Certification programme ZP "Zertifizierungsprogramm" 5101 of DVGW CERT GmbH, Bonn

Compatibility and permeation properties of elastomer materials for seals and diaphragms in gas appliances and equipment against hydrogen for a content of up to 100 vol. % H_2

0 Preliminary remark

This certification and test specification (Zertifizierungsprogramm ZP) describes the requirements, motivation, and tests to characterize elastomer materials for seals and diaphragms in gas equipment and systems for the use with up to 100 % by volume hydrogen (H_2) with respect to permeation of H_2. The permeation properties can be used for material selection and for the design of components in an application.

The objective of this certification programme are material tests on elastomer materials with DIN-DVGW certification according to DIN EN 549 or DIN EN 682.

Generally the material compatibility of elastomer materials with hydrogen is given based on the information given in the material table in DIN EN ISO 11114-2. The DVGW research project G 201615 [2] also referred to this standard, along with other sources, to classify compatibility. EN ISO 11114-2 incorporates findings on the service life, durability and long-term behaviour of various groups of plastics and elastomers. The compatibility data contained therein refer to single gases, but can also be used to a certain extent for gas mixtures. This therefore also applies to elastomers tested and certified according to DIN EN 549 or DIN EN 682 with regard to the gases of the 2nd and 5th gas families defined in DVGW G 260 .

However, it is expressly pointed out that DIN EN ISO 11114-2 deals only qualitatively with the subject of permeation. This standard can therefore only support the evaluation of the compatibility of gas/material combinations. Only the effect of the gas on changes in the material properties (e.g. due to a chemical reaction or changes in the physical state) is considered. The basic material properties required for design purposes, such as mechanical properties, are usually provided by the material supplier and are not considered in DIN EN ISO 11114-2.

This certification and testing programme is based on DVGW research projects (e.g. G 201205 [1], G 201615 [2], G 201824 [3], G 202138 [4], G 202021 [5]), industrial research and the diverse literature on hydrogen use in chemistry and industry (e.g. Marchi et al. [6], NASA publication series [7]).

The method described in this ZP leads to an additional material property regarding H_2 permeability. This technical parameter can be used to compare different materials with regard to the permeation of hydrogen. Therefor the ZP supports the selection of elastomer materials with regard to their specific behaviour for hydrogen applications. A limit value for H_2 permeation is not specified. The technically relevant H_2 permeation on material samples with standardized dimensions is considered.

Since design aspects play a significant role no statement with regard to the permeation or tightness of components is made. This ZP therefore makes the statement **"H_2 tested"** for the elastomer material.

Since elastomer materials are used as seals and diaphragms in products and systems, the leak test in the system is still decisive and cannot be replaced by the permeability information.

The method is based on ISO 15105-1 “Plastics - Film and sheeting - Determination of gas-transmission rate - Part 1: Differential-pressure methods”.

Bibliography

[1] Dörr, H., Kröger, P., Nitschke-Kowsky, P., Senner, J., Tali, E., Feldpausch-Jägers, S., „Untersuchungen zur Einspeisung von Wasserstoff in ein Erdgasnetz - Auswirkungen auf den Betrieb von Anwendungen im Be-stand, auf Gas-Plus-Technologien und auf Verbrennungsregelungsstrategien“, DVGW G 201205, DVGW Deutscher Verein des Gas- und Wasserfaches e. V. Technisch-wissenschaftlicher Verein, Bonn, 2016.

[2] Scholten, F., Dörr, H., Werschy, M., „Mögliche Beeinflussung von Bauteilen der Gasinstallation durch Wasserstoffanteile im Erdgas unter Berücksichtigung der TRGI“, DVGW 201615, DVGW Deutscher Verein des Gas- und Wasserfaches e. V. Technisch-wissenschaftlicher Verein, Bonn, 2018.

[3] Köppel, W., Mörs, F., Hüttenrauch, J., Burmeister, F., „Entwicklung einer Roadmap zur Umsetzung des DVGW-Energie-Impulses bis zum Jahr 2050“, DVGW G 201824, DVGW Deutscher Verein des Gas- und Wasserfaches e. V. Technisch-wissenschaftlicher Verein, Bonn, 2023.

[4] Anghilante, R., Bhagwan, R., Dörr, H., Burmeister, F., Joormann, N., Oberschelp, L., Tali, E., „Experimentelle Charakterisierung der Leckraten von Prüflecks mit Wasserstoff und/oder Methan-Gasmischungen gegenüber Luft“, DVGW G 202138, DVGW Deutscher Verein des Gas- und Wasserfaches e. V. Technisch-wissenschaftlicher Verein, Bonn, 2023

[5] Erler, F., Knorr, C., Wiersig, M., Strauß, A., Anghilante, R., Dörr, H., Elhami, O., Janßen, N., Burmeister, F., Kinnen, W., „F&E als Grundlage für den Einsatz von Wasserstoff in der Gasversorgung und der Umsetzung in Prüfgrundlagen – F&E für H_2“, DVGW G 202021, DVGW Deutscher Verein des Gas- und Wasserfaches e. V. Technisch-wissenschaftlicher Verein, Bonn, 2024.

[6] C. S. Marchi, B. P. Somerday, Technical Reference for Hydrogen Compatibility of Materials, Sandia Report SAND2012-7321 (unlimited release), (2012)

[7] NASA, SAFETY STANDARD FOR HYDROGEN AND HYDROGEN SYSTEMS, Guidelines for Hydrogen System Design, Materials Selection, Operations, Storage, and Transportation, Report NSS 1740.16 (1997)

1 Certification procedure

Gas products, conformity mark national (European non-harmonised area).

The possibility of using elastomer materials with natural gas-H_2 mixtures or pure hydrogen is indicated and listed in a directory of H_2 certification programs maintained by DVGW CERT GmbH.

2 Accreditations

An accreditation No. D-ZE-16028-01 exists for the procedure at German accreditation body (die Deutsche Akkreditierungsstelle GmbH) (DAkkS), Berlin.

3 Marks

3.1 Certification mark

DVGW resp. DIN-DVGW certification mark Products

Registration number scheme:
DG-5101DP0001 resp. NG-5101DP0001

DG = DVGW certification mark for gas,
NG = DIN-DVGW certification mark for gas,
5101 = product code, DP = 2024, 0001 = consecutive no.

3.2 Note on use

Note: The H_2-Ready mark of DVGW CERT GmbH has no direct reference to the tests described in this ZP. The H_2-Ready mark is an indication that the material can be used with natural gas-H_2 mixtures or pure hydrogen.

4 Type of certificate and test procedure

The subject of the certification are material tests on elastomer materials with DIN-DVGW certification according to DIN EN 549 or DIN EN 682.

The duration of validity of the confirmation of conformity according to this certification scheme is linked to the existing DIN-DVGW certificate according to DIN EN 549 or DIN EN 682.

5 Scope

Product group	Product code	Product type
Elastomer materials for seals and diaphragms	5101	Elastomer material for seals in gas appliances and equipment with life assessment
	5102	Elastomer material for diaphragm and seals in gas appliances and equipment with life assessment
	5104	Elastomer material for seals in gas supply mains and pipelines with life assessment
	5105	Materials for diaphragm in gas appliances and equipment, not reinforced, with life assessment
	5106	Materials for diaphragm in gas appliances and equipment, reinforced, with life assessment
	5111	Elastomer material for seals in gas installations
	5112	Elastomer material for seals in gas appliances
	5113	Elastomer material for seals in gas supply mains and pipelines
	5131	Materials for membranes for gas appliances and equipment, not reinforced
	5132	Materials for membranes for gas appliances and equipment, reinforced
	5133	Materials for membranes for gas equipment
	5134	Materials for membranes for gas meters and their equipment
	5139	Elastomer material for diaphragm and seals for gas appliances and equipment

6 Testing laboratories

Testing laboratories accredited in accordance with EN ISO/IEC 17025 for the relevant test bases and contractually bound to DVGW CERT GmbH.

7 Requirements

7.1 General requirements

The elastomer materials shall be certified by DVGW CERT GmbH in accordance with DVGW regulations for use with natural gas.

The materials tested and certified according to ZP 5101 are listed in a directory issued by DVGW CERT GmbH.

7.2 Requirements regarding use with hydrogen up to 100% by volume

An additional material property is determined without specifying a limit value. This technical parameter supports the selection of elastomer materials and dimensioning of the components to be manufactured from them.

7.3 Tests

Test conditions	Based on ISO 15105-1, "*Plastics - Film and sheeting - Determination of gas-transmission rate - Part 1: Differential-pressure methods*". Method with a pressure measurement according to Annex A of ISO 15105-1 (manometric method) Partial pressure difference (1 ± 0.1) bar (1 atmosphere = 1.01325 bar) Sample thickness d (2 ± 0.2) mm => Determination of the actual thickness according to DIN ISO 23529 Medium H_2 (purity at least 99.9% by volume) Test temperature (23 ± 2) °C The gas transmission rate (GTR) is determined according to ISO 15105-1. For reasons of practicability, the GTR is to be given in the unit [cm^3 / (m^2 (24 h) bar)]. Accordingly, the gas permeability as the relevant material parameter $P = GTR \times d$ is to be given in the unit of [(cm^3 mm) / (m^2 24 h bar)].
Evaluation	To determine the gas permeability, the gas transmission rate must be related to the actual thickness.

8 Applicable documents

In the case of undated references, the current edition of the following documents applies:

- DVGW CERT GmbH <40014> Geschäftsordnung der DVGW CERT GmbH zur Zertifizierung von Produkten im nicht harmonisierten Bereich
- DVGW Arbeitsblatt G 260:2021-09
  Gasbeschaffenheit
- DIN EN 549:2023-07
  Elastomer-Werkstoffe für Dichtungen und Membranen in Gasgeräten und Gasanlagen
- DIN EN 682:2006-10
  Elastomer-Dichtungen - Werkstoff-Anforderungen für Dichtungen in Versorgungsleitungen und Bauteilen für Gas und flüssige Kohlenwasserstoffe
- DIN EN ISO 11114-2:2022-02
  Gasflaschen - Verträglichkeit von Flaschen- und Ventilwerkstoffen mit den in Berührung kommenden Gasen - Teil 2: Nichtmetallische Werkstoffe
- EN ISO/IEC 17025
  Allgemeine Anforderungen an die Kompetenz von Prüf- und Kalibrierlaboratorien
- ISO 15105-1:2007-10
  Kunststoffe - Folien und Flächengebilde - Bestimmung der Gasdurchlässigkeit - Teil 1: Differentialdruck-Verfahren
- DIN ISO 23529:2020-10
  Elastomere – Allgemeine Bedingungen für die Vorbereitung und Konditionierung von Prüfkörpern für physikalische Prüfverfahren

The currently valid issue status applies.

9 Period of validity

This certification programme is valid from 06.09.2024.

In case of doubt, the German document is the legally binding document.