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Hydrogen detection apparatus — Stationary applications

Détecteurs d'hydrogène — Applications fixes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 26142 was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies*.

Introduction

Over the course of several years, international efforts have been initiated for the development of necessary regulations, codes and standards required for the introduction of hydrogen energy systems in consumer environments. Such codes and standards usually require a safety system to detect hydrogen concentrations before a fraction of the flammable or explosive limit is reached, in order to allow for purging, shut-off, and similar safety operations.

This International Standard provides requirements for stationary hydrogen detection apparatus, covering both performance requirements and test methods. This International Standard is intended to cover situations where the user desires the ability to detect hydrogen leaks and monitor hydrogen concentrations relevant to safety. This International Standard is primarily intended for hydrogen detection apparatus at vehicle refuelling stations, where a high level of safety management is required. This sector has an immediate need for this standard and is expected to be the main application for such apparatus, but this standard can also be applied to other stationary installations where the detection of hydrogen is required.

This International Standard is not intended to exclude any specific technologies that meet the performance requirements herein.

This International Standard contains the important quantitative and technical specifications against the danger of hydrogen leakage. This standard will promote international cooperation under easy-to-understand requirements, by leading to widespread use of hydrogen energy.

Benefits to be gained by the implementation of this International Standard include using the performance requirements in the standard to overcome safety concerns and aiding in development of the hydrogen fuel infrastructure.

In this International Standard, attention is concentrated on specific requirements related to performance and testing of hydrogen detection apparatus, such as a specific detection range for single and multiple safety systems, selectivity, poisoning, fast response time, and hydrogen-specific test methods needed by the hydrogen energy industry. This International Standard focuses primarily on stationary hydrogen technologies whose main purpose is to produce, store and handle hydrogen, and not on systems that might generate hydrogen as an undesirable by-product. The purpose of a hydrogen detection apparatus according to this standard is to mitigate risk from unintended hydrogen releases within a wide range of hydrogen concentrations including those exceeding the lower flammability limit.

Hydrogen-related facilities might be required to have the ability to detect hydrogen concentrations before a specified concentration of hydrogen or fraction of flammable limit is reached, in order to allow for single and/or multilevel safety operations, such as nitrogen purging or ventilation and/or system shut-off; or there might be a desire to detect hydrogen concentrations above the lower flammability limit, in order to monitor concentrations following a release. The hydrogen detection apparatus described in this International Standard can detect the hydrogen leak concentration at multiple points determined by users to realize such multilevel safety operations.

Hydrogen detection apparatus — Stationary applications

1 Scope

This International Standard defines the performance requirements and test methods of hydrogen detection apparatus that is designed to measure and monitor hydrogen concentrations in stationary applications. The provisions in this International Standard cover the hydrogen detection apparatus used to achieve the single and/or multilevel safety operations, such as nitrogen purging or ventilation and/or system shut-off corresponding to the hydrogen concentration. The requirements applicable to the overall safety system, as well as the installation requirements of such apparatus, are excluded. This International Standard sets out only the requirements applicable to a product standard for hydrogen detection apparatus, such as precision, response time, stability, measuring range, selectivity and poisoning.

This International Standard is intended to be used for certification purposes.

2 Normative references

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

ISO 14687-1:1999, *Hydrogen fuel — Product specification — Part 1: All applications except proton exchange membrane (PEM) fuel cell for road vehicles*

ISO 14687-1:1999/Cor.2:2008, *Hydrogen fuel — Product specification — Part 1: All applications except proton exchange membrane (PEM) fuel cell for road vehicles — Technical Corrigendum 2*

IEC 61000-4-1, *Electromagnetic compatibility (EMC) — Part 4-1: Testing and measurement techniques — Overview of IEC 61000-4 series*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test*

IEC 60079-0:2008, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 60079 (all parts), *Explosive atmospheres*

3 Terms and definitions

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

3.1
alarm set point
fixed or adjustable setting of the hydrogen detection apparatus that is intended to select the hydrogen volume fraction at which an indication, an alarm or another output function will automatically be activated

3.2
ambient air
normal atmosphere surrounding the hydrogen detection apparatus

3.3
aspirated hydrogen detection apparatus
hydrogen detection apparatus that samples the gas to be detected by introducing it to the hydrogen sensor(s) in a forced manner (e.g. use of a gas sampling pump or induction of a flow through a pressure differential)

3.4
clean air
air that is free of flammable gases, interfering or contaminating substances, and dust

3.5
control unit
part of hydrogen detection apparatus that is commonly referred to as the apparatus body and which excludes its remote sensor(s) and connections, if any

3.6
data collecting interval
time interval between the time when an indication data is collected and the time when the next indication data is corrected

3.7
diffusion chamber
chamber that can be sealed with controlled conditions of temperature, humidity and test-gas volume fraction, used for performing the test on the hydrogen detection apparatus

3.8
fault signal
audible, visible or other type of signal different from the alarm signal, providing, directly or indirectly, a warning or an indication that the hydrogen detection apparatus is not working satisfactorily

3.9
final indication
indication given by the hydrogen detection apparatus after stabilization

3.10
hydrogen detection apparatus
assembly with an integrated or a remote hydrogen sensor that is intended to detect and measure the hydrogen volume fraction over a declared measuring range

NOTE 1 The hydrogen detection apparatus may be provided with a single or multiple alarm set points.

NOTE 2 The hydrogen detection apparatus may include one or more built-in alarm indications, output contacts for alarm and/or electrical signals for alarm.

3.11
hydrogen sensing element
component that provides a measurable, continuously changing physical quantity in correlation to the surrounding hydrogen volume fraction

3.12
hydrogen sensor
assembly, which contains one or more hydrogen sensing elements and may also contain circuit components associated with the hydrogen sensing elements, that provides a continuously changing physical quantity or signal in correlation to the physical quantity provided by the hydrogen sensing element(s)

3.13
hydrogen volume fraction
hydrogen content expressed as the ratio of the volume of hydrogen to the total volume of all components in the gas mixture under standard conditions of temperature and pressure of 20 °C and 101,325 kPa

3.14
interferant
any substance that affects the sensitivity of a hydrogen sensing element by contacting or adhering to it

3.15
latching alarm
alarm that, once activated, requires deliberate manual action to be deactivated

3.16
measuring range
range, defined by the lowest and highest hydrogen volume fractions, within which a hydrogen detection apparatus can measure hydrogen volume fractions within the specified accuracy

3.17
multi-level detection
continuous detection and monitoring of hydrogen volume fraction with multiple alarm set points

3.18
nominal supply voltage
voltage corresponding to the manufacturer-recommended operating voltage for the hydrogen detection apparatus

3.19
poisoning
phenomenon caused by any interferant that permanently affects the sensitivity of a hydrogen sensing element

3.20
remote hydrogen sensor
hydrogen sensor that is remotely connected to a hydrogen detection apparatus

3.21
selectivity
response of the hydrogen detection apparatus to hydrogen compared with the response to other gases

NOTE If there is high selectivity to hydrogen, the results will be less ambiguous and the cross-sensitivity to other gases will be low.

3.22
sensitivity
ratio of change produced in the apparatus by a known volume fraction of hydrogen

NOTE 1 Depending on the context, this can refer to the minimum change in the volume fraction of hydrogen that the apparatus will detect.

NOTE 2 High sensitivity implies that low volume fractions can be measured.

3.23
special state
state of the hydrogen detection apparatus other than those in which monitoring of hydrogen volume fractions takes place, for example, warm-up, calibration mode or fault condition

3.24
stabilization
state in which three successive readings of a hydrogen detection apparatus, taken at 30 s intervals, indicate no changes greater than 5 % of the volume fraction of the test gas

3.25
test gas
mixture of hydrogen and clean air with a known volume fraction, which is used for performance tests of hydrogen detection apparatus

3.26
time of response
t_{90}
time interval, with the hydrogen detection apparatus in a warmed-up condition, between the time when an instantaneous variation from clean air to the standard test gas is produced at the inlet of the remote hydrogen sensor or the integrated hydrogen sensor(s) and the time when the response reaches a stated percentage (x) of the final indication

3.27
time of recovery
t_{10}
time interval, with the hydrogen detection apparatus in a warmed-up condition, between the time when an instantaneous variation from the standard test gas to clean air is produced at the inlet of the remote hydrogen sensor or the integrated hydrogen sensor(s) and the time when the response decreases to a stated percentage (x) of the final indication

3.28
warm-up time
time interval between the time when the hydrogen detection apparatus is switched on and the time when the special state indicator is turned off, showing that the hydrogen detection apparatus is in a warmed-up condition

4 General requirements

4.1 Construction

4.1.1 General

The hydrogen detection apparatus designed to be used in a hazardous area shall comply with IEC 60079-0 and the relevant parts of IEC 60079.

4.1.2 Enclosure

If the application demands it, all parts of the enclosure shall be constructed of corrosion-resistant materials or be protected against corrosion.

4.1.3 Measuring range

The measuring range of the hydrogen detection apparatus shall be declared by the manufacturer. The measuring range shall cover a minimum of one order of magnitude. If the hydrogen detection apparatus uses two or more hydrogen sensor technologies or principles to cover a wide measuring range, the manufacturer shall declare the number of hydrogen sensors and/or specify the measuring range pertaining to each hydrogen sensor technology or principle.

4.1.4 Alarm system

4.1.4.1 Alarm

The hydrogen detection apparatus shall have at least one latching alarm with a fixed or adjustable alarm set point. If two or more alarm set points are provided, the lower may be non-latching, based on user preference. While the alarm condition is still present, the hydrogen detection apparatus shall be designed in such a way

that any alarms, except for optional audible alarms, shall remain in operation. Alarm devices shall be tamper-proof.

At least one alarm set point shall be available at or below a hydrogen volume fraction in air of 1×10^{-2}.

4.1.4.2 Fault signals

The hydrogen detection apparatus shall provide a fault signal in the event of loss of power. A short circuit or open circuit in the connection to any remote hydrogen sensor shall also be indicated by a fault signal. An aspirated hydrogen detection apparatus shall indicate the adequacy of flow conditions and produce a fault signal in the event of a flow failure.

4.1.5 Indicators

4.1.5.1 Power indication

The detection apparatus shall provide a visual power indicator that clearly indicates if the power to the hydrogen detection apparatus is on or off.

4.1.5.2 Signals for recording

For a hydrogen detection apparatus where the resolution of the read-out device is inadequate to demonstrate compliance with this International Standard, the manufacturer shall identify suitable points for connecting, indicating or recording devices for the purpose of testing the compliance of the hydrogen detection apparatus with this International Standard.

4.1.5.3 Measuring range

Any under-range or over-range measurements shall be clearly indicated.

If the hydrogen detection apparatus covers more than one measuring range, the measuring range selected shall be clearly identified.

All indications may be shown on the separate control unit.

4.1.5.4 Indicating colours

If only one indicating light is provided for alarm, fault or other indications, it shall be red in colour.

If separate indicating lights are used, the colour shall be used in the following order of priority:

a) red for alarm indication;

b) yellow for fault indication;

c) green for operation.

In addition to the colour requirements, the indicator lights shall be labelled to show their functions.

4.1.6 Adjustments

All adjustment devices shall be designed so as to discourage unauthorized or inadvertent interference with the hydrogen detection apparatus. Examples would include procedural devices such as a keyboard instrument, or mechanical devices such as a cover requiring the use of a tool.

A fixed explosion-protected hydrogen detection apparatus or hydrogen sensor housed in explosion-protected enclosures shall be designed so that, if any facilities for adjustment are necessary for routine recalibration and

for resetting or similar functions, these facilities shall be externally accessible. The means for making adjustments shall not degrade the explosion protection of the hydrogen detection apparatus or hydrogen sensor.

The adjustments of the zero and signal amplification shall be so designed that adjustment of one will not affect the other.

4.1.7 Software-controlled hydrogen detection apparatus

4.1.7.1 General

In the design of software-controlled hydrogen detection apparatus, the risks arising from faults in the program shall be taken into account. In case of malfunction, a manual override switch shall be provided. The manual override switch shall be protected from use by unauthorized personnel.

4.1.7.2 Conversion errors

The relationship between corresponding analogue and digital values shall be unambiguous. The output range shall be capable of coping with the full range of input values within the instrument specification. A clear indication shall be provided if the conversion range is exceeded.

The design shall take into account the maximum possible analogue-to-digital, computational and digital-to-analogue converter errors. The combined effect of digitization errors shall not be greater than the smallest deviation of indication required by this International Standard.

4.1.7.3 Special state indication

All special states entered by the hydrogen detection apparatus shall be indicated by a contact or other transmittable output signal.

4.1.7.4 Software

The installed software version shall be identified, for example, by a marking on the installed memory component, a marking in (if accessible) or on the hydrogen detection apparatus, or a display during power-up or on user command.

It shall not be possible for the user to modify the program code.

Parameter settings shall be checked for validity. Invalid inputs shall be rejected. An access barrier shall be provided against parameter changing by unauthorized persons, e.g. it may be integrated by an authorization code in the software or may be realised by a mechanical lock. Parameter settings shall be preserved after removal of power, and while passing a special state. All user-changeable parameters and their valid ranges shall be listed in the software documentation.

Software shall have a structured design to facilitate testing and maintenance. If used, program modules shall have a clearly defined interface to other modules.

Software documentation shall be included in the technical file of the product. It shall include the following:

a) the hydrogen detection apparatus to which the software belongs;

b) identification of the software version;

c) functional description;

d) software structure (e.g. flow chart, Nassi-Schneidermann diagram);

e) any software modification provided with the date of change and new identification data.