ON-SITE HYDROGEN GENERATION SYSTEMS

COST EFFECTIVE STEAM METHANE REFORMING

HYGEAR

COST EFFECTIVE HYDROGEN GENERATION

HyGear offers small scale on-site hydrogen generation systems ranging from 5 Nm^3/h up to 100 Nm^3/h. This makes them highly suitable to be installed at industrial sites and hydrogen filling stations.

The Hy.GEN systems produce hydrogen by converting natural gas with Steam Methane Reforming. Decentralised hydrogen production offers a safer, more reliable and cost attractive alternative to conventional hydrogen supply by tube trailers or electrolysers and significantly lowers the environmental impact.

Applications

- Flat glass industry
- Metal industry
- Electronics industry
- Food industry
- Chemical industry
- Hydrogen filling stations

KEY BENEFITS

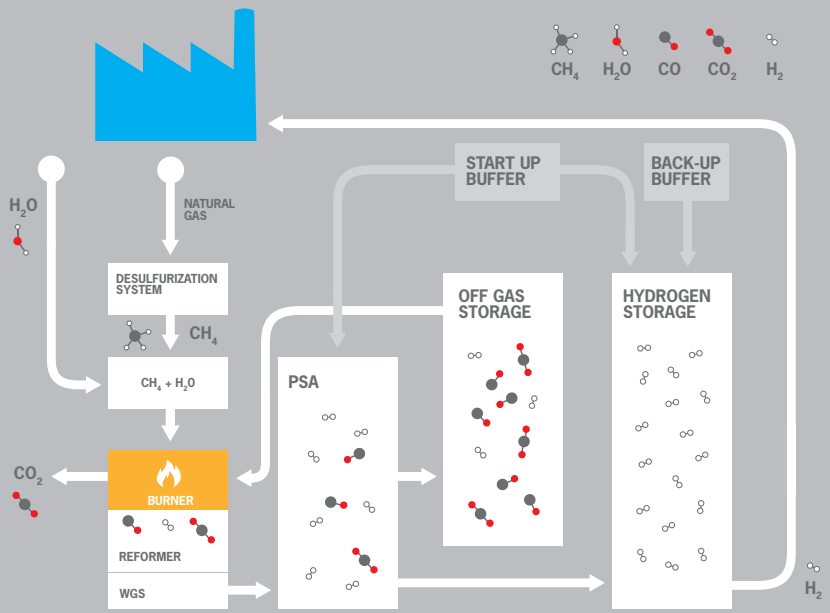
- Cost effective
- Reliability of supply
- Independency of third party supply
- Significant reduction of harmful emissions
- Compact and modular system
- Customer specific design
- Remote monitoring and operation
- Energy efficient process

TECHNOLOGY

The steam (H_2O) produced from waste heat is added to the desulphurised gas and led into the reformer. The heat and catalytic properties of the reformer cause the following reaction: $CH_4 + H_2O \rightleftarrows 3H_2 + CO$.

The remaining carbon monoxide is then converted in the Water Gas Shift assembly (WGS) to produce more hydrogen: $CO + H_2O \rightarrow CO_2 + H_2$.

The gases then enter the PSA where the hydrogen is separated from other gaseous species under elevated pressure using differences in adsorption properties. The cleaned hydrogen is then stored in the buffer vessel and can be used as an industrial gas or energy source.



Advanced reforming

HyGear uses its proprietary reforming technology to generate a hydrogen rich stream from natural gas. To ensure long lifetime, high system efficiency and avoid catalyst deactivation, the natural gas is stripped from sulphur before it is led into the reformer.

Effective PSA technology

HyGear uses vacuum pressure swing adsorption technology. This is more energy and cost efficient than traditional gas separation systems. The PSA consists of four parallel active vessels, enabling a continuous cleaning process. In the PSA, the hydrogen is separated from other gaseous species under elevated pressure by using differences in adsorption properties.

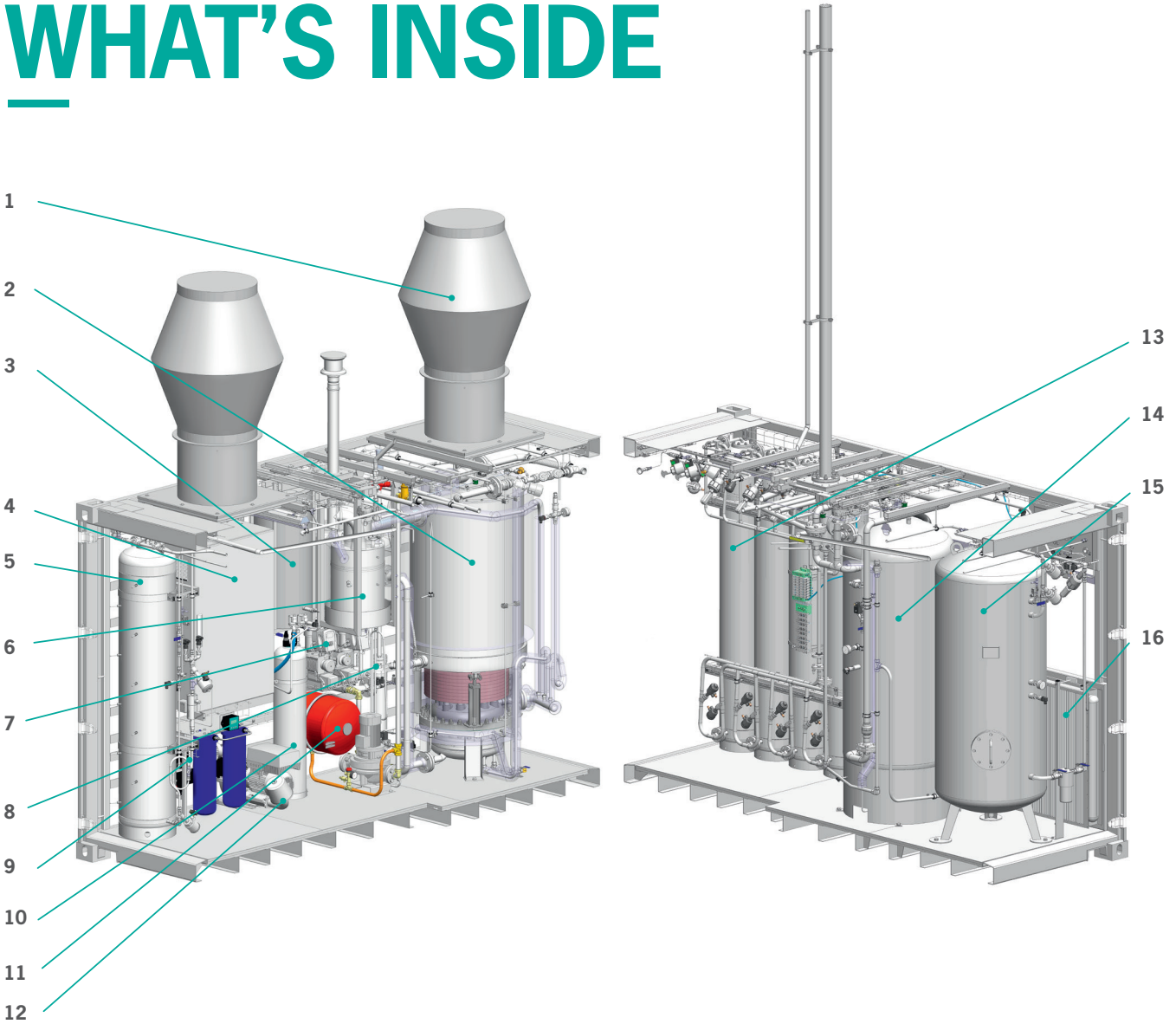
Optimised energy efficiency

By re-using the waste gases and waste heat of the process, the energy efficiency of the Hy.GEN is optimised to the highest level. No external fuel gases are needed for the reform reaction and steam generation. The off-gas from the PSA is used as input for the burner that provides heat for the reforming reaction. The residual heat is used for generating steam which is mixed with natural gas for the steam reforming process.

Connectivity

The system includes gas desulphurisation and water purification and can therefore be connected directly to the natural gas and feed water lines. Other required connections are electricity for controls and auxiliaries, hydrogen and nitrogen for system start-up and compressed air for valves.

WHAT'S INSIDE



1. Ventilation Fans
2. Reformer Unit
3. DI water storage
4. Electronics cabinet
5. Desulfurization Vessel
6. Steam generator
7. Water pumps
8. Water Gas Separator
9. Water Purification system
10. Ion exchanger
11. Coolant Expansion vessel
12. Burner Air Blower
13. PSA vessels
14. Off gas storage
15. H_2 storage
16. Reformate cooler

SPECIFICATIONS

Model	Hy.**GEN** 5	Hy.**GEN** 50	Hy.**GEN** 100
OUTPUT			
Nominal output	Max. 5 Nm^3/h	Max. 52 Nm^3/h	Max. 104 Nm^3/h
Hydrogen purity [1]	Max. 99.999%	Max. 99.999%	Max. 99.999%
Pressure	Max. 4.5 bar(g)	Max. 7.5 bar(g)	Max. 7.5 bar(g)
INPUT			
Natural gas [2]	Max. 95 MJ/h at 7 - 8 bar(g)	Max. 950 MJ/h at 10 - 11 bar(g)	Max. 1900 MJ/h at 10 - 11 bar(g)
Electricity	1.1 kWe	18.5 kWe	37 kWe
Water	21 L/h	275 L/h	550 L/h
Compressed air	Not required	Max. 3 Nm^3/h	Max. 6 Nm^3/h
DIMENSIONS			
Size	3.5 x 1.2 x 2.6 m	20 ft	30 ft
Weight	1800 kg	6500 kg	12000 kg
OPERATING CONDITIONS			
Start Up Time (warm)	Max. 30 min	Max. 30 min	Max. 30 min
Start Up Time (cold)	Max. 2 h	Max. 3 h	Max. 3 h
Modulation (H_2 product flow)	0 - 100 %	0 - 100 %	0 - 100 %
Modulation reformer (output)	20 - 100 %	10 - 100 %	10 - 100 %
Ambient Temperature Range [3]	-20 °C to +40 °C	-20 °C to +40 °C	-20 °C to +40 °C

All data and values are indicative and based on nominal and non-frost conditions.
Values might differ due to local circumstances and feedstock characteristics.

[1] Even higher purities possible with HyGear's polishing modules.

[2] For example: For the Hy.GEN 50 ≤ 26 Nm^3/h H-Gas of 36.5 $MJ/Nm^3/h$ is needed.

[3] Optional extension for temperatures lower than -20 °C.

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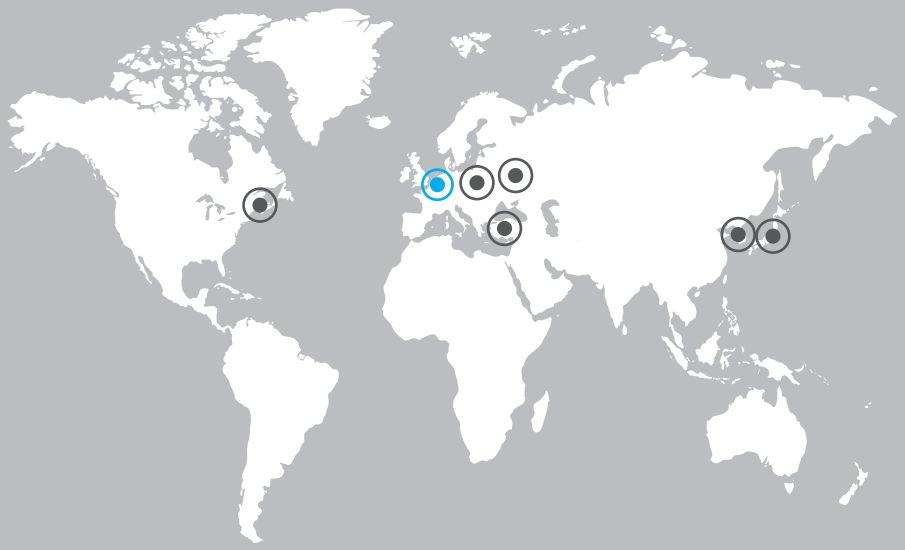

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