Certification programme ZP “Zertifizierungsprogramm” 3411 of DVGW CERT GmbH, Bonn

Supplementary tests for dark radiators for gaseous fuels with a hydrogen content of 100 % by volume

0 Preliminary remark

The following certification and test basis describes the necessary tests that supplement the requirements of DIN EN 416:2020 to qualify dark radiators for 100 % hydrogen by volume. The term 100 % hydrogen by volume refers to hydrogen in accordance with DVGW Worksheet G 260:2021, 5th gas family group A, unless otherwise specified. This certification programme (ZP) applies until there is a uniform European standard. This ZP refers to new appliances.

This ZP covers the following cases of certification in accordance with the Gas Appliances Regulation EU/2016/426:

- Independent certification for 100 % hydrogen by volume
- Extension of an existing certification to 100 % hydrogen by volume (this also includes the conversion kit for the devices)

A conformity assessment under the Gas Appliances Regulation is used, as the appliances are made available on the market and put into operation in accordance with Art. 3 of Regulation (EU) 2016/426.

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), industrial research and the diverse literature on hydrogen use in chemistry and industry (e.g. Marchi et al. [5], NASA publication series [6]).

The main results were that the elastomeric or polymeric (PTFE, fibre sealants/adhesive sealants) sealing materials for their respective temperature ranges of application do not exhibit any chemical incompatibility with hydrogen when used even with 100 % hydrogen.

The basic material compatibility of materials with hydrogen can be verified using the material tables in DIN EN ISO 11114-1:2024 and DIN EN ISO 11114-2:2022. These standards relate to the entire range of pressurised gas cylinders and the usual working pressures of 0 to 300 bar.

The DVGW research project G 201615 [2] also used this standard alongside other sources for the compatibility classification. The mentioned standards in the DIN EN ISO 11114 series incorporate findings regarding the service life, durability, and long-term behaviour of various material groups. The compatibility data contained therein relates to individual gases but can also be used to a certain extent for gas mixtures. This also applies to the gases of the 2nd and 5th gas family defined in DVGW Worksheet G 260:2021. However, it is expressly pointed out that DIN EN ISO 11114-1:2024 and DIN EN ISO 11114-2:2020 only deal with the materials qualitatively. These standards can therefore be used as an aid for assessing the compatibility of gas/material combinations. 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 11114-1:2024 and DIN EN ISO 11114-2:2022.

For the pressure and temperature conditions in gas appliances, no further material requirements are necessary, even for metallic materials in accordance with the assessments from [2], among others, that go beyond the requirements of the DIN EN 416:2020.

The tightness of hydrogen-carrying gas paths must be tested with the test medium standard test gas (NPG) or line gas (LG). Testing with NPG/LG and the limit values from section 6.2.1.1 of DIN EN 416:2020 is classified as permissible.

As soon as reliable findings from test results relating to an alternative test with air and/or other test media are available, these will be included here.

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

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

[7] K. E. Cox und K. D. Williamson, Hydrogen: Its Technology and Implications, Volume IV: Utilization of Hydrogen, Boca Raton, Florida: CRC Press, 1979.

[8] W. U. u. G. V. H. Rottländer, Grundlagen der Lecksuchtechnik, Oerlikon Leybold Vaccum GmbH, 2014.

1 Certification procedure

Products, Gas Appliance Regulation EU/2016/426

2 Declaration of Conformity

Issue of an EU type-examination certificate in accordance with EU/2016/426, Module B

3 Marks

3.1 Certification mark

CE 0085

Labelling in accordance with gas appliance regulation EU/2016/426
(by: NB 0085 – DVGW CERT GmbH)

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. It is an indication that the appliance can be used with pure hydrogen.

3.3 Labelling of the hydrogen admixture

In its "Guidance sheet Hydrogen in Gar certificate" dated 27 September 2023, the NBGA (Notified Bodies group Gas Appliances) defines that the suitability of gas appliances for burning H2NG pending to include H2NG in the new revision of the EN 437, should be mentioned in the Eu Type Examination Certificate like the following:

Gas groups:

Group	mbar
H	20
E	20
N	20 - 25

Group	mbar
HY100	20
EY100	20
NY100	20 - 25

The above gas groups can be combined according to the standard EN 437:2021 and the national situation of countries.

Note: The suffix "Y100" means that the appliances are suitable for use with pure H2 (5th gas family).

It should also be noted that the NBGA document only considers the admixture of up to 20 % hydrogen and is supplemented here analogously for pure H2 (5th gas family).

4 Type of certificate of conformity

Issue of an EU type examination certificate (duration <=10 years)

Registration number scheme/ product identification number: CE-0085DPxxxx

CE = Identification
0085 = No. notified body
DP = 2024
xxxx = consecutive no.

5 Scope

Product group	Product code	Product type
Dark radiator	3411	Appliances/product types within the scope of DIN EN 416:2020

6 Testing laboratories

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

7 Requirements

All tests carried out in the laboratory must be performed with hydrogen with a minimum purity of 99.9 % by volume (ISO 14687:2019-11 Grade B).

For the certification of dark radiators within the meaning of this certification programme, the following requirements in accordance with DIN EN 416:2020 must be complied with and may be tested at the installation site with the line gas (LG) distributed there with 100 % hydrogen by volume (in accordance with DVGW worksheet G 260:2021, 5th gas family group A). A corresponding current gas analysis of the line gas must be submitted to the testing laboratory.

The on-site adjustment to the existing gas quality according to the manufacturer's specifications in accordance with the instructions means: The instructions must ensure a sufficient air number setting for low-emission and stable burning for hydrogen in accordance with ISO 14687:2019-11 Grade B (99.9 % by volume) as well as in accordance with DVGW Worksheet G 260:2021, 5th gas family Group A (98 % by volume) and to avoid thermal overloads.

Section according to DIN EN 416	Requirements	Test condition	Comment	Test gas
5.1.2	H_2-resistance of components and materials	Manufacturer's declaration of resistance in conjunction with risk assessment and safety concept (integration of the safety times see also 6.2.4.2)	Declaration of conformity of the manufacturer for the selection and assessment of compatibility against H_2 of metallic and non-metallic materials. The basis can be the standard references from DIN EN 416:2020 and/or other standards such as DIN EN ISO 11114-1:2024 and DIN EN ISO 11114-2:2022	
5.1.1	Conversion to different gases		Information in the operating instructions for operation with 100 % vol. H_2 or for conversion to 100 % H_2 operation	-
6.2.1.1	Interior and external tightness on the gas side	Test pressure 50[1] mbar	Limit values: • Air 100 cm³/h • H_2 (NPG, LG)	NPG LG or air
6.2.2	Load setting Load measurement	Max. Min.	Standard condition	NPG or LG
6.2.4.1.1	Flame stability	Ignition	0.7 x p_n (cold/warm)	NPG or LG

[1] The national technical regulations for gas installations may provide different test pressures.

Section according to DIN EN 416	Requirements	Test condition	Comment	Test gas
6.2.4.1.1	Flame stability	Ignition/knockback	p_{min}; 0.81 x Q_{min} and 0.81 x Q_{max} (cold/hot) H_2 in flue gas < 2000 ppm air-free, dry	NPG or LG
6.2.4.1.1	Flame stability	Ignition/lift-off	p_{min}; 0.81 x Qmin and 0.81 x Q_{max} (cold/hot) H_2 in flue gas < 2000 ppm air-free, dry	NPG or LG
(based on DIN EN 15502 -1 Section 8.7.)	Throttle gas pressure		Q_{min} up to stationarity at 70 % nominal pressure, additionally 70 % p_n down to 0 hPa without safety-relevant malfunction of the appliance and effects on the gas network[2]	NPG or LG
6.2.4.2.2	Safety time		Risk analysis/safety concept	NPG or LG
6.2.4.1.4	Delayed ignition		Risk analysis/safety concept	NPG or LG
6.2.5	Pressure regulator		Gas flow should be within +7.5 % / -10 % remain	NPG or LG
6.2.6.2	Burning quality	Surveillance of the air supply or exhaust gas discharge	a) Covering the burning air H_2 in flue gas < 2000 ppm air-free dry, with stable burning	NPG or LG
6.2.6.2	Burning quality	Surveillance of the air supply or exhaust gas discharge	b) Covering the flue gas path H_2 in flue gas < 2000 ppm air-free dry, with stable burning	NPG or LG
6.2.6.2	Burning quality	Surveillance of the air supply or exhaust gas discharge	c) Reducing the fan speed H_2 in flue gas < 2000 ppm air-free, dry with stable burning	NPG or LG
6.2.6.3	Burning quality	Setting the gas/air ratio	Reduced cross-section of the burning air and flue gas path at $\lambda max_{\ and}\ \lambda_{min-}$, Q_{max} H_2 in flue gas < 2000 ppm air-free, dry with stable burning	NPG or LG
6.2.7.2	Burning quality	Boundary conditions	1.19 Q_n at p_{max} or at the maximum possible factor (minimum value 1.07) if 1.19 is not technically feasible, H_2 in flue gas < 2000 ppm air-free, dry with stable burning	NPG or LG

[2] To ensure that a flashback cannot occur as a result of falling gas pre-pressure, a low gas pressure safety device is required upstream of the burner.

Section according to DIN EN 416	Requirements	Test condition	Comment	Test gas
6.2.7.2	Burning quality	U=110%	H_2 in flue gas < 2000 ppm air-free, dry with stable burning	NPG or LG
6.2.7.2	Burning quality	U= 85%	H_2 in flue gas < 2000 ppm air-free, dry, with stable burning	NPG or LG
6.2.7.2	Burning quality	Flame lift-off/ lockout	0.93 x Q_{min} at p_{min} H_2 in flue gas < 2000 ppm air-free, dry	NPG or LG
6.3	NO_x		NOx <200 mg/kWh	NPG or LG
6.4	efficiencies, Annual standard utilisation factor	$Q_{max.}$ / $Q_{min.}$	Optional according to manufacturer's instructions	NPG

Standard test gas: "NPG": H_2, Purity min. 99.9% by volume (based on ISO 14687:2019-11 Grade B)

Line gas: "LG": Pipeline gas with 100 % by volume H_2 in accordance with DVGW G 260:2021 (similar to H_2 in accordance with ISO 14687:2019-11 Grade A)

8 Applicable documents

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

- DVGW CERT <40005> Geschäftsordnung zur Durchführung des Konformitätsbewertungsverfahrens nach den EU-Produktharmonisierungsrechtsakten
- Gasgeräteverordnung EU/2016/426
- DVGW G 260:2021-09
  Gasbeschaffenheit
- DIN EN 416:2020-04
  Gasbefeuerte Dunkelstrahler und Dunkelstrahlersysteme für gewerbliche und industrielle Anwendungen - Sicherheit und Energieeffizienz
- DIN EN 437:2021-07
  Prüfgase - Prüfdrücke - Gerätekategorien
- ISO/DIS 14687:2019-11
  „Hydrogen fuel quality – Product specification“
- DIN EN ISO 11114-1:2024-01
  Gasflaschen – Verträglichkeit von Werkstoffen für Gasflaschen und Ventile mit den in Berührung kommenden Gasen – Teil 1: Metallische Werkstoffe
- DIN EN ISO 11114-2:2022
  Gasflaschen – Verträglichkeit von Flaschen- und Ventilwerkstoffen mit den in Berührung kommenden Gasen – Teil 2: Nichtmetallische Werkstoffe
- EN ISO/IEC 17025:2018-03
  Allgemeine Anforderungen an die Kompetenz von Prüf- und Kalibrierlaboratorien

The currently valid issue status applies.

9 Period of validity

This certification programme is valid from 02.05.2024.

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