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INTERNATIONAL STANDARD



Fuel cell technologies –
Part 4-102: Fuel cell power systems for ~~industrial electric trucks~~ electrically
powered industrial trucks – Performance test methods

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.070

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –

Part 4-102: Fuel cell power systems for ~~industrial electric trucks~~ electrically powered industrial trucks – Performance test methods

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
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- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62282-4-102:2017. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 62282-4-102 has been prepared by IEC technical committee 105: Fuel cell technologies. It is an International Standard.

This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

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

- a) alignment of the Scope with the second edition of IEC 62282-4-101:2022;
- b) deletion of terms and definitions (previous entries 3.5, 3.10, and 3.15);
- c) addition of new terms in Clause 3: "delivered power" (3.13) and "regenerated power" (3.14);
- d) revision of symbols and their meanings in alignment with those of IEC 62282-3-201;
- e) replacement of "reference conditions" with "standard conditions" as seen in Clause 5;
- f) revision of the test method for the accessory load voltage spike test (13.3.2);
- g) addition of clarifications in Clause 14 (Power stability under operation);
- h) addition of a checklist for performance criteria dealt with in this document (Annex C).

The text of this International Standard is based on the following documents:

Draft	Report on voting
105/947/FDIS	105/954/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62282 series, published under the general title *Fuel cell technologies*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document 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 62282-4 provides consistent and repeatable test methods for the electric, thermal and environmental performance of fuel cell power systems for ~~industrial electric trucks~~ electrically powered industrial trucks.

The IEC 62282-4 series deals with categories such as safety, performance, and interchangeability of fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APUs). This document (IEC 62282-4-102) focuses on performance test methods for fuel cell power systems ~~for~~ used to drive industrial electric trucks, which are being manufactured and used increasingly worldwide. This is because such applications are urgently ~~demanded~~ needed in the world.

This part of IEC 62282-4 describes type tests and their test methods only. No routine tests are required or identified, and no performance targets are set in this document.

Fuel cell systems used in ~~industrial electric trucks~~ electrically powered industrial trucks, such as forklift trucks, ~~are hybrids~~ use both batteries and fuel cells, and so operate in several different modes. Similarly, forklift trucks operate in different modes. The purpose of this document is to evaluate the fuel cell system in the various combinations of fuel cell modes and forklift truck modes. This document breaks down these different modes and provides a framework for designing and evaluating a fuel cell system for use specifically in a forklift truck.

This part of IEC 62282-4 is intended to be used by either manufacturers of fuel cell power systems used for ~~industrial electric trucks and/~~ electrically powered industrial trucks or those who evaluate the performance of the systems used in them for certification purposes or both.

Users of this document ~~selectively execute test items that are suitable for their purposes from those described in this document~~ can select and perform the tests they need from those described. This document is not intended to exclude any other ~~methods~~ tests.

FUEL CELL TECHNOLOGIES –

Part 4-102: Fuel cell power systems for ~~industrial electric trucks~~ electrically powered industrial trucks – Performance test methods

1 Scope

This part of IEC 62282 specifies the performance test methods of fuel cell power systems for propulsion and auxiliary power units (APU). This document covers fuel cell power systems for propulsion other than those for road vehicles.

~~The scope of this document is limited to electrically powered industrial trucks. Hybrid trucks that include an internal combustion engine are not included in the scope. The scope of this standard will be applicable to material handling equipment, e.g. forklifts.~~

This document covers the performance test methods of fuel cell power systems intended to be used for electrically powered industrial trucks as defined in ISO 5053-1, except for:

- rough-terrain trucks;
- non-stacking low-lift straddle carrier;
- stacking high-lift straddle carrier;
- rough-terrain variable-reach truck;
- slewing rough-terrain variable-reach truck;
- variable-reach container handler;
- pedestrian propelled trucks.

This document applies to gaseous hydrogen-fuelled fuel cell power systems and direct methanol fuel cell power systems for electrically powered industrial trucks. The following fuels are considered within the scope of this document:

- gaseous hydrogen, and
- methanol.

~~This document does not apply to reformer equipped fuel cell power systems.~~

This document covers the fuel cell power system as defined in 3.7 and Figure 1.

This document applies to DC type fuel cell power systems, with a rated output voltage not exceeding DC 150 V for indoor and outdoor use.

This document covers fuel cell power systems whose fuel source container is permanently attached to either the industrial truck or the fuel cell power system. ~~A fuel source container of the detachable type is not permitted.~~

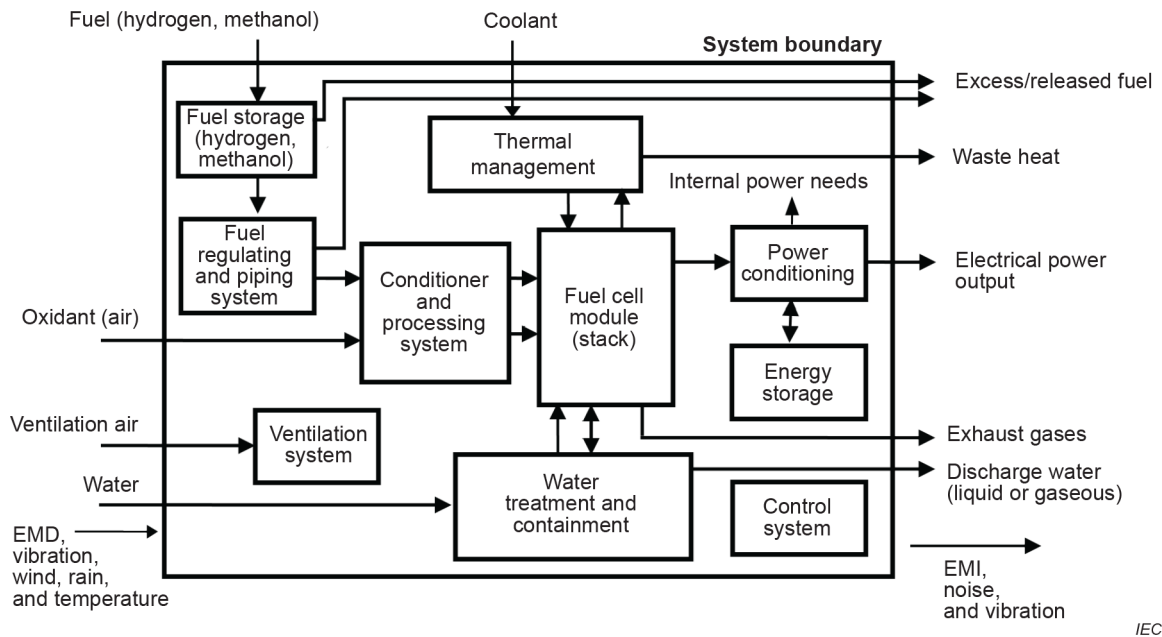
~~Fuel cell power systems intended for operation in potentially explosive atmospheres are excluded from the scope of this document.~~

~~This document does not cover the fuel storage systems using liquid hydrogen.~~

All systems with integrated energy storage systems are covered by this document. This includes systems such as batteries for internal recharges or recharged from an external source.

The following are not included in the scope of this document:

- detachable type fuel source containers;
- hybrid trucks that include an internal combustion engine;
- reformer-equipped fuel cell power systems;
- fuel cell power systems intended for operation in potentially explosive atmospheres;
- fuel storage systems using liquid hydrogen.



Key

EMD electromagnetic disturbance
EMI electromagnetic interference

NOTE A fuel cell power system can contain all or some of the above components.

Figure 1 – Fuel cell power systems for electrically powered industrial trucks

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.

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

~~IEC 62282-3-201, *Fuel cell technologies – Part 3-201: Small stationary fuel cell power systems – Performance test methods for small fuel cell power systems*~~

IEC 62282-6-300:2012, *Fuel cell technologies – Part 6-300: Micro fuel cell power systems – Fuel cartridge interchangeability*

~~ISO 9000, *Quality management series of standards*~~

ISO 6798-1, *Reciprocating internal combustion engines – Measurement of sound power level using sound pressure – Part 1: Engineering method*

ISO 6798-2, *Reciprocating internal combustion engines – Measurement of sound power level using sound pressure – Part 2: Survey method*

ISO 14687, *Hydrogen fuel quality – Product specification*

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

3.6

fuel cell system electrical efficiency

ratio of the average electric power output of a fuel cell power system ~~at~~ for a given duration to the average fuel power fed to the same fuel cell power system ~~at~~ for the same duration

3.7

fuel cell power system

generator system that uses one or more fuel cell modules to generate electric power and heat

~~Note 1 to entry:— See Figure 1 for a block diagram of a fuel cell power system.~~

~~Note 2 to entry:— A fuel cell power system may contain all or some of the components shown in Figure 1. The fuel cell power system for use with industrial trucks will be in one of the forms as outlined in 3.9 and 3.10 of IEC 62282-4-101.~~

~~[SOURCE: IEC/TS 62282-1:2013, 3.49, modified — New Note 1 to entry has been added, and existing Note 1 to entry has become Note 2 to entry with the addition of the second sentence.]~~

Note 1 to entry: The fuel cell power system for use with industrial trucks will be in one of the forms as outlined in IEC 62282-4-101:2022, 3.9 and 3.10.

[SOURCE: IEC 60050-485:2020, 485-09-01, modified – Note 1 to entry has been added.]

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fuel cell technologies –
Part 4-102: Fuel cell power systems for electrically powered industrial trucks –
Performance test methods**

**Technologies des piles à combustible –
Partie 4-102: Systèmes à piles à combustible pour chariots de manutention
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Users of this document can select and perform the tests they need from those described. This document is not intended to exclude any other tests.

FUEL CELL TECHNOLOGIES –

Part 4-102: Fuel cell power systems for electrically powered industrial trucks – Performance test methods

1 Scope

This part of IEC 62282 specifies the performance test methods of fuel cell power systems for propulsion and auxiliary power units (APU). This document covers fuel cell power systems for propulsion other than those for road vehicles.

This document covers the performance test methods of fuel cell power systems intended to be used for electrically powered industrial trucks as defined in ISO 5053-1, except for:

- rough-terrain trucks;
- non-stacking low-lift straddle carrier;
- stacking high-lift straddle carrier;
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- slewing rough-terrain variable-reach truck;
- variable-reach container handler;
- pedestrian propelled trucks.

This document applies to gaseous hydrogen-fuelled fuel cell power systems and direct methanol fuel cell power systems for electrically powered industrial trucks. The following fuels are considered within the scope of this document:

- gaseous hydrogen, and
- methanol.

This document covers the fuel cell power system as defined in 3.7 and Figure 1.

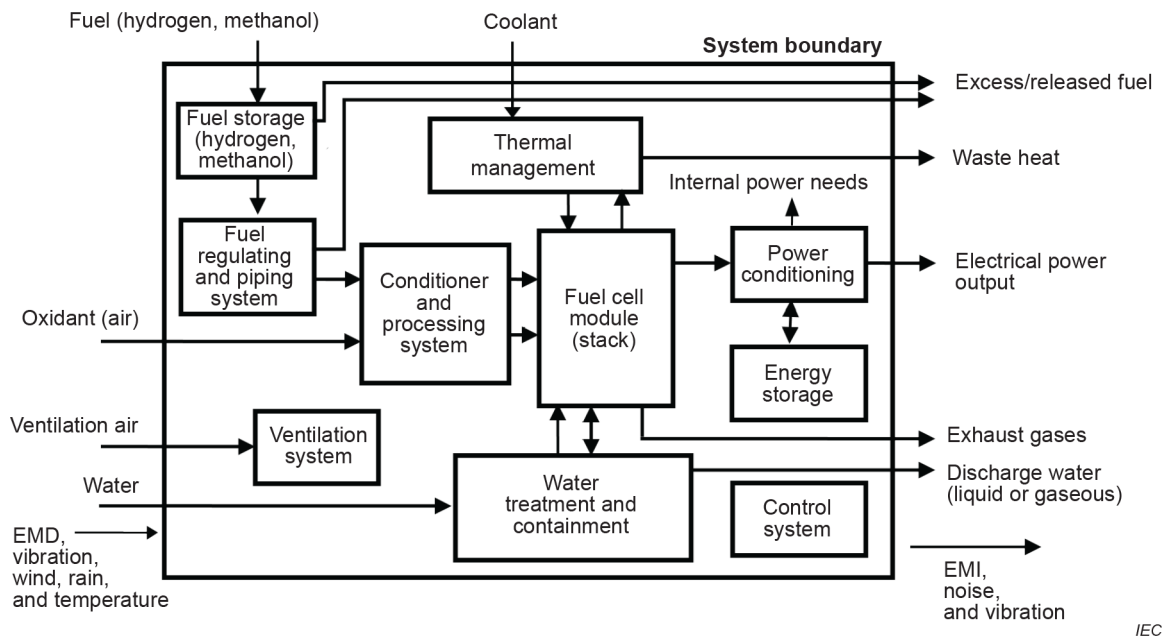
This document applies to DC type fuel cell power systems, with a rated output voltage not exceeding DC 150 V for indoor and outdoor use.

This document covers fuel cell power systems whose fuel source container is permanently attached to either the industrial truck or the fuel cell power system.

All systems with integrated energy storage systems are covered by this document. This includes systems such as batteries for internal recharges or recharged from an external source.

The following are not included in the scope of this document:

- detachable type fuel source containers;
- hybrid trucks that include an internal combustion engine;
- reformer-equipped fuel cell power systems;
- fuel cell power systems intended for operation in potentially explosive atmospheres;
- fuel storage systems using liquid hydrogen.



IEC

Key

EMD electromagnetic disturbance

EMI electromagnetic interference

NOTE A fuel cell power system can contain all or some of the above components.

Figure 1 – Fuel cell power systems for electrically powered industrial trucks**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.

IEC 62282-6-300:2012, *Fuel cell technologies – Part 6-300: Micro fuel cell power systems – Fuel cartridge interchangeability*

ISO 6798-1, *Reciprocating internal combustion engines – Measurement of sound power level using sound pressure – Part 1: Engineering method*

ISO 6798-2, *Reciprocating internal combustion engines – Measurement of sound power level using sound pressure – Part 2: Survey method*

ISO 14687, *Hydrogen fuel quality – Product specification*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

TECHNOLOGIES DES PILES À COMBUSTIBLE –

Partie 4-102: Systèmes à piles à combustible pour chariots de manutention électriques – Méthodes d'essai des performances

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L'IEC 62282-4-102 a été établie par le comité d'études 105 de l'IEC: Technologies des piles à combustible. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2017. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) alignement du domaine d'application sur la deuxième édition de l'IEC 62282-4-101:2022;
- b) suppression de termes et de définitions (les entrées 3.5, 3.10 et 3.15 qui existaient précédemment);

- c) ajout de nouveaux termes à l'Article 3: "puissance fournie" (3.13) et "puissance régénérée" (3.14);
- d) révision de symboles et de leurs significations en vue d'un alignement sur ceux de l'IEC 62282-3-201;
- e) remplacement de "conditions de référence" par "conditions normales" comme vu à l'Article 5;
- f) révision de la méthode d'essai pour l'essai de pointe de tension des charges accessoires (13.3.2);
- g) ajout de clarifications à l'Article 14 (Stabilité de la puissance en fonctionnement);
- h) ajout d'une liste de contrôle pour les critères de performance traités dans le présent document (Annexe C).

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
105/947/FDIS	105/954/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 62282, publiées sous le titre général *Technologies des piles à combustible*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

La présente partie de l'IEC 62282-4 fournit des méthodes d'essai cohérentes et reproductibles pour les performances électriques, thermiques et environnementales des systèmes à piles à combustible pour chariots de manutention électriques.

La série IEC 62282-4 traite d'aspects tels que la sécurité, les performances et l'interchangeabilité des systèmes à piles à combustible utilisés pour la propulsion autres que ceux destinés aux véhicules routiers et aux groupes auxiliaires de puissance (GAP). Le présent document (IEC 62282-4-102) porte essentiellement sur les méthodes d'essai des performances des systèmes à piles à combustible servant à entraîner les chariots de manutention, dont la fabrication et l'utilisation connaissent un développement important au niveau mondial. Cela est dû à un besoin urgent de disposer de ces applications partout dans le monde.

La présente partie de l'IEC 62282-4 ne décrit que les essais de type et leurs méthodes d'essai. Le présent document ne spécifie aucune exigence pour les essais individuels de série et n'établit aucun objectif de performance.

Les systèmes à piles à combustible utilisés sur les chariots de manutention électriques tels que les chariots élévateurs à fourche utilisent à la fois des batteries et des piles à combustible, et fonctionnent par conséquent dans différents modes. De même, les chariots élévateurs à fourche fonctionnent dans différents modes. Le présent document a pour objet d'évaluer le système à piles à combustible dans les différentes combinaisons de modes de fonctionnement des piles à combustible et des chariots élévateurs à fourche. Le présent document décompose ces différents modes et propose un cadre de conception et d'évaluation d'un système à pile à combustible destiné spécifiquement aux chariots élévateurs à fourche.

La présente partie de l'IEC 62282-4 est prévue pour être utilisée soit par les fabricants de systèmes à piles à combustible pour chariots de manutention électriques, soit par les responsables chargés de l'évaluation des performances des systèmes utilisés dans ceux-ci à des fins de certification, soit les deux.

Les utilisateurs du présent document peuvent choisir et réaliser les essais dont ils ont besoin parmi ceux décrits. Le présent document n'a pas pour objet d'exclure tout autre essai.

TECHNOLOGIES DES PILES À COMBUSTIBLE –

Partie 4-102: Systèmes à piles à combustible pour chariots de manutention électriques – Méthodes d'essai des performances

1 Domaine d'application

La présente partie de l'IEC 62282 spécifie les méthodes d'essai des performances des systèmes à piles à combustible pour la propulsion et les groupes auxiliaires de puissance (GAP). Le présent document couvre les systèmes à piles à combustible destinés à la propulsion, autres que ceux destinés aux véhicules routiers.

Le présent document concerne les méthodes d'essai des performances des systèmes à piles à combustible destinés à être utilisés sur des chariots de manutention électriques définis dans l'ISO 5053-1, à l'exception:

- des chariots tout-terrain;
- des chariots cavaliers élévateurs non gerbeurs;
- des chariots cavaliers élévateurs gerbeurs;
- des chariots tout-terrain à portée variable;
- des chariots tout-terrain rotatifs à portée variable;
- des chariots porte-conteneurs à portée variable;
- des chariots manuels.

Le présent document s'applique aux systèmes à piles à combustible utilisant de l'hydrogène gazeux et à ceux utilisant du méthanol direct pour les chariots de manutention électriques. Les combustibles suivants relèvent du domaine d'application du présent document:

- hydrogène gazeux; et
- méthanol.

Le présent document traite du système à pile à combustible défini en 3.7 et à la Figure 1.

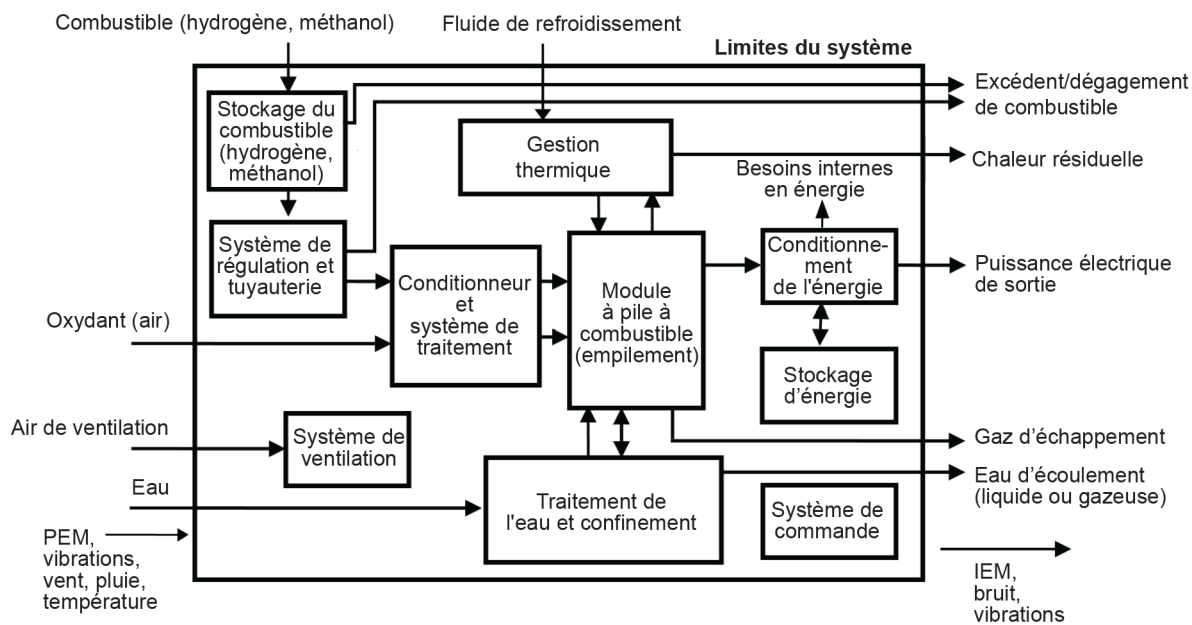
Le présent document s'applique aux systèmes à piles à combustible de type à courant continu, d'une tension de sortie assignée maximale de 150 V en courant continu pour utilisation à l'intérieur et à l'extérieur.

Le présent document concerne les systèmes à piles à combustible dont le conteneur de source de combustible est fixé à demeure, soit au chariot de manutention, soit au système à pile à combustible.

Le présent document s'applique à tous les systèmes équipés de systèmes de stockage d'énergie intégrés. Ces derniers comprennent des systèmes tels que des batteries pour recharge interne ou rechargées par une source externe.

Les éléments suivants ne relèvent pas du domaine d'application du présent document:

- conteneurs de source de combustible de type amovible;
- chariots hybrides qui contiennent un moteur à combustion interne;
- systèmes à piles à combustible équipés d'un reformeur;
- systèmes à piles à combustible conçus pour fonctionner dans des atmosphères potentiellement explosives;
- systèmes de stockage de combustible utilisant de l'hydrogène liquide.



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NOTE Un système à pile à combustible peut comporter tous les composants représentés ci-dessus ou seulement certains d'entre eux.

Figure 1 – Systèmes à piles à combustible pour chariots de manutention électriques

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 62282-6-300:2012, *Technologies des piles à combustible – Partie 6-300: Systèmes à micro-piles à combustible – Interchangeabilité de la cartouche de combustible*

ISO 6798-1, *Moteurs alternatifs à combustion interne – Mesurage du niveau de puissance acoustique à partir de la pression acoustique – Partie 1: Méthode d'expertise*

ISO 6798-2, *Moteurs alternatifs à combustion interne – Mesurage du niveau de puissance acoustique à partir de la pression acoustique – Partie 2: Méthode de contrôle*

ISO 14687, *Qualité du carburant hydrogène – Spécification de produit*