English translation

AR 214

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Validated Dutch Version

Approval requirement 214

Fitness for admixtures up to and including 100% hydrogen gas

Certification Hydrogen Gas

Trust
Quality
Progress

Foreword Kiwa

This GASTEC QA approval requirement (Dutch version) has been approved by the Board of Experts product certification GASTEC QA, in which relevant parties in the field of gas related products are represented. This Board of Experts supervises the certification activities and where necessary require the GASTEC QA approval requirement to be revised. All references to Board of Experts in this GASTEC QA approval requirement pertain to the above mentioned Board of Experts.

This GASTEC QA approval requirement (Dutch version) will be used by Kiwa Nederland BV in conjunction with the GASTEC QA general requirements and the KIWA regulations for certification.

This approval requirement is a translation from the Dutch validated version and can only be used as supporting document.

Kiwa Nederland B.V.
Wilmersdorf 50
Postbus 137
7300 AC Apeldoorn

Tel. 088 998 33 93
Fax 088 998 34 94
info@kiwa.nl
www.kiwa.nl

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1 Introduction

1.1 General

This GASTEC QA – Hydrogen gas approval requirement in combination with the GASTEC QA general requirements include all relevant requirements, which are adhered by Kiwa as the basis for the issue and maintenance of a GASTEC QA – Hydrogen gas certification certificate fitness for admixtures up to and including 100% hydrogen gas.

Note: This certificate is only issued in combination with a GASTEC QA product certificate for natural gas.

1.2 Field of application / scope

This approval requirement is applicable to gas distribution and installation materials for natural gas with an admixture of hydrogen gas and pure hydrogen gas.

The maximum operating pressure (MOP) and operating temperature are specified in the approval requirement for the product for GASTEC QA certification.

Remark 1: Considering that hydrogen embrittlement does not occur at a pressure of less than 10 bar, resistance to hydrogen embrittlement is not included as a requirement in this approval requirement.

Remark 2: This approval requirement includes two methods to perform a leak tightness test:

- Products used in indoor installations including gas stoppers, regulators, safety valves, and ball valves shall be tested with hydrogen.
- Couplings and valves used in gas distribution networks up to 10 bar shall be tested with air.

The supporting information with regard to testing with air is included in annex A. There is a limited number of clients for these products in the Netherlands and they have reached mutual consensus about the requirements leak tightness of gas distribution networks shall satisfy.

2 Definitions

In this approval requirement the following terms and definitions apply:

Board of Experts: Board of Experts GASTEC QA

MOP: Maximum operating pressure

Decree quality of gas: Regulation from the Minister of Economics for determine the requirements for gas quality

Hydrogen gas: Di-hydrogen or molecular hydrogen (H_2), the main singular material from the element hydrogen. At normal pressure and temperature hydrogen gas is colourless, odourless, tasteless and highly flammable.

Sealing materials: Materials used for sealing threads according to approval requirement 31-1, 31-2 and 31-3.

Suitability for hydrogen: Products that satisfy the requirements included in this approval requirement are deemed to be suitable to be used with an admixture for hydrogen gas and pure hydrogen gas.

Resistance to hydrogen: The extent materials used for the manufacture are resistant to long-term exposure to admixtures of hydrogen gas and natural gas and pure hydrogen gas.

Installation materials: Materials applied after the meter and whose scope is defined in NEN 1078 or NEN 8078 (see design and application).

Other definitions are available in the relevant GASTEC QA approval requirements.

3 Product requirements

3.1 General

Products approved by this approval requirement shall fulfil the requirements GASTEC QA approval requirements belonging to the product. The approval requirement is mentioned on the certificate of the product.

3.2 Materials

The materials in table 1 are proven to be suitable to hydrogen gas. For the materials which are not investigated or are not mentioned in table 1 shall be proven to be suitable for hydrogen gas to fulfil the requirements of this approval requirement.

Material	Suitability
PE80	X
PE100	X
PVC-A	X
PVC-CPE	X
NBR	X
POM	X
Nodular cast iron	X
Copper / copper alloys	X
Carbon steel (St 37/235, ASTM A106 gr. B, API 5L gr. B)	X
Stainless steel (AISI 316 types)	X
Aluminum alloys	X
Methacrylate ester resins	X
Natural rubber (Latex)	X

Table 1: Materials resistant to hydrogen

4 Performance requirements and test methods

4.1 General

The products shall be tested according to table 2.

Products:	Leak tightness internal	Leak tightness external	Long-term behaviour	Functionality
Valves	X	X	X	
Regulators	X	X	X	X
Maximum flow rate safety valves	X	X	X	X
Gasstopper	X		X	X

Table 2: Performance requirements

4.1.1 Test pieces

When testing the performance requirements, test pieces are tested in accordance with the corresponding GASTEC QA approval requirement.

4.1.2 Determination of leak tightness

The leak tightness is determined with the medium air, the foundation for this can be found in Annex A.

The uncertainty of the equipment gas shall not exceed 5 cm^3/h.

4.1.3 Long-term behavior

The long term behavior shall be tested with hydrogen gas. If applicable, a leak tightness test before or after the functional test, is performed with the medium air according to paragraph 4.1.2.

4.1.4 Funcitionality

The functionality of the product shall be tested with 2 concentrations of test gases. First with 20% hydrogen gas in natural gas and next with pure hydrogen gas. If applicable, a leak tightness test before or after the functional test, is performed with the medium air according to paragraph 4.1.2.

4.2 Leak tightness internal

4.2.1 Valves

The valves shall be tested in closed position with the testing equipment connected to 1 side.

Valves	Requirement	Test medium	Test time	Test temperature	Test pressure
KE 69 (-1)	≤50 DN: 6.6 cm3/h 50<DN≤100: 13.3 cm^3/h	air	10 minutes low pressure followed by 10 minutes high pressure	23 ± 2 °C	6 mbar followed by 1.5 x MOP

Table 3: Test parameters for internal leak tightness of valves

4.2.2 Regulators

The gas pressure regulator and combination regulator shall be tested with the control valve in closed position. The inlet and outlet sides are connected to a leak tight measuring system with pressures that can be set independently from each other.

The internal leak tightness of a gas pressure regulator and a combination regulator shall be measured at a pressure of 300 mbar at the inlet side and 37.5 mbar at the outlet side. The internal tightness test is performed according to approval requirement 11.

The leak between the inlet and outlet sides shall not exceed 6.6 cm_{st}^3/h.

4.2.3 Maximum flow rate safety valves

When the valve is completely closed, leakage shall not exceed 1.0 dm^3/h. This leakage shall be determined according to approval requirement 191, paragraph 4.4.

4.2.4 Gas stoppers

At a test pressure of 1x MOP, the leakage flow with a fully closed gas stoppers shall not exceed 1l/dm3 without bypass and one third of the manufacturer's stated value (for natural gas) for gas stoppers with bypass. The leakage flow will be tested according to approval requirement 210, paragraph 5.6.

4.2.5 Thermally responsive safety valve

Leakage when the valve is completely closed shall not exceed 10 dm^3/h. This leakage will be determined according to approval requirement 171, paragraph 4.6.

4.2.6 Equipment for temperoralily closing off gas pipes

The leakage of the closing element for pipes within a building shall not exceed 2.0 dm^3/h. This leakage shall be determined according to approval requirement 194, paragraph 4.2.4.

The leakage of the closing element for pipes outside a building shall not exceed 0.1 dm^3/h. This leakage shall be determined according to approval requirement 194, paragraph 4.2.5.

The leakage of the closing element in a drill hole shall not exceed 0.1 dm^3/h. This leakage shall be determined according to approval requirement 194, paragraph 4.2.6.

4.3 Leak tightness external

The external leak tightness test of the products shall be performed according to table 2, paragraph 4.1.2., and the test method applicable to the with the product corresponding approval requirement.

4.4 Long-term behavior

4.4.1 General

Testing of long-term behavior is performed according to paragraph 4.1.3 and the following methods.

4.4.2 Valves

For this test, the cut-off valves that were tested as per 4.2.1 will be used. The valves, after the number of times of opening and closing according to the GASTEC QA approval requirement associated to the valve, shall be internally leak tight according to paragraph 4.2.1 and 4.3.

4.4.3 Gas pressure regulator and combination regulator

The gas pressure regulator and the combination regulator, after 40.000 times of opening and closing of the control valve at an environmental temperature of -20 ± 1 °C and subsequently after 40,000 times of opening and closing at an environmental temperature of 50 ± 1 °C shall satisfy the requirements of paragraph 4.2.2 and 4.3.2.

4.4.4 Gas leak protectors

A gas leak protector (GGB) and a combination regulator with closed inlet side, however with the outlet side connected to a varying pressure of 0 mbar to 25 mbar, after 5,000 times of opening and closing of the closing element at an environmental temperature of -20 ± 1 °C and subsequently after 5,000 times of opening and closing at an environmental temperature of 50 ± 1 °C shall satisfy the requirements of paragraph 4.3.

4.4.5 Maximum flow rate safety valves

After repeatedly (10 times) closing and opening the valve, according to approval requirement 191, paragraph 4.5, it shall still satisfy the requirements according to paragraph 4.2.3 and 4.3.

4.4.6 Gas stoppers

After repeatedly (100 times) closing and opening the gas stoppers with a test piece at 1x MOP, it shall still satisfy the requirements according to paragraph 4.2.4.

4.4.7 Equipment for temporatily closing of gas pipes

After repeatedly installing the insertion element through the valve seat, the seal between the insertion element and the attachment shall be leak tight according to paragraph 4.3.

4.5 Functionality

4.5.1 Gas pressure regulator and combination regulator

The gas pressure regulator and the combination regulator shall satisfy the requirements of approval requirement 11, pressure regulation, silence, and vibration. The test shall be performed with the 2 concentrations of test gases according to paragraph 4.1.4.

When there is 20% hydrogen gas in the natural gas, the flow rate specified for natural gas shall be applied. When using pure hydrogen gas, the flow rate times 3 for natural gas shall be applied.

4.5.2 Gas leak protector

A gas leak protector (GGB) device shall satisfy the requirements of approval requirement 11, pressure regulation, silence, and vibration. The test shall be performed with the 2 concentrations of test gases according to paragraph 4.1.4.

When there is 20% hydrogen gas in the natural gas, the flow rate specified for natural gas shall be applied. When using pure hydrogen gas, the flow rate times 3 for natural gas shall be applied.

4.5.3 Maximum flow rate safety valves

The flow rate at which the safety valve closes shall be at least 10% and at the most 30% more than the nominal flow rate as specified by the manufacturer. The test shall be performed with the 2 concentrations of test gasses according to paragraph 4.1.4; the method according to approval requirement 191, paragraph 4.3.

When there is 20% hydrogen gas in the natural gas, the flow rate specified for natural gas shall be applied. When using pure hydrogen gas, the flow rate times 3 for natural gas shall be applied.

4.5.4 Gas stoppers

The gas stoppers applied in a piping system with an MOP of 200 mbar shall not close at a sudden increase of the flow rate from nominal to 115%. The test shall be performed with the 2 concentrations of test gasses according to paragraph 4.1.4, and the method according to approval requirement 210, paragraph 5.6.

When there is 20% hydrogen gas in the natural gas, the flow rate specified for natural gas shall be applied. When using pure hydrogen gas, the flow rate times 3 for natural gas shall be applied.

4.5.5 Thermally responsive safety valve

40 seconds after insertion of the test piece in the oven, the valve shall close completely. The test shall be performed with the 2 concentrations of test gasses according to paragraph 4.1.4; the method according to approval requirement 171, paragraph 4.6.

When there is 20% hydrogen gas in the natural gas, the flow rate specified for natural gas shall be applied. When using pure hydrogen gas, the flow rate times 3 for natural gas shall be applied.

5 Marking and instructions

5.1 Marking

The marking shall be according to the requirements of the GASTEC QA approval requirement of the product.
In addtition, the product and/or packaging shall be marked with:

- The words “Bestand tegen waterstofgas” or “Hydrogen ready.”
- For pressure regulators the outlet pressure at rising and decreasing input for the different mixtures.

5.2 Instructions

The instruction document shall be according to the requirements of the GASTEC QA approval requirements of the product. In addition, the instruction document shall mention the product is suitable to use in gas distribution systems for hydrogen gas.

Remark: for adjusting the marking and instruction documents of existing products, it’s allowed to fulfil the requirements by using a sticker on the product and documents during the time needed for adjusting the marking and documentation.

6 Summary of tests

This chapter contains a summary of tests carried out during:

- The initial product assessment;
- The periodic product verification;

6.1 Text matrix

Description of requirement	Clause	Test within the scope of		
		Initial product assessment	Product verification	
			Verification	Frequency
Product requirements	3			
General	3.1	X		
Material	3.1	X	X	Once a year
Performance requirements	4			
General	4.1			
Leak tightness internal valves	4.2.1	X	X	Once a year
Leak tightness internal regulators	4.2.2	X	X	Once a year
Leak tightness maximum flow rate safety valves	4.2.3	X	X	Once a year
Leak tightness internal gasstopper	4.2.4	X	X	Once a year
Thermally responsive safety valve	4.2.5	X	X	Once a year
Equipment for temporarily closing of gas pipes	4.2.6	X	X	Once a year
External leak tightness	4.3	X	X	Once a year
Long-term behavior	4			
General	4.4.1			
Long-term behavior valves	4.4.2	X	X	Once a year
Long-term behavior gas pressure regulator and combination regulator	4.4.3	X	X	Once a year
Long-term behavior gas outage protection	4.4.4	X	X	Once a year
Long-term behavior maximum flow rate safety valves	4.4.5	X	X	Once a year
Long-term behavior gas stoppers	4.4.6	X	X	Once a year
Long-term behavior equipment for temporarily closing of gas pipes	4.4.7	X	X	Once a year
Functioning of gas pressure regulator and combination regulator	4.5.1	X	X	Once a year
Functioning of gas leak protector (GGB)	4.5.2	X	X	Once a year
Functioning of maximum flow rate safety valves	4.5.3	X	X	Once a year
Functioning of gas stoppers	4.5.4	X	X	Once a year
Functioning of thermally responsive safety valve	4.5.5	X	X	Once a year
Marking and instructions				
Marking	5.1	X	X	Once a year
Instructions	5.2	X	X	Once a year

7 Titles of standards and sources

7.1 Standards / Normative documents:

All references in this GASTEC QA approval requirement remit to the version of the relative document in accordance with the following list.

NEN 7239:2018	Gas pressure regulators, gas leak protectors and gas pressure regulators combined with gas leak protectors for domestic installations with a capacity up to 10 m3 and an inlet pressure (MOP_u) up to 200 mbar
NEN 331:2015	Manually operated ball valves and closed bottom taper plug valves for gas installations for buildings

7.2 Sources

Parts of the text of this approval requirements are based on approval requirement 69-1, NEN 7239 and the Kiwa report “Networks for the Future”/”Future-proof gas distribution networks”.

8 Annex A:

Leak tightness hydrogen.

In the GASTEC QA approval requirements, requirements are laid down with regard to leak tightness. A distinction can be made between products (for example couplings) for which leak tightness is a requirement and products (for example ball valves and regulators) for which certain leakage is allowed.

The first type of products is usually tested in a container of water and whereby under certain conditions there shall not be any visible bubbles. For the second type of products, measuring equipment is used that allows for measuring the leak using a certain method.

In the following reasoning, it can be arguably stated that it is unnecessary to impose additional leak-tightness requirements for products that already are already GASTEC QA certified and whose leak-tightness has been tested in a container of water.

In case of a leak, the Volume flow rate is calculated as follows.

$$V = A\sqrt{\frac{2\Delta p}{\rho}}$$

V = volume flow rate in m^3/s
A = surface in m^2
P = pressure in Pa
ρ = tightness in kg/m^3

ρ_{air} = 1 kg/m^3
$\rho_{natural\ gas}$ = 0.83 kg/m^3
$\rho_{hydrogen}$ = 0.09 kg/m^3

When comparing identical leaks, this renders the following volume flow rates for air, natural gas, and hydrogen:

	Air	Natural gas	Hydrogen
V = volume flow rate in m^3/s	1	1.1	3.3

When multiplying the volume flow rate by the tightness, the mass of the amount of gas flowed out is obtained.

$mass_{airt}$ = 1 x 1 = 1 kg
$mass_{natural\ gas}$ = 1.1 x 0.83 = 0.9 kg
$mass_{natural\ gas}$ = 3.3 x 0.09 = 0.30 kg

The specific energy of natural gas and hydrogen has the following values.

Natural gas = 50 MJ/kg
Hydrogen = 120 MJ/kg

The energy of a leak is calculated by multiplying the specific energy of the gas by the mass of the escaped gas.

Natural gas = 50 x 0.9 = 45 MJ
Hydrogen = 120 x 0.30 = 36 MJ

It is concluded that in the case of an identical leakage, natural gas releases more energy than hydrogen.

Based on this energy comparison, imposing additional requirements for leak tightness is not justifiable.

Considering the fact that the volume flow rate for hydrogen is 3 times higher than that of natural gas, for products for which a maximum leak value with the test medium air has been established in the relevant GASTEC QA approval requirement, this maximum leak value for hydrogen shall be 3 times higher than the maximum value determined for natural gas (for example 9 dm3/h will be 3 dm3/h).