



A reliable solution for
CLEAN, QUIET, and EFFICIENT
hydrogen **GENERATION**



Powered by
Helbio
Hydrogen & Energy Systems

HHG Series
Helbio Hydrogen Generators



Highly **INNOVATIVE**
Environmentally **FRIENDLY**
Energy **EFFICIENT**
Cost **EFFECTIVE**

10 – 200 m³/h
Hydrogen Production

- Fueled by
- Natural Gas
 - LPG
 - Biogas

HHG Series

Helbio Hydrogen Generators

“READY TO USE” HYDROGEN PRODUCTION SYSTEMS

Helbio has developed a family of Hydrogen Generators designed to meet demanding requirements of small-scale hydrogen supply, using fuels such as Natural Gas, LPG or Biogas. The system offers clean, quiet and efficient hydrogen generation under continuous operation with long service intervals.

The standards systems HHG-10, HHG-20, HHG-50, HHG-100, HHG-150 and HHG-200 generate 10, 20, 50, 100, 150 and 200 Nm³/h of H₂ respectively.

Hydrogen purity ranges from 99,9% to 99,999% upon customer request.

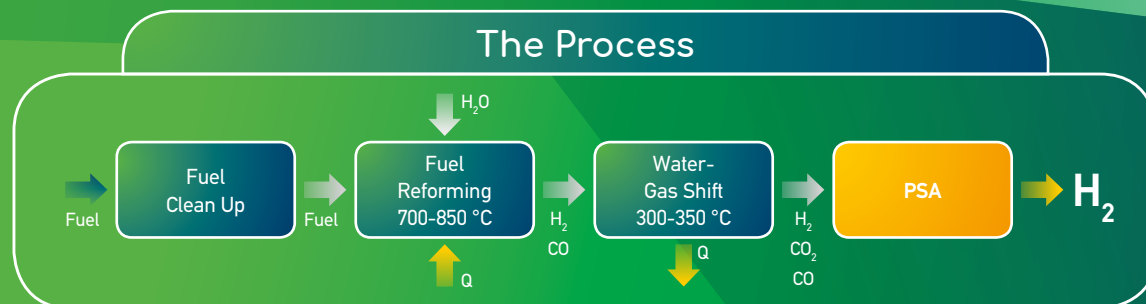
Natural Gas can be obtained from the existing network. Biogas can originate from various sources such as waste water treatment plants, landfills or organic waste from industry and/or households.

SYSTEM OVERVIEW

Helbio's Hydrogen Generators are composed of four primary subsystems:

- **The Fuel Pretreatment** unit which removes fuel impurities and contaminants such as sulfur, ammonia and halides. A series of traps which is used operate in ambient temperature; thus, they do not require any energy input.
- **The Fuel Processor** which converts the fuel into a hydrogen rich stream.
- **The Pressure Swing Absorption (PSA)** unit which purifies the Hydrogen outlet to the desired level
- **The Control System** which ensures smooth and fail- safe operation. The units are highly automated with industrial grade PLC control systems and can operate autonomously and unattended. Remote monitoring and control are included.

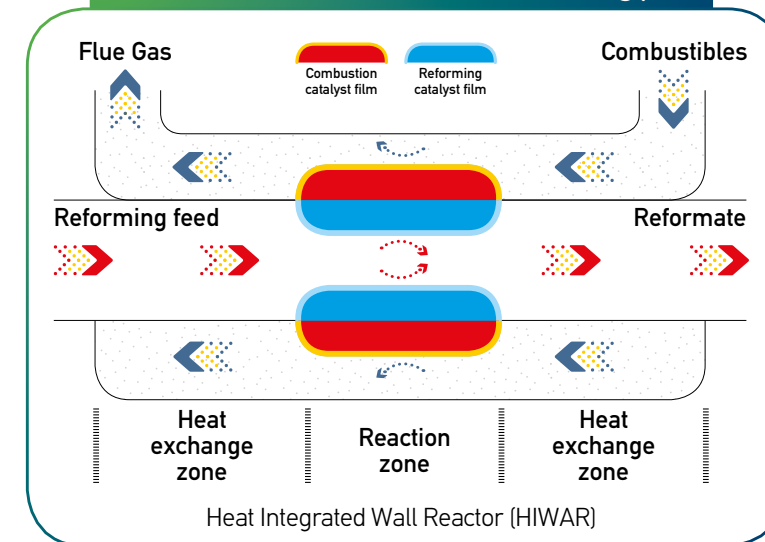
The Process



The fuel stream is mixed with steam and fed to the reforming reactor that produces most of the H₂. A large portion of the hydrogen comes from the water, i.e. water acts as a fuel in this process! The heat required for the process is produced by catalytic combustion of a fraction of the fuel, eliminating open flames. The CO contained in reformer outlet is converted in the Water-Gas-Shift (WGS) reactors where CO reacts with water to produce additional hydrogen and CO₂. A Pressure Swing Absorption unit purifies Hydrogen to the desired level.

TECHNOLOGY

HIWAR Patented Technology



Helbio's technology is based on proprietary and patented reactor catalyst configurations for reformation processes. The reactor configurations utilize the concept of the Heat Integrated Wall Reactor which offers very rapid heat exchange characteristics.

The reactor pursues a very efficient heat transfer through the metallic wall (low resistance) while Heat is produced very close to where the demand exists. The required amount of reforming catalyst is significantly lower than a typical fixed bed reactor.

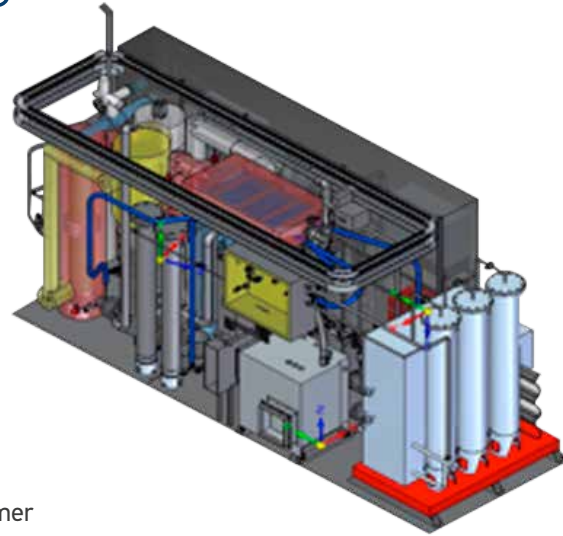
APPLICATIONS

10- 200 Nm³/h Helbio Hydrogen Generators are of high efficiency ideal for application such as:

- ▶ Automobile Refilling Fuel Stations for Fuel Cell Vehicles (FCVs)
- ▶ Power generation through Fuel Cell technology
- ▶ Industrial Processes requiring Hydrogen such as
 - Oil and fat hydrogenation
 - Electronics industry
 - Steel industry and metallurgy (iron reduction, blanketing gas, forming gas)
 - Glass industry
 - Cooling of electrical generators
 - Hydrogen enrichment for internal combustion engines which improves efficiency and reduces emissions
 - Hydrogen enrichment of fuel of piston gas generators such as biogas applications
- ▶ Hydrogen injection to the Natural Gas grid.

HHG SERIES CLAIMS

Highly Innovative
Environmentally Friendly
Energy Efficient
Cost Effective



HEL BIO Hydrogen Generation Systems incorporate the following features

- Compact: 40 times smaller than a conventional reformer
- Catalytic combustion: Close coupling of reforming/combustion sides which leads to a low-cost reactor design
- Heat transfer: Superior heat transfer characteristics. Heat is produced very close to where heat is consumed.
- Lower operating temperatures: Material cost reduction and NOx elimination.
- Enhanced safety – No flames
- Highly efficient: High plant efficiency, not depending on system's 'size'. Depending on operating conditions and pressure, the system presents 5-8% higher efficiency compare to conventional technologies due to the patented HIWAR reactor
- 50% less operational cost compared to an electrolyzer
- Compact design: Smaller plant footprint. It can fit to a 20" or 40" container, depending on system capacity
- Easy on-site installation
- Designed for 20 years life and 3 years service intervals



HHG SERIES HELBIO HYDROGEN GENERATORS SYSTEM CHARACTERISTICS

SPECIFICATIONS	HHG-20	HHG-50	HHG-100	HHG-200
Hydrogen Production [Nm³/h]	20	50	100	200
Feeding Fuel Consumption				
N.G. [Nm ³ /h] ¹	8.0	20.0	40.0	80.0
LPG/Propane [kg] ²	6.9	17.3	34.6	100.0
Biogas [Nm ³ /h] ³	15.7	39.0	78.0	150.0
Operating Range Capacity (%)	50-100	50-100	50-100	50-100
Delivery Hydrogen Content [% vol]	≥99.999%	≥99.999%	≥99.999%	≥99.999%
PSA recovery [%]⁴	80.0	79.0	79.0	79.0
Hydrogen delivery pressure [barg]⁵	7	7	7	7
Input Voltage [V]	400, 3ph +/- 5%	400, 3ph +/- 5%	400, 3ph +/- 5%	400, 3ph +/- 5%
Power consumption [kW]	<5	<15	<20	<25
Dimensions	20' container	20' container	40' container	40' container

1. CH₄ content >91%
 2. Commercial Propane, C₃H₈ content > 95%
 3. CH₄ content >65%
 4. Depending also on the required H₂ purity
 5. Can vary upon request

NOTE: HYDROGEN PURITY CAN REACH FROM 99,99% TO 99,999% UPON CUSTOMER REQUEST

THE COMPANY

HEL BIO is a high-tech company founded in 2001 and based in Patras, Greece is specialized in development, manufacturing and marketing of Hydrogen & Energy Production Systems.

Unique selling point and expertise:

- Advanced Hydrogen and Energy Production Technologies
- Products based on Innovative Technologies, developed In-house
- Reforming technology of NG, LPG, Biogas and Bioethanol
- Compact and efficient reactor-catalyst configurations (patented HIWAR concept)
- Reaction engineering and Catalysis
- Process design
- System integration and control
- Efficient integration of hydrogen generation with fuel cells
- 6 International & European registered patents, secure Helbio's «freedom to operate» (FTO), enabling a successful Commercialization of existing & new products

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