gas from the *fuel cell stack*, associated pressure relief devices, other gas ducting and flow controlling components or from gas crossover

3.28 general artificial ventilation

movement of air and its replacement with fresh air by artificial means, for example fans, and applied to a general area

3.29 hazardous locations (classified)

any area or space where combustible dust, ignitable fibers, or flammable, volatile liquids, gases, vapors or mixtures are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures

3.30 heat recovery efficiency

ratio of the thermal energy actually recovered from the *fuel cell power system* by thermal media compared to the energy input as calorific value of the fuel supplied (low heating value) under stable operating conditions

3.31 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 to be assessed should be determined by agreement of the parties

3.32 leakage current

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

3.33 manifold

piping system of an appliance which supplies gas to or collects it from the *fuel cell* or the *fuel cell stack*

3.34 maximum operating pressure

maximum pressure, specified in gage pressure by the manufacturer, of a component or system at which it is designed to operate continuously
Note- Includes all normal operation; both steady state and transient.

3.35 minimum voltage

minimum continuous voltage that a *fuel cell module* is able to produce at its rated power or the maximum permissible overload conditions, whichever voltage is lower

3.36 molten carbonate fuel cell

fuel cell that employs molten carbonate as the electrolyte
Note- Usually, either the two elements of lithium and potassium or the two elements of lithium and sodium are used for the carbonate.

3.37 noise level (power system)

sound pressure level, expressed as decibels (dBA), generated by the *fuel cell power system* at the steady state operating condition where it generates maximum noise, and measured at a specified point

3.38 natural ventilation

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

3.39 onboard energy storage

internal energy source intended to aid or complement the *fuel cell module* in providing power to internal or external loads

3.40 open circuit voltage (fuel cell stack)

voltage across the terminals of a *fuel cell stack* when no continuous external conductive path exists between these terminals
Note- The fuel cell stack open circuit voltage has the greatest value of voltages attainable from the stack.

3.41 overall energy efficiency

ratio of the sum of electric energy output and recovered heat from the power system, during a given time period, to the caloric value of the fuel supplied (low heating value) to the power system during the same time period, under specified steady-state operating conditions

3.42 oxidant processing system

system that meters, conditions, processes, and may pressurize the incoming oxidant supply for use within the *fuel cell power system*

3.43 parasitic load

power for auxiliary machines and equipment such as balance of plant (BOP) necessary to continuously operate a *fuel cell power system* under stable operating conditions
Note- Examples are blowers, pumps, heaters, sensors, etc.

3.44 phosphoric acid fuel cell

fuel cell that employs aqueous solution of phosphoric acid as the electrolyte

3.45 PEM (proton exchange membrane/polymer electrolyte) fuel cell

fuel cell that employs solid positive ion exchange resin membrane as the electrolyte

3.46 portable fuel cell power system

fuel cell power system with an integral fuel supply, and capable to be carried by one person while being in operation
Examples:

(**small portable power generator**-units up to 10 kg in weight with fuel for up to 1 or 2 kW h energy; provides power for recreational uses or short term emergencies.)
(**portable device power packs**-provides up to 100 W h through refueling cartridges; for computers, cellular phones. Power tools, etc.)

3.47 power conditioning system

equipment which is used to change voltage level or waveform, or otherwise alter or regulate the output of a power source

3.48 recovered heat
thermal energy actually recovered from the *fuel cell power system*, measured by determining the temperatures and flow rates of fluid media (cooling liquid, steam, air, oil,

etc.) entering and leaving the thermal energy recovery subsystem at the boundary of the *fuel cell power system*

3.49 response time

time required for a *fuel cell power system* to transfer from one defined state to another
Note- This may also be quoted as a "response ramp rate" expressed in kW s^{-1}.

3.50 routine test

conformity test made on each individual item during or after manufacture

3.51 shutdown time

for a *fuel cell power system* generating electric power at 100% of nominal rated load, this is the time from when shutdown action is initiated to when an inert gas purge (if necessary) is completed or when the power consumption of auxiliaries goes down to their minimum value
Note- The shutdown operation is classified into two types: normal shutdown and emergency shutdown.

3.52 solid oxide fuel cell

fuel cell that employs an oxide ion-conducting electrolyte

3.53 standard gas conditions

arbitrarily chosen conditions for measured volumes of gases when recalculated to a temperature of 20 C and an absolute pressure of 101.3 kPa

3.54 standby state

operational state of the *fuel cell power system* in which the subsystems are being maintained at elevated temperatures and the power system is ready to generate electric active power, the value of delivered net electric output power being zero
Note- The manufacturer should specify the conditions for the standby state so that the state is stable for long time intervals.

3.55 start-up energy

total electric and/or thermal energy delivered to the *fuel cell power system* during the *start-up time*

3.56 start-up time

time required for the *fuel cell power system* to transition from *storage state* to commencement of electrical output (net power) after the initiation of start-up actions

3.57 stationary fuel cell power system

fuel cell power system that is permanently connected and fixed in place

3.58 storage state

state of the *fuel cell power system* that may require some thermal or electrical energy input in order to prevent deterioration of the components

3.59 thermal equilibrium conditions

state indicated by changes in temperature of no more than 3C (5F) between two readings 15 minutes apart

3.60 test for power output change

test to verify the characteristic of the *fuel cell power system* output to load change under grid-connected operation

3.61 thermal management system

provides cooling and heat rejection to maintain thermal equilibrium within the *fuel cell power system*, and may provide for the recovery of excess heat and assist in heating the power train during startup

3.62 time to full power

time taken to change from the *standby state* to reach 100% of rated power specified by the manufacturer
Note- This may also be quoted as “Full Power Ramp Rate” expressed in kW s^{-1}

3.63 type test

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

3.64 ventilation system

part of the *fuel cell power system* that provides, by mechanical means, air to its cabinet

3.65 vibration level

vibration level produced by the *fuel cell power system* during operation
Note- This value expressed as decibels (dB) measured at the base or support on which the fuel cell power system is installed, and operating at the power load which generates maximum level of vibration.

3.66 waste water

excess water that is removed from the *fuel cell power system*, and which does not constitute part of the thermal recovery system

3.66 water treatment system

provides for treatment and purification of recovered or added water for use within the *fuel cell power system*

3.67 zero emission vehicle

vehicle that does not produce any air pollutants; such as, carbon oxides, nitric oxides, unburned hydrocarbons or particulates

4 EQUATIONS

4.1 Electrical efficiency (ηE)

$$\eta E = \frac{P \times 3600}{F \times K} \times 100\%$$

Where, P (kW): electrical output at sending terminal

F (Nm^3/h or kg/h) consumption of raw fuel per hour

K (kJ/Nm^3 or kJ/kg) calorific value of fuel

4.2 Overall Energy Efficiency (ηT)

$$\eta T = \frac{(P \times 3600 + H)}{F \times K} \times 100\%$$

Where, P (kW): electrical output at sending terminal

F (Nm^3/h or kg/h) consumption of raw fuel per hour

K (kJ/Nm^3 or kJ/kg) calorific value of raw fuel

H (kJ/h) calorific value of recovered waste heat