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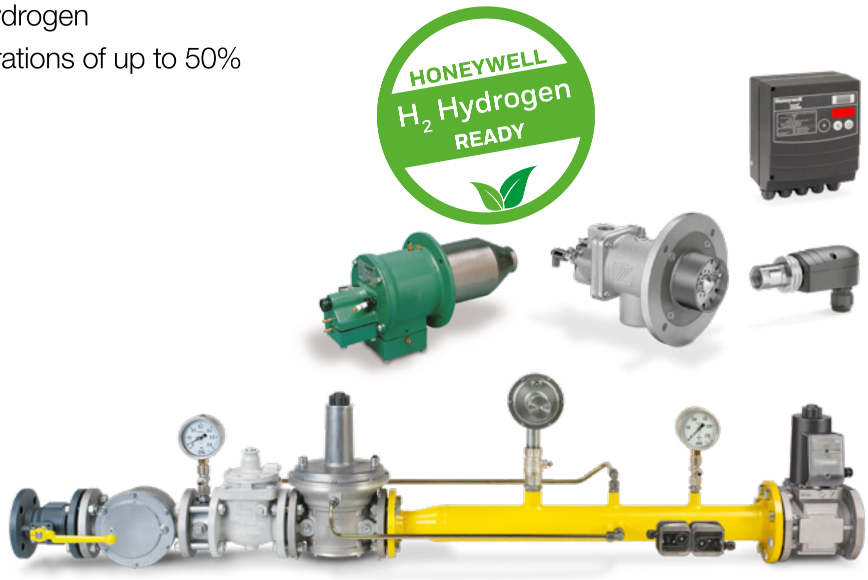
Products for hydrogen H_2

TECHNICAL INFORMATION

- Almost all controls suitable for 100% hydrogen
- Most burners can be used for concentrations of up to 50% hydrogen.
- Can be used with old plants



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Contents

1 Use of hydrogen

The importance of hydrogen as a climate-neutral fuel is on the rise.

Honeywell Thermal Solutions can supply controls and burners suitable for the use of hydrogen to generate process heat.

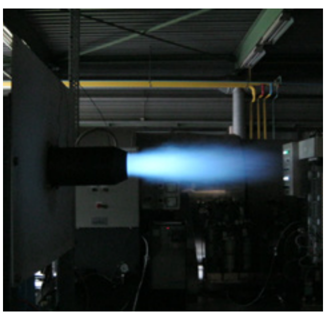
Hydrogen is the smallest and lightest element in the periodic table. It normally occurs in H_2 molecular form, a colourless and odourless gas. In certain chemical reactions, hydrogen temporarily occurs in atomic form as H. In this form, it features significantly higher reactivity in comparison to normal H_2 molecules. Hydrogen embrittlement caused, for example, by the ingress of atomic hydrogen into metals due to high pressures, high temperatures, vibrations and acid, cannot occur in the products featured in this Technical Information bulletin.

As a result of its low density compared to natural gas, hydrogen can escape more easily, for example at connections.

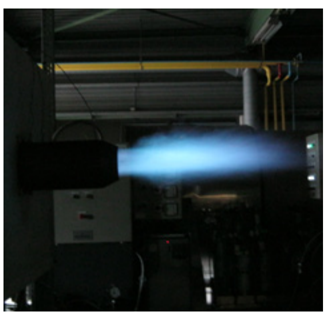
See page 5 (Hydrogen-compatible) for details of all controls and burners which are suitable for use with hydrogen.

See page 7 (Tightness) for further information about tightness.

Flame comparison for the ThermJet TJ with a rating of 213 kW, λ = 1.15



100% natural gas



Ratio of natural gas/hydrogen 40/60

Ratio of natural gas/hydrogen 20/80

100% hydrogen

2 Certification

The current application standards ISO 13577 and EN 746 for industrial thermoprocessing equipment or EN 676 and ISO 22967 for forced draught gas burners contain very few references to hydrogen. However, the revision discussions currently taking place have already covered the regulations that should be included for fuel gases with a high hydrogen content.

Under the Gas Appliance Regulation (GAR) (EU) 2016/426, there is now a new technical report entitled “CEN TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects” which relates to the use of hydrogen.

This document refers to gas appliances with a maximum declared inlet pressure of up to and including 500 kPa (5 bar) and a nominal connection diameter of up to and including DN 250. The aim of the document is to provide guidance on hydrogen topics which must be taken into consideration in the future standardization of the areas covered by CEN/TC 58, such as gas safety valves, gas pressure regulators, gas pressure switches, ignition and monitoring components.

Almost all fittings, seals, manual valves, filters, pressure regulators, valves, butterfly valves, pressure switches, ignition and monitoring components are suitable for use with 100% hydrogen and all mixtures of natural gas and H_2. Hydrogen embrittlement caused, for example, by the ingress of atomic hydrogen into metals due to high pressures, high temperatures, vibrations and acid, may occur at low pressure values of less than 500 kPa (5 bar) and can therefore be ruled out in most burner and control components.

Measurements conducted by independent institutions have confirmed that the limit values for internal and external leaks can be maintained for both pure hydrogen and hydrogen mixtures and do not have to be adjusted.

3 Hydrogen-compatible

3.1 Controls and accessories

Type	Name	100% H_2
Manual valves and filters		
AKT	Manual valves	√
TAS	Thermal equipment trips	√
GFK	Gas filters	√
Pressure regulators		
J78R	Gas pressure regulators	√
GDJ	Gas pressure regulators	√
VGBF	Gas pressure regulators	√
JSAV	Safety shut-off valves	√
VSBV	Relief valve	√
VAR	Circulation pressure control and relief regulators	√
GIK, GIK..B	Air/gas ratio controls	√
GIKH	Variable air/gas ratio controls	√
Valves and butterfly valves		
VAS	Gas solenoid valves	√
VCS	Double solenoid valves	√
VAD	Pressure regulators with solenoid valve	√
VAG	Air/gas ratio controls with solenoid valve	√
VAH	Flow rate regulators with solenoid valve	√
VRH	Flow rate regulators	√
VAV	Variable air/gas ratio controls with solenoid valve	√
VBY	Bypass valves	√
VMV	Fine-adjusting valves	√
VMO	Measuring orifices	√
VMF	Filter modules	√
VGP	Gas solenoid valves	√
VG	Gas solenoid valves	√
VAN	Magnetic relief valves	√

Type	Name	100% H_2
VK	Motorized valves	√
BVG, BVGF	Butterfly valves for gas	√
VFC	Linear flow controls	√
VR4xx	Gas control blocks	√
VRB	Gas control blocks	√
V4730, V8730	Gas control blocks	√
VMU	Mixers	√
RV	Control valves	√
Pressure switches		
DG	Gas pressure switches	√
C6097	Gas pressure switches	√
C60VR	Gas pressure switches	√
DGM	Gas pressure switches	√
Ignition and monitoring components		
UVS	UV sensors	√
UVC 1	UV flame detectors	√
Accessories		
KFM..M, RFM..M	Pressure gauges	√
GEH, GEHV	Flow adjusting cocks	√
DH	Manual cocks	√
DMG	Electronic pressure gauge	√
EKO	Stainless steel bellows units	√
ES	Stainless steel flexible tubes	√
GRS, GRSF	Non-return gas valves	√

DM, DE flow meters are suitable for 20% hydrogen.

3.2 Burners

Type	Name	H_2
ZAI	Pilot burners	≤ 50 % 1)
ZMI(C)	Pilot burners	≤ 50 % 1)
ZKIH	Pilot burners	≤ 50 % 1)
ZKIH..-2	Pilot burners	≤ 100 % 4)
ZIO 40	Pilot burners	≤ 50 % 1)
ZIO 40HB..-2	Pilot burners	≤ 100 % 4)
ZT 40	Pilot burners	≤ 50 % 1)
ZTA	Pilot burners	≤ 50 % 1)
ZTI	Pilot burners	≤ 50 % 1)
BIO(W), BIC(W)	Burners	≤ 50 % 1)
BIO(W)..HD..-2, BIC(W)..HD..-2	Burners	≤ 100 % 4)
BIOA, BICA	Burners	≤ 50 % 1)
BIOA..HD..-2, BICA..HD..-2	Burners	≤ 100 % 4)
ZIO(W), ZIC(W)	Burners	≤ 50 % 1)
ZIO(W)..HD..-2, ZIC(W)..HD..-2	Burners	≤ 100 % 4)
BIO(W)..L, BIC(W)..L	With pilot burner	≤ 10 % 1)
ZIO(W)..L, ZIC(W)..L	With pilot burner	≤ 10 % 1)
BICR	Burners	≤ 50 % 1)
GLG, GLA, GLH	Burners for bell-type annealing furnaces	≤ 100 % 3)
ECOMAX	Self-recuperative burners	≤ 50 % 1)
ECOMAX LE	Self-recuperative burners	≤ 100 % 4)
ThermJet	Burners	≤ 50 % 2)
Wide Range	Burners	≤ 30 %
UNIRAD-Vilvoorde	Burners	≤ 50 % 1)
PrimeFire FH (Next Gen)	Burners	≤ 50 % 1)
OXYTHERM 300	Burners	≤ 50 % 1)
OXYTHERM LE	Burners	≤ 50 % 1)
PrimeFire 100	Burners	≤ 50 % 1)
OXYTHERM FHR	Burners	≤ 50 % 1)
OXYTHERM Titan	Burners	≤ 50 % 2)
NP-RG	Burners	≤ 50 % 2)
LV Airflo	Burners	≤ 50 % 2)
COMBUSTIFUME	Burners	≤ 50 % 2)
HC AIRFLO	Burners	≤ 50 % 1)
OVENPAK 400	Burners	≤ 30 % 3)
OVENPAK 500	Burners	≤ 30 %
VALUPAK-II	Burners	≤ 30 % 2)
UnoPak	Burners	≤ 30 % 2)
MEGAFIRE HD	Burners	≤ 30 % 2)
KINEMAX	Burners	≤ 50 % 1)

1) *Higher hydrogen concentration available on request*

2) *The specified hydrogen volume can be combusted after the burner has undergone minor adjustments and after the application has been reviewed.*

3) *Available on request and after reviewing the application*

4) *From 95% H_2, a UV sensor must be used for flame control.*

4 Tightness

As a result of its smaller molecular size and the changed dynamic viscosity of hydrogen (H_2), it has different leakage rates compared to methane (CH_4).

Internal and external tightness to EN 13611

Gas appliances must be tight and must comply with the leakage rates for air specified in EN 13611.

Nominal size	Medium	Internal tightness [cm³/h]	External tightness [cm³/h]
DN < 10	Air	≤ 20	
10 ≤ DN ≤ 25	Air	≤ 40	
25 ≤ DN ≤ 80	Air	≤ 60	
80 ≤ DN ≤ 150	Air	≤ 100	≤ 60
150 ≤ DN ≤ 250	Air	≤ 150	≤ 60

If less than 10% H_2 is added, the leakage rates specified in EN 13611 are satisfied.

The following table shows the leakage rates found for 100% hydrogen (H_2):

Nominal size	Medium	Internal tightness [cm³/h]	External tightness [cm³/h]
DN < 10	Hydrogen (H_2)	≤ 25	
10 ≤ DN ≤ 25	Hydrogen (H_2)	≤ 80	
25 ≤ DN ≤ 80	Hydrogen (H_2)	≤ 120	
80 ≤ DN ≤ 150	Hydrogen (H_2)	≤ 200	≤ 120
150 ≤ DN ≤ 250	Hydrogen (H_2)	≤ 300	≤ 120

For an application using 100% H_2 or which involves adding more than 10% H_2, there are no guarantees that compliance with the leakage rates specified in EN 13611 can be achieved due to the lower density and changed dynamic viscosity of hydrogen. **The suitability** of the application for operation with mixtures of natural gas and hydrogen with a hydrogen content of ≥ 10% **must be verified by means of a risk assessment**.

Breather orifices to EN 13611

Breather orifices in gas appliances with diaphragms, e.g. pressure regulators, which do not have a connector for a venting pipe, must be designed in such a way that no more than 70 dm³/h of air can escape if the diaphragm is damaged and the gas is at the highest inlet pressure. This air volume of 70 dm³/h is equivalent in the event of an accident to a leak of 100 dm³/h of natural gas (CH_4) or 270 dm³/h of hydrogen (H_2).

This specification is replaced by a diaphragm rupture test for pressure switches that comply with EN 1854.

Flammability limits

Gas mixture	Lower limit [% v/v]	Upper limit [% v/v]
H_2	4.0	77
CH_4	4.4	16.5

The lower flammability limit is reached more quickly in applications using hydrogen.

Flow rate calculation

In the case of a “turbulent flow”, such as that caused by a breather orifice, the flow rate can be calculated using the density ratio:

Conversion factor from density ratio (reference value air):

Medium	Density [kg/m³]	Conversion factor
Air	1.29	1
Natural gas H	0.81	1.3
H_2	0.09	3.79

The tightness of systems must always be tested before commissioning. In addition to the devices themselves, the thread and flange connections must also be checked.

5 Calculating the nominal size

A web app for calculating the nominal size is available at www.adlatus.org.

Enter the appropriate density for hydrogen or hydrogen-natural gas mixtures manually.

6 Project planning information

6.1 Combustion principles for adding hydrogen to natural gas

The heating value of natural gas-hydrogen mixtures falls significantly as the volume of added H_2 increases, in other words a higher flow rate is required to achieve the same thermal capacity. As a result of hydrogen's low density, the Wobbe index falls by significantly less but nevertheless the gas pressure must be up to 65% higher to achieve the same capacity. The recommended flow velocity for natural gas of 20 to 30 m/s should also be given due consideration for the addition of H_2.

The laminar flame velocity of hydrogen is significantly higher than that of natural gas. Nevertheless, the visible flame length on many burners changes very little when H_2 is added. However, the high flame velocity may cause resonance and generate noise depending on the burner design.

The demand for combustion air falls as the amount of added H_2 increases, in other words in an established system, there is no additional risk posed by excess gas due to the addition of H_2. If the burner settings are left unchanged, however, the excess air will increase by up to 45% and therefore, you should check whether the burner can still be operated stably with a higher volume of added H_2.

The adiabatic combustion temperature and the flame temperature will rise as the level of added H_2 increases. This causes the formation of thermal NO_X to increase, and an exponential increase in NO_X emissions, particularly if around 50% or more H_2 has been added, which necessitates additional action to reduce NO_X, for example by selecting suitable low NO_X burners.

6.2 Conversion of existing burner systems

If 10–20 % hydrogen is added to natural gas, what is normally required is only an adjustment to the burners, particularly if they are low NO_X solutions, in which the precise adjustment of the gas/air ratio plays a vital role.

An extended gas/air ratio control must be used if the amount of added hydrogen varies.

For higher hydrogen contents, a burner suitable for that gas type must be selected.

6.3 Burner monitoring and control for hydrogen

As a result of the physical principle, flame control for pure hydrogen or hydrogen added to natural gas at a level of more than around 95% is not possible using ionization. It is only possible using UV sensors.

As a result of the significantly higher flammability limit of hydrogen compared to natural gas, you should check in each individual case whether the gas line between the shut-off valve and burner must be purged after the burner has been shut down (closing of the automatic shut-off valves). In certain circumstances, it may be possible that a flammable mixture will form between the burner and shut-off valve and flashback into the gas line will occur when the burner is restarted. In any event, shut-off valves and flame-arresting non-return valves, if necessary, should be placed as close to the burner as possible when hydrogen is used so as to minimize the danger of a potentially flammable mixture.

For more information

The Honeywell Thermal Solutions family of products includes Honeywell Combustion Safety, Eclipse, Exothermics, Hauck, Kromschröder and Maxon. To learn more about our products, visit ThermalSolutions.honeywell.com or contact your Honeywell Sales Engineer.
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