

BS EN 50465:2008



BSI Standards Publication

Gas appliances — Fuel cell gas heating appliance — Fuel cell gas heating appliance of nominal heat input inferior or equal to 70 kW

bsi.

...making excellence a habit.
AVA Documents™
Document Sharing Hub

National foreword

This British Standard is the UK implementation of EN 50465:2008.

The UK participation in its preparation was entrusted to Technical Committee GEL/105, Fuel cell technologies.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© BSI 2009

ISBN 978 0 580 61289 3

ICS 27.070; 97.100.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2009.

Amendments issued since publication

Amd. No.	Date	Text affected
----------	------	---------------

**Gas appliances -
Fuel cell gas heating appliances -
Fuel cell gas heating appliance of nominal heat input
inferior or equal to 70 kW**

Appareils fonctionnant au gaz -
Appareils à gaz produisant de la chaleur
au moyen d'une pile à combustible -
Appareil de chauffage produisant
de la chaleur au moyen d'une pile
à combustible dont le débit calorifique
nominal est inférieur ou égal à 70 kW

Gasgeräte -
Brennstoffzellen-Gasheizgeräte -
Brennstoffzellen-Gasheizgerät
mit einer Nennwärmebelastung
kleiner oder gleich 70 kW

This European Standard was approved by CENELEC on 2008-05-01.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CENELEC Central Secretariat or to any CEN or CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN or CENELEC member into its own language and notified to the CENELEC Central Secretariat has the same status as the official versions.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees, respectively, of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.



CEN Management Centre:
rue de Stassart, 36 ± B-1050 Brussels

CENELEC Central Secretariat:
rue de Stassart, 35 ± B-1050 Brussels

© 2008 CEN/CENELEC - All rights of exploitation in any form and by any means reserved
worldwide for CEN national members and for CENELEC members.

Ref. No. EN 50465:2008 E

Documents
Document Sharing Hub

Foreword

This European Standard was prepared by the CEN/CLC/JWG FCGA, "Fuel cell gas appliances".

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50465 on 2008-05-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2009-05-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2011-05-01

This European Standard has been prepared under Mandate M/349 given to CEN and CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 90/396/EEC (see Annex ZZ, which is an integral part of this document).

The essential requirement of EC Directive 90/396/EEC relating to "rational use of energy" is defined by the maximum quantity of energy recovered (thermal and electrical energy output) from the gas energy input.

This European Standard deals with a very early state of new technology. The requirements of this European Standard are not intended to constrain innovations. When considering materials, designs or constructions not specifically dealt with in this European Standard the alternatives shall be evaluated as to their ability to yield levels of safety and performance equivalent to those prescribed by this European Standard. This can be done by a risk assessment. Furthermore not all requirements could be described in detail up to now. This is valid both for the requirements and the test procedures. This will be done in later revisions of this European Standard. Guidance to fuel cell stacks and their performance may be found in EN 62282-2.

Due to the development of new technology other solutions than those described in this standard are possible if these solutions provide at least an equivalent level of safety.

Matters related to quality assurance systems, tests during production, and certificates of conformity of auxiliary devices are not dealt with in this European Standard.

Contents

1	Scope	6
2	Normative references	6
3	Definitions	8
4	Classification	23
4.1	Gases / Category	23
4.2	Mode of air supply and evacuation of combustion products	24
4.3	Maximum water side operating pressure	25
5	Constructional requirements	26
5.1	General construction (method of construction)	26
5.2	Conversion to different gases	29
5.3	Materials and thicknesses	29
5.4	Gas circuit	40
5.5	Cooling circuit / Water circuit	42
5.6	Electrical equipment	42
5.7	Requirements for adjusting, control and safety devices (if applicable)	43
5.8	Pressure test points	47
6	Operational requirements	48
6.1	General requirements	48
6.2	Soundness	48
6.3	Heat inputs and heat output	50
6.4	Safety of operation (Temperatures / Limit gas)	50
6.5	Start / Release of adjusting, control and safety devices (if applicable)	54
6.6	Overall efficiency at the nominal heat input	58
6.7	Operation	58
6.8	Combustion	58
6.9	Resistance of the materials to pressure	59
6.10	Hydraulic resistance	60
7	Test methods	60
7.1	General test conditions	60
7.2	Soundness	68
7.3	Heat input and heat output	71
7.4	Safety of operation	73
7.5	Start / Release (if applicable)	87
7.6	Overall efficiency at the nominal heat input	91
7.7	Operation	92
7.8	Combustion	92
7.9	Resistance of the materials to pressure	96
7.10	Hydraulic resistance	97
8	EMC / Electrical requirements	98
9	Marking, installation and operating instructions	99
9.1	Fuel cell gas heating appliance marking	99
9.2	Fuel cell heating appliance installation instructions	102
9.3	Fuel cell gas heating appliance operating instructions (users instruction)	104
9.4	Conversion instructions	105
9.5	Presentation	105
Annex A	(informative) National situations	106
A.1	Categories marketed in the various countries	106
A.2	FCGHA supply pressures	108
A.3	Gas connections conditions in common use in the various countries	109
Annex B	(informative) Particular national conditions	110
B.1	Gas groups distributed locally	110
B.2	Special categories marketed nationally or locally	110
B.3	Particular conditions	110

Annex C (informative) Classification of type B and type C fuel cell gas heating appliances	111
Annex D (informative) Composition of the gas circuit	115
D.1 Minimum requirements for fuel cell gas heating appliance with fan, with ignition burner or prepurge	115
D.2 Minimum requirements for fuel cell gas heating appliances with fan, without permanent or alternating ignition burner and without prepurge	116
Annex E (informative) Practical method of calibrating the test rig to enable the heat loss D_p to be determined	117
Annex F (informative) A-deviations	118
Annex G (informative) Main symbols and abbreviations used	119
Annex H (informative) Examples for marking	120
H.1 Data-plate (see 9.1.2)	120
H.2 Additional data-plate (see 9.1.3)	120
Annex I (informative) Calculation of conversions of NO_x	121
Annex J (informative) Requirements and test methods for separate air supply and combustion products evacuation ducts of type C_6 appliances	122
J.1 Requirements	122
J.2 Test methods	123
Annex ZZ (informative) Coverage of Essential Requirements of EC Directives	126
Bibliography	129

Figures

Figure 1 – Typical set-up of a fuel cell gas heating appliance (all-in-one type)	11
Figure 2 – Fuel cell gas heating appliance with external thermal conditioning system	12
Figure 3 – Example for a sampling probe for the measurement of the products of combustion	62
Figure 4 – Example for the location of the probe at a C type appliance	63
Figure 5 – Test rig for the determination of the efficiency	65
Figure 6 – Test rig for the soundness of the gas circuit	67
Figure 7 – Test rig for the soundness of components (pressure drop method)	68
Figure 8 – Test rig for thermostats: short cut circulation	75
Figure 9 – Test rig for thermostats with heat exchanger	76
Figure 10 – Test rig for type C appliances, equipped with horizontal wind protection device at a vertical wall	80
Figure 11 – Test rig for type C_1 appliances for installation in buildings with tilted roof	81
Figure 12 – Test rig for type C_3 appliances for installation in flat roofed buildings	82
Figure 13 – Test rig for type C_3 appliances for installation in buildings with tilted roof	83
Figure 14 – Test rig for the determination of water losses	98
Figure C.1 – Type B_2	111
Figure C.2 – Type B_3	111
Figure C.3 – Type C_1	112
Figure C.4 – Type C_3	112
Figure C.5 – Type C_4	113
Figure C.6 – Type C_5	113
Figure C.7 – Type C_6	114
Figure C.8 – Type C_8	114
Figure D.1 – Automatic gas shut off valves in the gas supply line for burners	115
Figure D.2 – Automatic gas shut off valves in the gas supply line for permanent or alternating burners	116
Figure J.1 – Maximum permitted recirculation of the combustion products	122
Figure J.2 – Set up for pressure loss test in still air	124
Figure J.3 – Set up for wind test	125

Tables

Table 1 – Mechanical and chemical compositions of carbon and stainless steels	32
Table 2 – Minimum requirements for cast iron	33
Table 3 – Parts in aluminium and aluminium alloys	33
Table 4 – Parts in copper or copper alloys	33
Table 5 – Minimum thicknesses for rolled parts	33
Table 6 – Nominal minimum thicknesses of fuel cell gas heating appliance sections	33
Table 7 – Weld joints and welding processes	34
Table 8 – Maximum admissible leakage rates	49
Table 9 – NO _x classes	59
Table 8 – (CO ₂) _N concentration of the combustion products, in percent	93
Table 9 – Supplementary markings	101
Table A.1 – Simple categories marketed	106
Table A.1 – Double categories marketed	107
Table A.2 – Normal supply pressures	108
Table A.3 – Gas connections conditions in common use in the various countries	109
Table B.1 – Locally distributed gas groups	110
Table H.1 – Category(ies), direct and indirect country(ies) of destination	120
Table H.2 – Example 1: Possibilities for the second gas family	120
Table H.3 – Example 2: Possibilities for the third gas family	120
Table I.1 – Conversion of the emission value of NO _x for second family gases	121
Table I.2 – Conversion of the emission value of NO _x for third family gases	121
Table ZZ.1 – Clauses of this European Standard addressing essential requirements or other provisions of EC Directives	126

1 Scope

This European Standard applies to the construction, the safety, the functional requirements and the test methods, as well as the classification and the marking of a fuel cell gas heating appliance, which will be operated predominantly heat followed, meeting the following boundary conditions:

- maximum heat load (gas input): 70 kW
- maximum electrical output: 11 kW.

NOTE Due to the fact, that there are national deviations on the maximum electrical output in Europe, this maximum electrical output is independent referring the number of connected phases to the public low voltage grid.

- fuel: combustion gas in accordance with EN 437
- maximum heating water temperature: 95 °C (under normal operational conditions)
- process pressures in the fuel cell gas appliance:
 - heating water: max. 6 bar
 - domestic hot water (if installed): max. 10 bar
- device construction: According to the expositions in accordance with CEN/TR 1749, EN 483 or EN 297 (B₂₂, B₂₃, B₃₂, B₃₃, C₁₂, C₁₃, C₃₂, C₃₃, C₄₂, C₄₃, C₅₂, C₅₃, C₆₂, C₆₃, C₈₂, C₈₃)¹⁾.

This European Standard applies to type testing only.

This European Standard does not contain the requirements necessary for appliances for producing electrical energy without thermal energy.

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.

EN 88	Pressure governors for gas appliances for inlet pressures up to 200 mbars
EN 125	Flame failure devices
EN 126	Multifunctional controls for gas burning appliances
EN 161	Automatic shut-off valves for gas burners and gas appliances
EN 297	Heating boilers operated with gaseous fuels – Type B ₁₁ + B _{11BS} boilers of nominal heat input not exceeding 70 kW
EN 298	Automatic gas burner control systems for gas burners and gas burning appliances with or without fans

¹⁾ The classification used in this European Standard is based on upon the classification of CEN/TR 1749.

EN 437:1993 + A1:1997	Test gases, test pressures and categories of appliance, for gas appliances
EN 483:1999 + A2:2001	Gas-fired central heating boilers – Type C boilers of nominal heat input not exceeding 70 kW
EN 549	Rubber materials for seals and diaphragms for gas appliances and gas equipment
EN 677:1998	Gas fired central heating boilers Specific requirements for condensing boilers with a nominal heat input not exceeding 70 kW
EN 1057	Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications
EN 1443	Chimneys – General requirements
CEN/TR 1749	European scheme for the classification of gas appliances according to the method of evacuation of the products of combustion (types)
EN 1856-1	Chimneys – Requirements for metal chimneys – Part 1: System chimney products
EN 1856-2	Chimneys – Requirements for metal chimneys – Part 2: Metal liners and connecting flue pipes
EN 1859	Chimneys – Metal chimneys – Test methods
EN 10029	Hot rolled steel plates 3 mm thick or above; tolerances on dimensions, shape and mass
EN 12067-1	Gas/air ratio controls for gas burners and gas burning appliances – Part 1: Pneumatic types
EN 12067-2	Gas/air ratio controls for gas burners and gas burning appliances – Part 2: Electronic types
EN 13611	Safety and control devices for gas burners and gas-burning appliances – General requirements
EN 14459	Methods of risk analysis for the use of electronics in systems and control functions for gas burners and gas burning appliances
EN 50438	Requirements for the connection of micro-generators in parallel with public low-voltage distribution networks
EN 60335-1	Household and similar electric appliances – Safety – Part 1: General requirements (IEC 60335-1, modified)
EN 60335-2-102	Household and similar electrical appliances – Safety – Part 2-102: Particular requirements for gas, oil and solid-fuel burning appliances having electrical connections (IEC 60335-2-102, modified)
EN 60529	Degrees of protection provided by enclosures (IEC 60529)
EN 60730-2-9	Automatic electrical controls for household and similar use – Part 2-9: Particular requirements for temperature sensing controls (IEC 60730-2-9, modified)
EN 61000-3-2	Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase) (IEC 61000-3-2)

EN 61000-3-3	Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection (IEC 61000-3-3)
EN 61000-6-1	Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments (IEC 61000-6-1)
EN 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments (IEC 61000-6-2)
EN 61000-6-3	Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3)
EN 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments (IEC 61000-6-4)
IEC/TS 62282-1	Fuel cell technologies – Part 1: Terminology
EN 62282-2:2004	Fuel cell technologies – Part 2: Fuel cell modules (IEC 62282-2:2004)
EN ISO 3166-1	Codes for the representation of names of countries and their subdivisions – Part 1: Country codes (ISO 3166-1)
EN ISO 4063	Welding and allied processes – Nomenclature of processes and reference numbers (ISO 4063)
CR 1404	Determination of emissions from appliances burning gaseous fuels during type-testing
ISO 7-1	Pipe threads where pressure-tight joints are made on the threads – Part 1: Designation, dimensions and tolerances
ISO 228-1	Pipe threads where pressure-tight joints are not made on the threads – Part 1: Designation, dimensions and tolerances
ISO 262	ISO general purpose metric screw threads – Selected sizes for screws, bolts and nuts
ISO 301	Zinc alloy ingots intended for casting
ISO 857	Welding, brazing and soldering processes – Vocabulary
ISO 2553	Welded brazed and soldered joints – Symbolic representation on drawings
ISO 7005-1	Metallic flanges – Part 1: Steel flanges

3 Definitions

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

3.1

reference conditions

these correspond to 15 °C and 1 013,25 mbar, unless otherwise specified

[3.9 of EN 437:1993, modified]

NOTE 1 mbar = 10^2 Pa.

3.2 combustible gases

3.2.1 test gases

gases intended for the verification of the operational characteristics of appliances using combustible gases

[3.2 of EN 437:1993, modified]

In each gas family or group, test gases are defined

3.2.2 reference gas

test gas on which appliances operate under nominal conditions, when they are supplied at the corresponding normal pressure condensed

[3.3 of EN 437:1993]

3.2.3 limit gases

test gas representative of the extreme variations in the characteristics of the gases for which appliances have been designed

[3.4 of EN 437:1993]

3.2.4 calorific value

quantity of heat produced by the complete combustion, at a constant pressure of 1 013,25 mbar of unit volume or mass of gas, the constituents of the combustible mixture being taken at reference conditions and the combustion products being brought to the same conditions

A distinction is made between

- gross calorific value in which the water produced by combustion is assumed to be condensed
 - symbol: H_s
- net calorific value in which the water produced by combustion is assumed to be in the vapour state
 - symbol: H_i
 - unit: either megajoule per cubic metre (MJ/m^3) of dry gas brought to reference conditions, or megajoule per kilogram (MJ/kg) of dry gas

[3.11 of EN 437:1993/A1:1997, modified]

3.2.5 relative density

ratio of the masses of equal volumes of dry gas and dry air under the same conditions of temperature and pressure: 15 °C and 1 013,25 mbar

Symbol: d

[3.10 of EN 437:1993, modified]

3.2.6

Wobbe index

ratio of the calorific value of a gas per unit volume to the square root of its relative density under the same reference conditions. The Wobbe index is said to be gross or net according to whether the calorific value used is the gross or net calorific value

Symbol: gross Wobbe index: W_s
net Wobbe index: W_i

Unit: either megajoule per cubic meter (MJ/m^3) of dry gas at the reference conditions,
or megajoule per kilogram (MJ/kg) of dry gas

[3.12 of EN 437:1993/A1:1997, modified]

3.2.7

gas pressure

3.2.7.1

general

all the pressures are static pressures of the moving gas, relative to the atmospheric pressure, measured at right angles to the direction of flow of the gas

Symbol: p

Unit: millibar (mbar)

3.2.7.2

test pressures

gas pressures used to verify the operational characteristics of appliances using combustible gases. They consist of normal and limit pressures

Unit: millibar (mbar)

[3.5 of EN 437:1993]

3.2.7.3

normal pressure

pressure under which the appliances operate in nominal conditions when they are supplied with the corresponding reference gas

Symbol: p_n

[3.6 of EN 437:1993]

3.2.7.4

limit pressures

pressures representative of the extreme variations in the appliance supply conditions

Symbols:

- maximum pressure: $p_{\max}$
- minimum pressure: $p_{\min}$

[3.7 of EN 437:1993]

3.2.7.5

pressure couple

combination of two distinct gas distribution pressures applied by reason of the significant difference existing between the Wobbe indices within a single gas family or group in which

- the higher pressure corresponds only to gases of low Wobbe index,
- the lower pressure corresponds to gases of high Wobbe index

[3.8 of EN 437:1993]

3.3

fuel cell gas heating appliance

appliance which produces simultaneous thermal energy and electrical energy (electrochemical reaction) from only one primary energy source

The fuel cell gas heating appliance consists typically of distinct parts (see Figure 1):

1. **the fuel processing system:** chemical processing equipment including any associated heat exchangers and controls required to convert input fuel to a composition suitable for the fuel cell stacks
[3.24 of IEC/TS 62282-1];
2. **the fuel cell module:** assembly including a fuel cell stack(s) which electrochemically converts chemical energy to electric energy and thermal energy intended to be integrated into the fuel cell gas heating appliance
[3.21 of IEC/TS 62282-1, modified];
3. **the power conditioning system:** equipment which is used to change the magnitude or waveform of the voltage, or otherwise alter or regulate the output of a power source
[3.50 of IEC/TS 62282-1];
4. **the internal thermal management and the thermal conditioning system:** the internal thermal management system provides cooling and heat rejection to maintain equilibrium within the fuel cell gas heating system, assists in heating the power train during start up and supplies heat to the thermal conditioning system.

This module can be divided in two parts if the thermal conditioning system is external (see Figure 2).

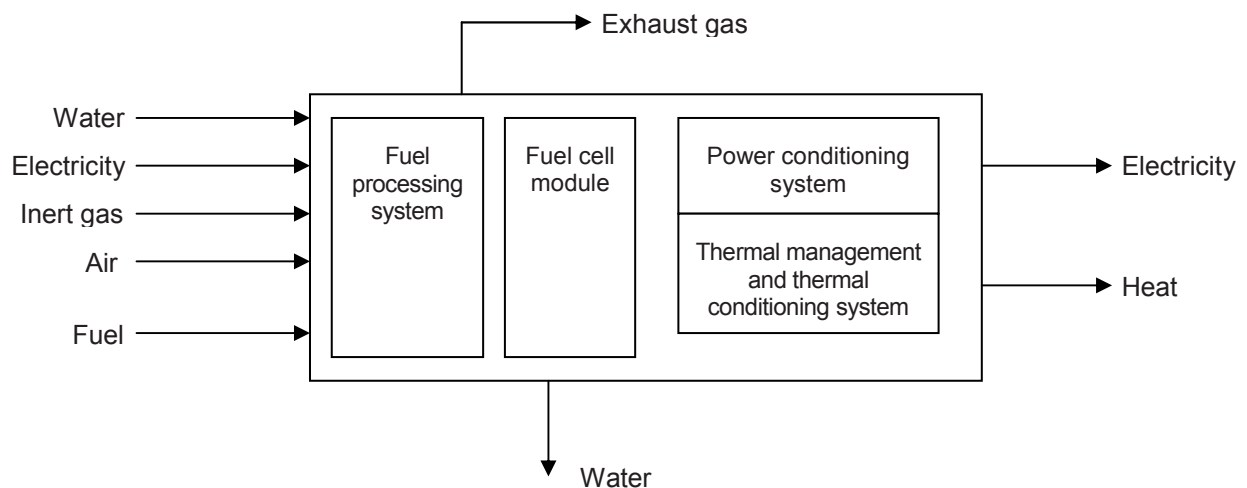


Figure 1 ± Typical set-up of a fuel cell gas heating appliance (all-in-one type)

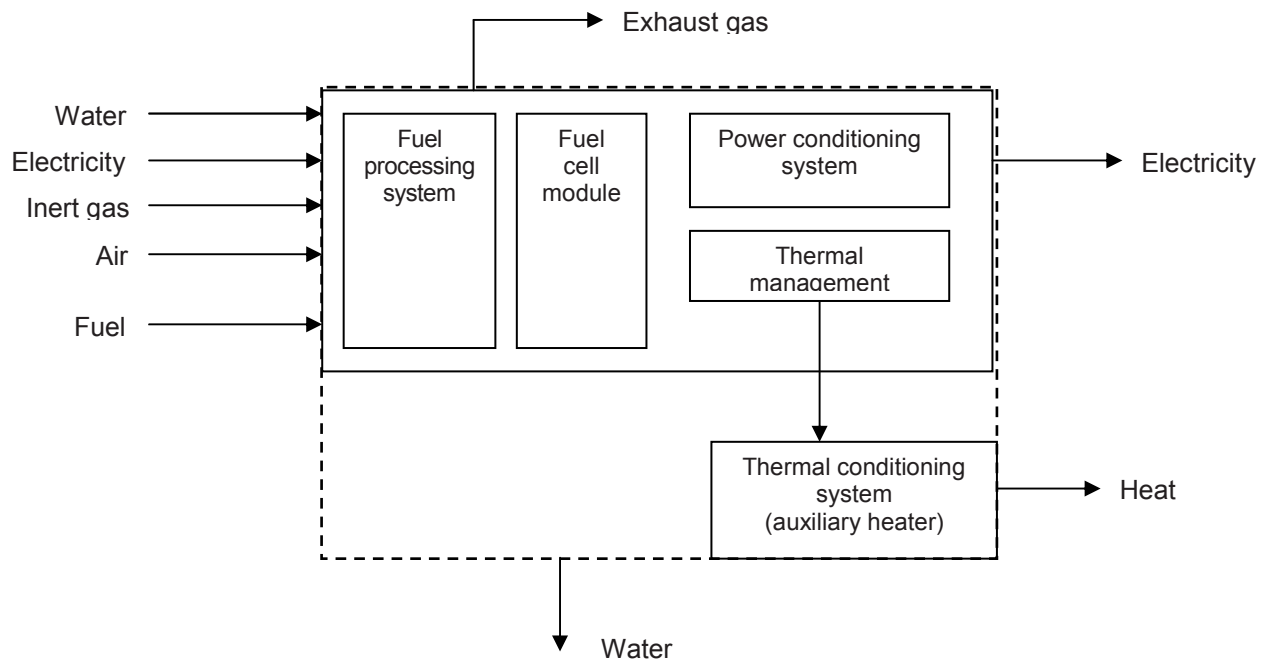


Figure 2 ± Fuel cell gas heating appliance with external thermal conditioning system

3.4 constituent parts of the fuel cell gas heating appliance

3.4.1

supplied gas

gaseous fuel in vapour phase at 15 °C, 1 013,25 mbar, which supplies the fuel cell gas appliance to be transformed in a process gas and to supply a burner if necessary.

It is represented by the tests gases described in EN 437 and is called “gas” in this standard

3.4.1.1

gas inlet connection

part of the fuel cell gas heating appliance intended to be connected to the gas supply

3.4.1.2

gas circuit

assembly of parts of the fuel cell gas heating appliance that carry or contain the combustible gas between the fuel cell gas heating appliance gas inlet connection and the point at which air is admitted or the point at which the supplied gas is reformed into process gas

3.4.1.3

process gas circuit

assembly of parts of the fuel cell gas heating appliance that carry or contain the process gas between the fuel processing system, the fuel cell module and the after burning unit (if available)

3.4.1.4

restrictor

device, which is placed in the gas circuit so as to create a pressure drop and thus bring the gas pressure at the burner to a predetermined value for a given supply pressure and a given rate

3.4.1.5

injector

component that admits gas into a burner

3.4.1.6

gas rate adjuster

component allowing the gas rate of a burner to be brought to a predetermined value according to the supply conditions.

The action of operating this device is called “adjustment of the gas rate”

3.4.1.7

range-rating device

component on the fuel cell gas heating appliance intended to be used by the installer to adjust the nominal heat input of the fuel cell gas heating appliance within the range of maximum and minimum heat inputs stated by the manufacturer, to suit the actual heat requirements of the installation

3.4.1.8

primary aeration adjuster

device enabling the primary aeration of a burner to be set to the desired value according to the supply conditions

3.4.1.9

sealing an adjuster or control device

arrangements made to make evident any attempt to change its adjustment (e.g. breakage of a device or a sealing material).

A sealed adjuster or control device is considered to be non-existent

3.4.1.10

putting an adjuster or control device out of service

action intended to put an adjuster or control (rate, pressure, etc.) out of service

3.4.1.11

burners

3.4.1.11.1

main burner

burner that is intended to assure the thermal function of the fuel cell gas heating appliance and is generally called “the burner”

3.4.1.11.2

premixed burner

burner in which the gas and a quantity of air at least equal to that theoretically necessary for complete combustion are mixed before the flame ports

3.4.1.11.3

catalytic burner

burner (oxidizer) in which the gas and a quantity of air at least equal to that theoretically necessary for complete combustion are mixed before the reaction zone, with a flameless combustion taking place in the reaction zone which is supported by catalysts

3.4.1.11.4 **ignition device**

3.4.1.11.4.1 **general**

any means (flame, electrical ignition device or other device) used to ignite the gas admitted to the ignition burner or the main burner

3.4.1.11.4.2 **manual ignition device**

device by means of which the ignition burner is ignited following manual intervention

3.4.1.11.4.3 **automatic ignition device**

automatic device which ignites the ignition burner or the main burner directly

3.4.1.11.5 **ignition burner**

burner intended to ignite a main burner. Those recognised are respectively

- permanent ignition burner: ignition burner that operates continuously throughout the whole period that the fuel cell gas heating appliance is in use,
- intermittent ignition burner: ignition burner that is ignited before and extinguished at the same time as the main burner,
- alternating ignition burner: ignition burner that is extinguished as soon as ignition of the main burner is effected. It re-ignites at the main burner flame just before the latter goes out,
- interrupted ignition burner: ignition burner that operates only during the ignition sequence

3.4.2 **process gas**

gas, containing predominantly hydrogen, issued by the transformation of the supply gas

3.4.3 **fuel cell**

electro chemical devices that convert process gas and oxygen, usually from the air, into DC power, heat water and other by-products

3.4.3.1 **anode**

fuel electrode, at which fuel oxidation takes place, by the removal of electrons from the fuel to the electric load, followed by the release of oxidized fuel products

[3.4 of IEC/TS 62282-1]

3.4.3.2 **cathode**

air/oxidant electrode at which reduction takes place, by the donation of electrons from the electric load to the oxidant, followed by the release of reduced oxidant products

[3.7 of IEC/TS 62282-1]

3.4.3.3 **fuel cell stack**

assembly of two or more fuel cells which are electrically connected

[3.23 of IEC/TS 62282-1]

3.4.3.4

PEM (Proton Exchange Membrane) fuel cell

fuel cell that employs proton exchange membrane as the electrolyte

[3.51 of IEC/TS 62282-1]

3.4.3.5

SO (Solid Oxide) fuel cell

fuel cell that employs an oxide ion-conducting electrolyte

[3.58 of IEC/TS 62282-1]

3.4.4

air supply and combustion products evacuation

3.4.4.1

combustion circuit

circuit including the air supply duct, the combustion chamber, the heat exchanger, the combustion products evacuation duct and either the fitting piece or the connection to the terminal, if any

3.4.4.2

combustion products circuit

circuit including the combustion chamber, the combustion products evacuation duct and either the fitting piece or the connection to the terminal, if any

3.4.4.3

combustion chamber

enclosure inside which combustion of the air-gas mixture takes place

3.4.4.4

air supply and combustion products evacuation ducts

means for air transporting combustion air to the burner and combustion products to the terminal or fitting piece.

It is necessary to distinguish between

- completely surrounded ducts: the combustion products evacuation duct is surrounded by combustion air throughout its length,
- separate ducts: the combustion products evacuation duct and the combustion air supply duct are neither concentric nor completely surrounded ducts

3.4.4.5

terminal

device fitted to the outside of the building, to which are connected

- the air supply and combustion products evacuation ducts for type C₁ and C₃ fuel cell gas heating appliance (one or two devices),
- the air supply duct on the one hand and the combustion products evacuation duct on the other hand for type C₅ fuel cell gas heating appliance (two devices),
- the air supply duct for type C₈ fuel cell gas heating appliance (one device)

NOTE Sometimes, the expression 'terminal' is also used for electric connectors.

3.4.4.6

terminal guard

device that protects the terminal from mechanical damage from outside influences

3.4.4.7

fitting piece

device which allows the fitting of

- the air supply and combustion products evacuation ducts to two ducts of a shared duct system for type C₄ fuel cell gas heating appliance,
- type C₆ fuel cell gas heating appliance to a system for air supply and combustion products evacuation that is approved and marketed independently from the fuel cell gas heating appliance,
- the combustion products evacuation duct to a chimney that is part of the building for type C₈ fuel cell gas heating appliance.

The fitting piece may be part of the fuel cell gas heating appliance or of the air supply and/or combustion products evacuation system

3.4.5

monitoring and safety devices

3.4.5.1

pressure governor

device which maintains the downstream pressure constant to within fixed limits independent of variations, within a given range, of the upstream pressure and the gas rate

3.4.5.2

adjustable pressure governor

pressure governor fitted with a means of adjusting the downstream pressure. This means is considered as an “adjusting device”

3.4.5.3

volume governor

device which maintains a rate between fixed limits independent of upstream and downstream pressures, within a range of given values

3.4.5.4

water rate monitoring device

device that shuts off the gas supply to the main burner when the water rate through the fuel cell gas heating appliance is less than a predetermined value and automatically reopens the gas supply when the water rate reaches at least this value

3.4.5.5

flame supervision device

device that, in response to a signal from the flame detector, keeps the gas supply open and shuts it off in the absence of the supervised flame

3.4.5.6

ignition interlock

part which prevents the operation of the ignition device as long as the main gas path is open

3.4.5.7

restart interlock

mechanism which prevents the re-opening of the gas path to the main burner or to the main burner and the ignition burner until the armature plate has separated from the magnetic element

3.4.5.8

control thermostat

device enabling the water temperature to be kept automatically within a given range at a predetermined value

3.4.5.9

adjustable control thermostat

control thermostat that permits the user to obtain setting temperatures between a minimum and a maximum value

3.4.5.10

limit thermostat

device that shuts off the gas supply when a limit value of the temperature is reached, and automatically reopens the gas supply when the temperature returns below the fixed limit

3.4.5.11

safety temperature limiter

device that causes safety shutdown and non-volatile lockout so as to prevent a gas or a water temperature exceeding a preset limit

3.4.5.12

overheat cut-off device

device that causes safety shutdown and non-volatile lockout before the fuel cell gas heating appliance is damaged and/or before safety is put in question

3.4.5.13

temperature sensing element

component that detects the temperature of the environment to be supervised or controlled

3.4.5.14

control knob

component intended to be moved by hand in order to act on a fuel cell gas heating appliance control (tap, thermostat, etc.)

3.4.5.15

flame detector

device which detects and signals the presence of a flame. It may consist of a flame sensor, an amplifier and a relay for signal transmission. These parts, with the possible exception of the actual flame sensor, may be assembled in a single housing for use in conjunction with a programming unit

3.4.5.16

flame signal

signal given by the flame detector, normally when its sensor reacts to a flame

3.4.5.17

flame simulation

condition which occurs when a flame signal is given by the flame detector although in reality there is no flame

3.4.5.18

programming unit

device that reacts to impulses from control and safety systems, gives control commands, controls the start-up program, supervises the burner operation and causes controlled shutdown, safety shutdown or lockout, if necessary. The programming unit follows a predetermined sequence of actions and operates in conjunction with the flame detector

3.4.5.19

automatic burner control system

system that comprises a programming unit and all the elements of a flame detector. All the functions of an automatic burner control system may be assembled in one or more housings

3.4.5.20

start

action which causes the fuel cell gas heating appliance to leave its start position and the predetermined programme of the programming unit commences

3.4.5.21

programme

sequence of control operations determined by the unit involving switching on, supervising and switching off the burner

3.4.5.22

automatic valve ²⁾

device that automatically opens, closes or varies a rate on a signal from the control circuit and/or the safety circuit

3.4.5.23

multifunctional control

device having at least two functions, one of which is a shut-off function, integrated into one housing, whereby the functional elements cannot operate if separated

3.4.5.24

closure member

movable part of the valve or the thermoelectric device that opens, varies or shuts off the gas path

3.4.5.25

breather hole

orifice that allows atmospheric pressure to be maintained in a compartment of variable volume

3.4.5.26

diaphragm

flexible component that operates the valve by means of a force resulting from a pressure difference

3.4.5.27

external soundness

soundness, with respect to the atmosphere, of an enclosure containing gas

3.4.5.28

internal soundness

soundness of a closure member in the closed position and isolating an enclosure containing gas from another enclosure or from the outlet of the valve

3.4.5.29

sealing force

force acting on the valve seat when the closure member is in the closed position, independent of the force provided by the gas pressure

²⁾ Automatic valves are classified in accordance with EN 161 into classes A, B, C, D and J.

3.5 operation of the fuel cell gas heating appliance

3.5.1 gas rates

3.5.1.1 volume flow rates

volume of gas consumed by the appliance in unit time during continuous operation

Symbol: - V (under test conditions)
- V_r (under reference conditions)

Unit: cubic metre per hour (m^3/h)

[3.16 of EN 437:1993/A1:1997]

3.5.1.2 mass flow rates

mass of gas consumed by the appliance in unit time during continuous operation

Symbol: - M (under test conditions)
- M_r (under reference conditions)

Units: kilogram per hour (kg/h) or gram per hour (g/h)

[3.15 of EN 437:1993/A1:1997, modified]

3.5.1.3 heat input

quantity of energy used in unit time corresponding to the volumetric or mass flow rates, the calorific value used being either the net or gross calorific value

Symbol: Q

Unit: kilowatt (kW)

[3.13 of EN 437]

3.5.1.4 nominal heat input³⁾

value of the heat input declared by the manufacturer

Symbol: Q_n

Unit: kilowatt (kW)

[3.14 of EN 437, modified]

3.5.1.5 ignition rate

average heat input during the ignition safety time

Symbol: Q_{IGN} (in accordance with EN 297)

Unit: kilowatt (kW)

³⁾ Range-rated fuel cell gas heating appliances operate at a nominal heat input between the maximum and minimum adjustable heat input. Modulating fuel cell gas heating appliances operate between the nominal and minimum controlled heat inputs.

3.5.2 outputs

3.5.2.1 useful heat output

quantity of heat transmitted to the heat carrier in unit time

Symbol: P_{th}

Unit: kilowatt (kW)

3.5.2.2 nominal heat output

useful output as stated by the manufacturer

Symbol: P_{th_n}

Unit: kilowatt (kW)

3.5.2.3 maximum and minimum electric output

quantity of net AC electricity transmitted in low voltage grid in unit time

Symbol: $P_{el_{max}}$ resp. $P_{el_{min}}$

Unit: kilowatt (kW)

3.5.2.4 nominal electric output

electric net AC output stated by the manufacturer

Symbol: P_{el_n}

Unit: kilowatt (kW)

3.5.3 overall efficiency

ratio of the useful heat output and the electric output to the heat input, expressed in per cent

Symbol: η_g

3.5.4 gas combustion

3.5.4.1 combustion

fast oxidation reaction of a fuel with oxygen, producing heat and/or light.

Combustion is said to be “complete” if there are no more than traces of combustible constituents (hydrogen, hydrocarbons, carbon monoxide, carbon, etc.) in the combustion products.

Conversely, combustion is said to be “incomplete” if at least one combustible constituent is present in significant proportions in the combustion products.

The amount of carbon monoxide, CO, in the dry, air-free combustion products is used as the criterion to distinguish between ‘hygienic’ and ‘non-hygienic’ combustion.

This standard specifies maximum CO limits according to the circumstances of use or of test. In each case, the combustion is regarded as hygienic if the CO concentration is below or equal to the permitted limit, but non-hygienic if it is above the limit

3.5.4.2

flame stability

characteristics of flames that remain on the burner ports or in the flame holding zone

3.5.4.3

flame lift

phenomenon characterised by the total or partial lifting of the base of the flame away from the burner port or the flame retention zone

3.5.4.4

light-back

phenomenon characterised by the entry of a flame into the body of the burner

3.5.4.5

light-back at the injector

phenomenon characterised by ignition of the gas at the injector, either as a result of light-back into the burner or by the propagation of a flame outside the burner

3.5.4.6

sooting

phenomenon appearing during incomplete combustion and characterised by deposits of soot on the surfaces or parts in contact with the combustion products or with the flame

3.5.4.7

yellow tipping

phenomenon characterised by the yellowing of the tip of the blue cone of an aerated flame

3.5.5

times

3.5.5.1

ignition opening time (T_{IA})

for a thermoelectric flame supervision device, the time that elapses between ignition of the supervised flame and the moment when the closure element is held open by the flame signal

3.5.5.2

extinction delay time (T_{1E})

for a thermoelectric flame supervision device, the time that elapses between disappearance of the supervised flame and interruption of the gas supply concerned

3.5.5.3

ignition safety time (T_{SA})

time that elapses between the order to open and the order to close the gas supply to the burner in the event of ignition not taking place

3.5.5.4

maximum ignition safety time ($T_{SA, max}$)

ignition safety time measured under the least favourable conditions of ambient temperature and variation in supply voltage

3.5.5.5

extinction safety time (T_{SE})

time that elapses between extinction of the supervised flame and the order to shut off the gas supply to the burner

3.5.5.6

closing time

time interval between the interruption of the auxiliary energy or the voltage and the achievement of the closed position

3.5.6

spark restoration

automatic process by which, following flame failure, the ignition device is switched on again without total interruption of the gas supply

3.5.7

recycling

automatic process by which, after loss of flame during operation, the gas supply is interrupted and the full start procedure is re-initiated automatically

3.5.8

controlled shutdown

process by which a control device (on the fuel cell gas heating appliance or external to it) causes the gas supply to the burner to be stopped immediately; the fuel cell gas heating appliance returns to its start position

3.5.9

safety shutdown

process which is initiated immediately in response to the signal from a limiting device or sensor and which causes the burner to shut down; the fuel cell gas heating appliance returns to its start position

3.5.10

locking out

3.5.10.1

general

complete interruption of the gas supply with lockout

3.5.10.2

non-volatile lockout

shutdown condition such that a restart can only be accomplished by a manual reset

3.5.10.3

volatile lockout

shutdown condition such that a restart can also be accomplished by restoration of the electrical supply after its loss

3.5.11

de-energised to trip principle

principle according to which neither auxiliary energy nor external action is required to activate a safety device

3.5.12

purge

mechanical introduction of air into the combustion circuit in order to displace any gas/air mixture, which could remain there. A distinction is made between

- pre-purge: the purge that takes place between the start command and the ignition device being energised,
- post-purge: the purge that is carried out after burner shutdown

3.5.13

air proving device

device intended to cause safety shutdown in the event of abnormal conditions of air admission or of combustion products evacuation

3.5.14

gas/air ratio control

device that automatically adapts the combustion air rate to the gas rate or vice versa

3.5.15

nominal voltage

voltage or range of voltages stated by the manufacturer at which the fuel cell gas heating appliance can operate normally

3.5.16

nominal frequency

frequency stated by the manufacturer at which the fuel cell gas heating appliance can operate normally

3.6

country of destination

3.6.1

direct country of destination

country for which the fuel cell gas heating appliance has been certified, and which is specified by the manufacturer as the intended country of destination. At the time of putting the fuel cell gas heating appliance on the market and/or of installation, the fuel cell gas heating appliance shall be capable of operating, without adjustment or modification, with one of the gases distributed in the country concerned, at the appropriate supply pressure.

More than one country can be specified if the fuel cell gas heating appliance, in its current state of adjustment, can be used in each of these countries

3.6.2

indirect country of destination

country for which the fuel cell gas heating appliance has been certified, but for which, in its present state of adjustment, it is not suitable. Subsequent modification or adjustment is essential in order that it can be used safely and correctly in this country

3.7

internal cooling loop

loop in which a coolant fluid circulates intended to maintain the various elements of the FCGHA at their operating temperature

3.8

d.w.h.

water delivered by the apparatus, raised at a certain temperature in order to use it for domestic needs (kitchen, bathroom, etc.)

4 Classification

4.1 Gases / Category

Gases are classified into families, groups and ranges in accordance to EN 437.

Fuel Cell Gas Heating Appliances are classified into categories in accordance to EN 437.

The applicable categories for each country should be given in Annex A. Other categories can be defined with the information of Annex B, in accordance to EN 437.

Due to this new technology it could be possible that additional test gases have to be taken into account in the future.

Unless there is no decision made, the currently existing limit gases are state of the art.

4.2 Mode of air supply and evacuation of combustion products ⁴⁾

4.2.1 General

Type B fuel cell gas heating appliance is an appliance to be connected to a flue system evacuating the combustion products outside the room, with the combustion air being drawn directly from the room where the appliance is installed, or

Type C fuel cell gas heating appliance is an appliance in which the combustion circuit is sealed with respect to the inhabitable area of the building in which the appliance is installed.

The air supply and the combustion products evacuation ducts and the terminal or the fitting piece which is used to connect the fuel cell gas heating appliance to a chimney or duct system are part of the fuel cell gas heating appliance unless otherwise stated. They admit fresh air from inside or outside the inhabitable part of the building to the system and they discharge the products of combustion to the outside.

Fuel cell gas heating appliances are classified into several types according to the mode of evacuation of the combustion products and supply of the combustion air (see examples attached in the informative Annex C).

The types are defined by two subscripts:

- the first subscript number is based upon the possible installation of the fuel cell gas heating appliance with respect to the mode of air supply and evacuation of the combustion products (see 4.2.2);
- the second subscript number is based upon the presence and the positioning of one or more integral fan(s) in the fuel cell gas heating appliance (see 4.2.3).

NOTE A combination of suitable type B and type C appliances may be permitted if they are separated to the different functions as e.g. reformer or stack.

4.2.2 Type of installation of the fuel cell gas heating appliance

4.2.2.1 Type C₁

This is a type C fuel cell gas heating appliance which is connected via its ducts to a horizontally installed terminal at the wall or on the roof. The orifices of the ducts are either concentric or close enough to come under similar wind conditions.

4.2.2.2 Type C₃

This is a type C fuel cell gas heating appliance which is connected via its ducts to a vertically installed terminal. The orifices of the ducts are either concentric or close enough to come under similar wind conditions.

4.2.2.3 Type C₄

This is a type C fuel cell gas heating appliance which is connected via its ducts possibly by means of a fitting piece to a shared duct system consisting of a duct for the supply of the combustion air and a duct for the discharge of the combustion products.

The orifices of the ducts are either concentric or close enough to come under similar wind conditions.

⁴⁾ The classification used in this standard is based on the classification of CEN/TR 1749.

4.2.2.4 Type C₅

This is a type C fuel cell gas heating appliance which is connected via its separate ducts to two terminals that may terminate in zones of different pressure.

4.2.2.5 Type C₆

This is a type C fuel cell gas heating appliance which is intended to be connected to a separately approved and marketed system for the supply of combustion air and discharge of the combustion products.

4.2.2.6 Type C₈

This is a type C fuel cell gas heating appliance which is connected via its ducts possibly by means of a fitting piece to an air supply terminal and fitted to an individual or shared chimney.

4.2.2.7 Type B₂

This is a type B fuel cell gas heating appliance without a draught diverter. See informative Annex C.

4.2.2.8 Type B₃

This is a type B fuel cell gas heating appliance without a draught diverter. The appliance is connected via its ducts possibly by means of a fitting piece to a duct system or to an individual or shared chimney for the discharge of the combustion products. The supply of the combustion air was drawn directly from the room where the appliance is installed. The duct for the combustion products is completely integrated in the combustion air duct. See informative Annex C.

4.2.3 Presence and the position of a fan

This is a type B or type C fuel cell gas heating appliance that incorporates at least one fan downstream of the combustion chamber or in such a manner, that all process gas and flue gas carrying parts are permanently surrounded by combustion air (pressure conditions below ambient) is identified by the second subscript number "2".

This is a type B or type C fuel cell gas heating appliance that incorporates at least one fan upstream of the combustion chamber or in such a manner, that all process gas and flue gas carrying parts are not permanently surrounded by combustion air is identified by the second subscript number "3".

Due to this new technology it could be possible that additional classifications referring 4.2.2 and 4.2.3 have to be taken into account in the future. Unless there is no decision made, the currently existing classification is state of the art.

4.3 Maximum water side operating pressure

FCGHA classification according to the maximum water side operating pressure:

- pressure class 1: PMS = 1 bar
- pressure class 2: PMS = 3 bar
- pressure class 3: 3 bar < PMS < 6 bar

Other possibly existing internal cooling circuits for heat exchange are not considered under this classification.

5 Constructional requirements

5.1 General construction (method of construction)

Except where otherwise stated, the constructional requirements are verified by inspection of the fuel cell gas heating appliance and its technical documents.

Appropriate materials, components and monitoring devices for the fuel cell gas heating appliance shall be chosen.

The following components of a fuel cell gas heating appliance shall be housed in a unit to prevent unintended discharge of fuel gas, process gas, or flue gas in the installation room:

- fuel gas and combustion air supply;
- fuel cell stack;
- internal flue system;
- fuel gas processing (if existing);
- internal cooling system (if existing).

For functions not (fully) described in other existing standards, as e.g. EN 483, the risk out of them has to be analysed and appropriate measures to avoid hazardous situations throughout the anticipated lifetime shall be taken.

NOTE 1 Guidance to fuel cell stacks and their performance may be found in EN 62282-2.

NOTE 2 Due to the development of new technology other solutions than those described in the following, provided with specific instructions, are possible if these solutions provide at least an equivalent level of safety.

5.1.1 Use and servicing

The user shall be able to gain access to and operate all control knobs and buttons necessary for normal use of the fuel cell gas heating appliance without having to remove any part of the case. However, part of the case may be removed provided that this part can be handled safely by the user, that this part can be removed without the use of tools and that incorrect replacement is difficult (e.g. by the provision of stops).

All markings intended for the user shall be easily visible and shall be made in a clear and indelible manner.

Parts which are required to be inspected or removed for servicing shall be easily accessible, possibly after removal of the case, in accordance with the manufacturer's instructions.

Removable parts shall be designed or marked so that they are difficult to re-assemble incorrectly.

In accordance with the manufacturer's instructions, it shall be possible to clean the burner, combustion chamber and parts in contact with combustion products easily and/or remove them easily for servicing with the use of commercially available tools.

This shall not involve disconnection of the fuel cell gas heating appliance from the gas or water pipes.

For fuel cell gas heating appliances connected to an air supply system and/or combustion products evacuation system that forms part of the construction of the building, it shall be possible to carry out servicing of the fuel cell gas heating appliance without dismantling the permanent connections to the duct.

The soundness of the combustion circuit shall be maintained after reassembly and, if necessary, in accordance with the manufacturer's instructions, after replacement of the seal(s) following cleaning and servicing operations.

5.1.2 Connections to the gas and water pipes

5.1.2.1 General

The fuel cell gas heating appliance connections shall be easily accessible. They shall be clearly identified in the installation instructions and possibly on the fuel cell gas heating appliance. The clearance around the connections, after removing the case if necessary, shall be adequate to allow easy use of the tools required to make the connection. It shall be possible to make all the connections without special tools.

5.1.2.2 Connection to the gas pipe

It shall be possible to connect the fuel cell gas heating appliance by a rigid or a flexible metallic pipe to the gas supply pipe.

If the fuel cell gas heating appliance has a threaded connection, this thread shall comply with ISO 228-1, ISO 7-1 or EN 1057. In the first case (ISO 228-1), the end of the fuel cell gas heating appliance inlet connection shall offer a sufficiently flat annular surface to allow the use of a sealing washer.

If flanges are used, they shall comply with ISO 7005-1, and the manufacturer shall provide the counter-flanges and sealing gaskets.

The different national gas connection conditions are given in Clause A.3.

5.1.2.3 Connections to the water pipe

Threaded connections shall comply with ISO 228-1 or ISO 7-1.

If copper connections are used, the connecting end of the tube shall comply with EN 1057.

If other than metallic materials are used, the manufacturer shall provide the appropriate justification for their suitability of use.

5.1.3 Soundness

5.1.3.1 Soundness of the gas circuit (process gas or fuel gas)

Holes for screws, studs, etc., intended for the assembly of parts shall not open into gas paths. The wall thickness between drillings and gas paths shall be at least 1 mm. This does not apply to orifices for measurement purposes.

The soundness of parts and assemblies making up the gas circuit and likely to be dismantled during a normal routine servicing operation in situ or during gas conversion shall be achieved by means of mechanical joints, for example metal to metal joints, gaskets or toroidal seals, i.e. excluding the use of all sealing materials such as tape, paste or liquid. However, the sealing materials mentioned above may be used for permanent assemblies. These sealing materials shall remain effective under normal conditions of fuel cell gas heating appliance use.

Where parts of the gas circuit are assembled without threads, soundness of the assembly shall not be achieved by means of soft solder or by means of adhesives.

5.1.3.2 Soundness of the combustion circuit

Parts which have to be removed during routine service and affect the soundness of the fuel cell gas heating appliance and/or its ducts, shall be sealed by mechanical means, excluding pastes, liquids and tapes. The need for replacement of the seal(s), following a cleaning or servicing operation as stated by the manufacturer, is permitted.

Where the fuel cell gas heating appliance case forms part of the combustion circuit and it can be removed without the use of tools, either the appliance shall not operate, or there shall be no leakage of combustion products into the room where the appliance is installed when the case is replaced incorrectly.

However, parts of the assembly that are not intended to be dismantled for maintenance may be joined in such a way, that permanent soundness is assured during continuous service under normal conditions of use.

The ducts, bends, if any, and the terminal or fitting piece shall fit together correctly and shall form a stable assembly. Parts intended to be dismantled for periodic servicing shall be designed and arranged so that soundness is guaranteed after reassembly.

Any fitting piece shall allow a sound connection to be made to the system intended for the evacuation of combustion products and supply of air.

5.1.4 Supply of air (reformer, burner and stack) and evacuation of gas from the combustion or from the stack

5.1.4.1 General

All fuel cell gas heating appliances shall be designed so that there is an adequate supply of air during ignition and over the whole range of possible heat inputs stated by the manufacturer. A gas/air ratio control is permitted.

All fuel cell gas heating appliances shall be designed so that there is an adequate supply of air during connection with the stack and over the whole range of possible heat inputs stated by the manufacturer.

Unless otherwise stated, fan assisted fuel cell gas heating appliances may be fitted with a means of adjustment in the combustion circuit intended to adapt the fuel cell gas heating appliance to the pressure losses in the installed ducts. Either by restrictors or by setting the means of adjustment to predetermined positions in accordance with detailed instructions from the manufacturer.

According to the appliance type, the manufacturer shall supply any terminal and/or fitting piece, with the fuel cell gas heating appliance for test.

5.1.4.2 Air supply and combustion products evacuation ducts ⁵⁾

The assembly of the various parts during installation shall be such that no work is necessary other than adjusting the length of the air supply and combustion products evacuation ducts (possibly by cutting them). Such adaptation shall not impair the correct operation of the fuel cell gas heating appliance.

It shall be possible to connect the fuel cell gas heating appliance, the air supply and combustion products evacuation ducts and the terminal or fitting piece using ordinary tools if necessary. All necessary accessories and the fitting instructions shall be supplied by the manufacturer.

Terminal guard if it exists and fitting pieces have to be installed in accordance with the manufacturer's instructions.

5.1.4.3 Special requirements for certain components of fuel cell gas heating appliances with a fan

5.1.4.3.1 Fan

Direct access to the rotating parts of a fan shall be prevented. The parts of a fan in contact with combustion products shall be effectively protected against corrosion unless they are of corrosion resistant material; furthermore they shall withstand the temperature of the combustion products.

⁵⁾ In accordance with national regulations sampling points in the combustion circuit may be required.

5.1.4.3.2 Gas/air ratio controls

Gas/air ratio controls shall be designed and constructed so that reasonably foreseeable damage does not give rise to a change capable of affecting safety.

Control tubes may be made of metal with suitable mechanical connections or of other materials with at least equivalent properties and in this case are considered immune to breakage, accidental disconnection and leakage after initial soundness checks. As such they are not subject to the tests in 7.5.4.4.2.

Control tubes for air or combustion products shall have a minimum cross-sectional area of 12 mm^2 with a minimum internal dimension of 1 mm. They shall be located and fixed so that any retention of condensate is avoided and positioned such that creasing, leakage or breakage is prevented. Where more than one control tube is used the relevant connection position for each shall be obvious. Provided that evidence is given and precautions are taken to avoid condensation in the control tubes, the minimum cross sectional area of air control tubes shall be 5 mm^2 .

Due to the new technology other solutions are possible.

5.1.5 Checking the state of operation

It shall be possible for the user, perhaps after opening a door, to check the state of operation of the fuel cell heating appliance and if it supplies electricity, either by visual observation of the flame (for example flame of reformer – depends on the available concept) or by some other indirect means. These indirect means are depending on the specific solution of the manufacturer, caused by the new technology.

5.1.6 Operational safety in the event of failure of the auxiliary energy

If the fuel cell gas heating appliance uses auxiliary energy, its design shall be such that no risk can occur in the event of failure of the auxiliary energy or following its restoration.

5.2 Conversion to different gases

The following actions are allowed in order to convert from a gas of one family or group to a gas of another family or group (see EN 483, 5.6.2.1 and 5.6.4):

- electronic adjustment;
- adjustment of the gas rate of the burners;
- change of restrictor or injector;
- change of gas rate modulation system;
- putting out of service and sealing a gas rate adjuster and/or a governor.

These operations shall be possible without having to interfere with the connections of the fuel cell heating appliance to its pipework (gas, water, duct system).

5.3 Materials and thicknesses

5.3.1 General

The quality and thickness of the materials used in the construction of the fuel cell gas heating appliance, and the method of assembling the various parts, shall be such that the constructional and performance characteristics are not significantly altered during a reasonable life and under normal conditions of installation and use.

In particular, in the fuel-cell stack, fuel-cell processing, the components carrying the supply gas, the process gas and the combustion circuit shall withstand the mechanical, chemical and thermal conditions to which they may be subjected when the fuel cell gas heating appliance is used normally. The same applies to the entire system peripheral equipment.

The design dependent jacketing of the stack shall have adequate thermal stability.

Materials downstream of heat exchangers shall be corrosion-resistant or be effectively protected against corrosion.

For a separated combustion products evacuation duct the requirements given in 5.3.5, in accordance with EN 1443 apply as well as the applicable requirements of EN 1856-1, EN 1856-2 and EN 1859.

The use of asbestos-containing materials is forbidden.

Hard solder containing cadmium in its formulation shall not be used in the construction of fuel cell gas heating appliances.

NOTE Safety requirements are under development by IEC/TC 105 and ISO/TC 197 which shall be referred to when published.

5.3.2 Materials and thicknesses of sheet metal walls or tubes under water pressure for fuel cell gas heating appliance of pressure class 3

5.3.2.1 General

The characteristics of the materials and the thicknesses of walls under pressure shall comply with the requirements of 5.3.2.2, 5.3.2.3 and 5.3.2.4. If other materials and/or other thicknesses are used, the manufacturer shall provide appropriate justification in respect of fitness for purpose.

5.3.2.2 Materials

Materials for parts under pressure shall be appropriate for their duty and envisaged use.

The following materials satisfy these criteria:

- steels that have the properties and chemical composition detailed in Table 1;
- cast irons that have the mechanical properties detailed in Table 2;
- the non-ferrous materials detailed in Table 3 and Table 4.

5.3.2.3 Thicknesses

The minimum wall thicknesses of parts under water pressure are given in Table 5 and Table 6.

For rolled steel the tolerances are given in EN 10029.

The thicknesses of cast walls given in the production drawings shall not be less than the nominal minimum thicknesses given in Table 6 for parts of cast iron or of cast materials which are subjected to pressure. The actual minimum thickness of the fuel cell gas heating appliance sections and of parts subjected to pressure shall be greater than 0,8 times those given in the drawings.

5.3.2.4 Welded seams and welding fillers

Materials shall be suitable for welding. The materials given in Table 1 may be used and do not require additional heat treatment for welding.

Welded seams shall show no cracks or bonding faults and butt welded seams shall be faultlessly welded over the whole cross-section.

Single-sided fillet welds and half Y-welds without full penetration into the base metal shall not be subjected to bending stresses. Flue pipes, set-through stays and similar components need not to be welded from both sides. Double fillet welds are permissible if sufficiently cooled.

Projections into the flue ways in areas of high thermal stresses shall be avoided.

Corner welds, edge welds and similar welds which are subject to considerable bending stresses under unfavourable manufacturing or operating conditions are to be avoided.

For welded-in longitudinal stays, stay tubes or stay bolts, the shearing cross-section of the fillet weld shall be at least 1,25 times the required cross-section of the bolt or stay tube.

Details of the welds mentioned are given in Table 7. Welding fillers shall permit a joint appropriate to the base material to be made.

The terms given in Table 7 are in accordance with ISO 2553; the reference numbers of welding processes are respectively in accordance with ISO 857 and EN 24063.

Table 1 ± Mechanical properties and chemical compositions of carbon and stainless steels

Mechanical Properties						Chemical composition by mass									
						%									
Materials	Steel type	Tensile strength R_m N/mm ²	Yield point $R_{0,01}/R_p$ 0,2 N/mm ²	Breaking elongation A_{long} at $L_0 = 5d_0$ %	Breaking elongation A_{transv} at $L_0 = 5d_0$ %	C	P	S	Si	Mn	Cr	Mo	Ni	Ti	Nb/Ta
Pipes, sheets	carbon	≤ 520	≤ 0,7 ^a	≥ 20	—	≤ 0,25	≤ 0,05	≤ 0,05	—	—	—	—	—	—	—
	ferritic	≤ 600	≥ 250	≥ 20	≥ 15	≤ 0,08	≤ 0,045	≤ 0,030	≤ 1,0	≤ 1,0	15,5 to 18	≤ 1,5	—	≤ 7 × %C	≤ 12 × %C
	austenitic	≤ 800	≥ 180	≥ 30	≥ 30	≤ 0,08	≤ 0,045	≤ 0,030	≤ 1,0	≤ 2,0	16,5 to 20	2,0 to 3,0	9 to 15	≤ 5 × %C	≤ 8 × %C
^a Ratio yield point–tensile strength. An adequate high temperature yield point for the highest possible temperature of the steel shall be guaranteed.															

Table 2 ± Minimum requirements for cast iron

Flake graphite cast iron (EN 1561):
- Tensile strength $R_m \geq 150 \text{ N/mm}^2$
- Brinell hardness 160 HB to 220 HB 2,5/187,5
Spheroidal graphite cast iron (annealed ferritic):
- Tensile strength $R_m \geq 400 \text{ N/mm}^2$
- Notch impact strength $\geq 23 \text{ J/cm}^2$

Table 3 ± Parts in aluminium and aluminium alloys

	Tensile strength R_m N/mm ²	Temperature range °C
Al 99,5	≥ 75	up to 300
Al Mg2 Mn 0,8	≥ 275	up to 250

Table 4 ± Parts in copper or copper alloys

	Tensile strength R_m N/mm ²	Temperature range °C
SF – Cu	≥ 200	up to 250
Cu Ni 30 Fe	≥ 310	up to 350

Table 5 ± Minimum thicknesses for rolled parts

Carbon steels; aluminium			Protected steels; stainless steels; copper		
a ^a mm	b ^b mm	c ^c mm	a ^a mm	b ^b mm	c ^c mm
4	3	2,9	2	2	1
^a Column a: for walls of combustion chambers exposed to water and fire, and for horizontal walls of convection heating surfaces. ^b Column b: for walls exposed only to water and for rigid shapes, for example convection heating surfaces outside the combustion chamber. ^c Column c: tubes of convection heat exchangers.					

Table 6 ± Nominal minimum thicknesses of fuel cell gas heating appliance sections

Nominal heat input Q_n kW	Flake graphite cast iron aluminium mm	Spheroidal graphite annealed ferritic cast iron, copper mm
≤ 35	3,5	3,0
> 35	4,0	3,5

Table 7 ± Weld joints and welding processes

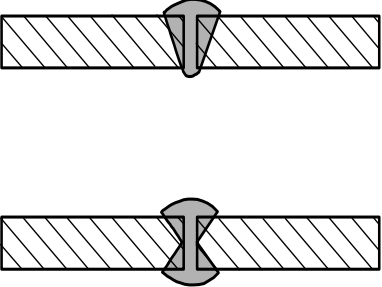
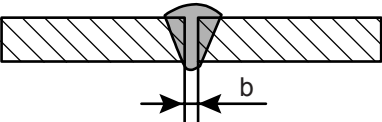
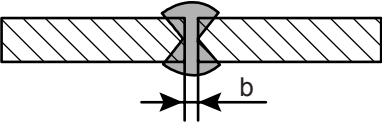
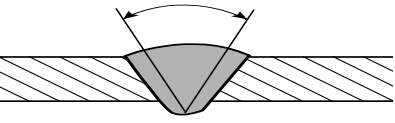
No.	Weld joint type	Material thickness t mm	Welding process ^a	Remarks
1.1	Square butt weld 	≤ 6 (8)	135 12 131 (111)	Permissible up to $t = 8$ mm on use of deep penetration electrodes or welding on both sides
1.2	Square butt weld 	≥ 6 up to 12	12	Root gap $b = 2$ mm to 4 mm with stiffener, powder holder necessary
1.3	Square butt weld (double) 	> 8 up to 12	135 12 (111)	Root gap $b = 2$ mm to 4 mm Deep penetration electrodes shall be used for manual electro welding
1.4	Single-V butt weld 	up to 12	(111)	Seam preparation V-seam 60°

Table 8 ± Weld joints and welding processes (continued)

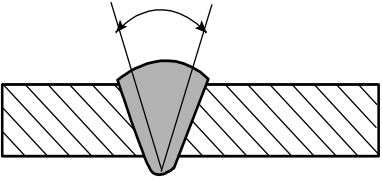
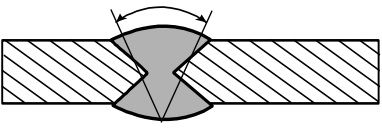
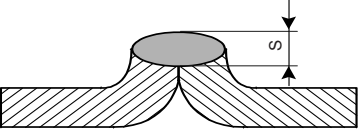
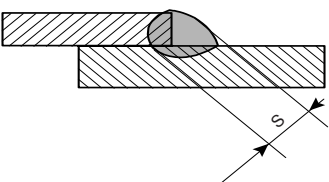
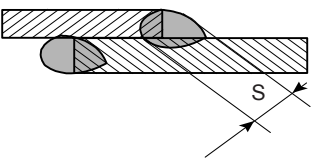
No.	Weld joint type	Material thickness t mm	Welding process ^a	Remarks
1.5	Single-V butt weld 	up to 12	135 12	Seam preparation V-seam 30° to 50° depending on thickness of material
1.6	Double-V butt weld 	greater than 12	135 12	Seam preparation double V-seam 30° to 50° depending on material thickness
1.7	Butt weld between plates with raised edges 	≤ 6	135 141 131 (111)	Only permissible in exceptional cases for parts welded in. Moreover, the welds have to be kept largely free from bending stresses. Not suitable for directly fired wall parts $s = 0,8 \times t$
1.8	Overlap welding 	≥ 6	135 12	Welds of this type are to be kept largely free from bending stresses. Not suitable for directly fired wall parts $s = t$
1.9	Overlap welding (continued) 	≤ 6	135 12 (111)	Not suitable for directly fired wall parts $s = t$

Table 9 ± Weld joints and welding processes (*continued*)

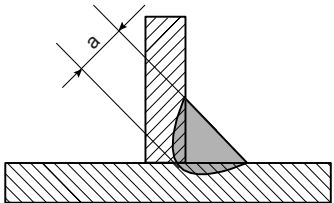
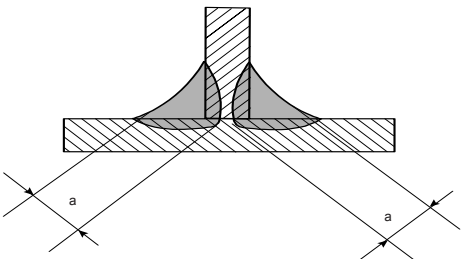
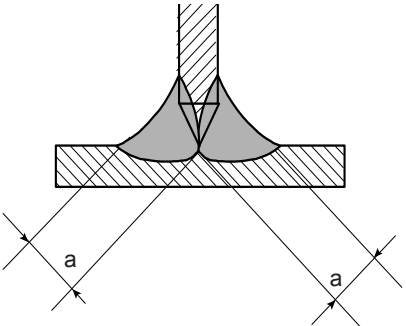
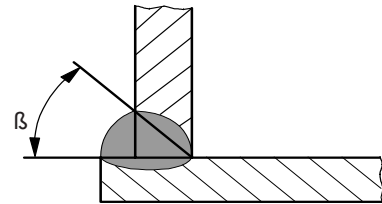
No.	Weld joint type	Material thickness t mm	Welding process ^a	Remarks
2.1	Fillet weld 	≤ 6	135 12 (111)	Welds of this type are to be kept largely free from bending stresses $a = t$
2.2	Double fillet weld 	≤ 12 > 12	135 12 (111) 135 12 (111)	$a = t$ $a = 2/3 t$
2.3	Double-bevel butt weld 	≤ 12 > 12	135 12 (111) 135 12 (111)	$a = t$ $a = 2/3 t$
2.4	Single bevel butt weld 	≤ 12 > 12	135 12 (111) 135 12	for (111) ° = 60° for 135, 12 ° = 45° to 50°

Table 10 ± Weld joints and welding processes (continued)

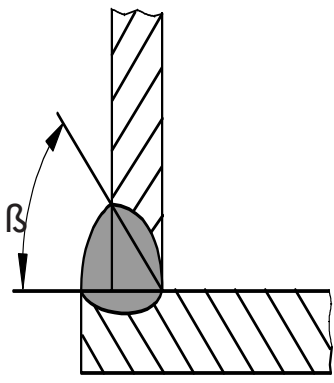
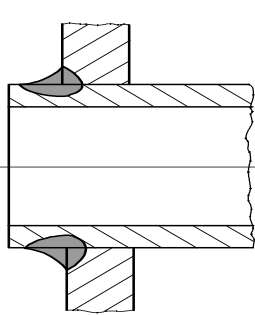
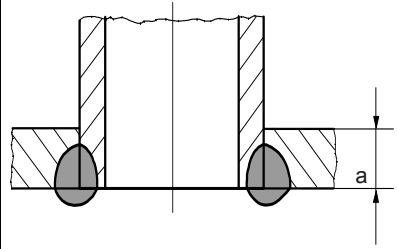
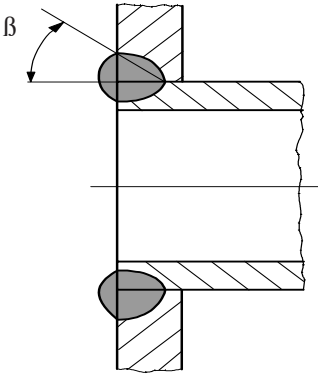
No.	Weld joint type	Material thickness t mm	Welding process ^a	Remarks
2.5	Single-bevel butt weld 	≤ 12	135 12 (111)	for (111) ° = 60° for 135, 12 ° = 45° to 50°
2.6		≤ 12	135 (111)	Tube ends shall not project beyond fillet weld if it is subjected to heat radiation.
2.7		≤ 6	135 (111)	Welding in of tube under high thermal stress $a \geq t$

Table 11 ± Weld joints and welding processes (continued)

No.	Weld joint type	Material thickness t mm	Welding process ^a	Remarks
2.8			135 (111)	Welding in of tube under high thermal stress For (111) ° = 60° For 135 ° = 45° to 50°
^a Reference numbers of welding processes in accordance with ISO 857 or EN ISO 4063: Reference number Process 12 Submerged arc welding 111 Metal-arc welding with covered electrode 131 Metal-arc inert gas welding; MIG welding 135 Metal-arc-active gas welding; MAG welding 141 Tungsten inert gas arc welding TIG welding				

5.3.3 Thermal insulation

Any thermal insulation shall withstand the temperatures which can occur under normal operation and under failure conditions without deformation and shall retain its insulating properties under the influences of heat and aging.

The insulation shall withstand the normally expected thermal and mechanical stresses.

For the appliance casing and thermal insulation, only non-inflammable materials shall be used. However inflammable materials are permitted provided that

- the insulation is applied to surfaces in contact with water, or
- the temperature of the surface to which it is applied does not exceed 85 °C in normal operation, or
- the insulation is protected by a non-combustible case having an appropriate wall thickness.

5.3.4 Control and safety devices (only for automatic shut off valve)

5.3.4.1 Housing

The parts of the housing that directly or indirectly separate an enclosure containing gas from the atmosphere shall be made only of metallic materials.

Nevertheless, an enclosure part containing gas may be made of non-metallic materials provided that in the event of this non-metallic part being detached or broken, under any circumstances, no more than 30 dm³/h of air can escape at the highest normal pressure. This requirement does not apply to toroidal seals, governor diaphragms, sealing gaskets and other means of sealing.

Zinc alloys may only be used if they are of the chemical composition ZnAl₄, as specified in ISO 301, and if the parts are not liable to be exposed to a temperature above 80 °C. Only external threads in accordance with ISO 228-1 are accepted for principal inlet and outlet connections made of zinc alloy.

5.3.4.2 Spring(s) providing the closing force and the sealing force

The closing force and the sealing force shall be assured by the action of a spring or springs. The spring(s) assuring the closing force and the sealing force shall be designed for oscillatory action and shall withstand fatigue.

The springs shall be made from corrosion resistant material.

5.3.4.3 Resistance to corrosion and surface protection

All parts in contact with gas or with the ambient atmosphere, as well as springs other than those specified in 5.3.4.2, shall be made of corrosion-resistant materials or be suitably protected. The corrosion protection for springs and other moving parts shall not be affected by any movement.

5.3.4.4 Impregnation of the body

Treatment during manufacture (impregnation) by an appropriate process, for example treatment under vacuum or internal pressure, using suitable sealing products is permitted.

5.3.5 Separate combustion products evacuation duct

5.3.5.1 Stability under mechanical loading

The duct shall be capable of withstanding horizontal and vertical loads. The following aspects shall be considered:

- compressive strength;
- tensile strength;
- where applicable, resistance to lateral load for a reference wind velocity pressure of 1,5 kN/m².

5.3.5.2 Stability under exposure to heat

The stability of the walls of the duct shall be ensured during and after exposure to heat occurring under all operating conditions of the fuel cell gas heating appliance.

5.3.5.3 Corrosion resistance

The duct shall keep its essential characteristics in the presence of the corrosion load corresponding to all operating conditions of the fuel cell gas heating appliance.

5.3.5.4 Resistance to condensate and moisture under normal operating conditions

The duct shall keep its essential characteristics in the presence of condensate and moisture under normal operating conditions.