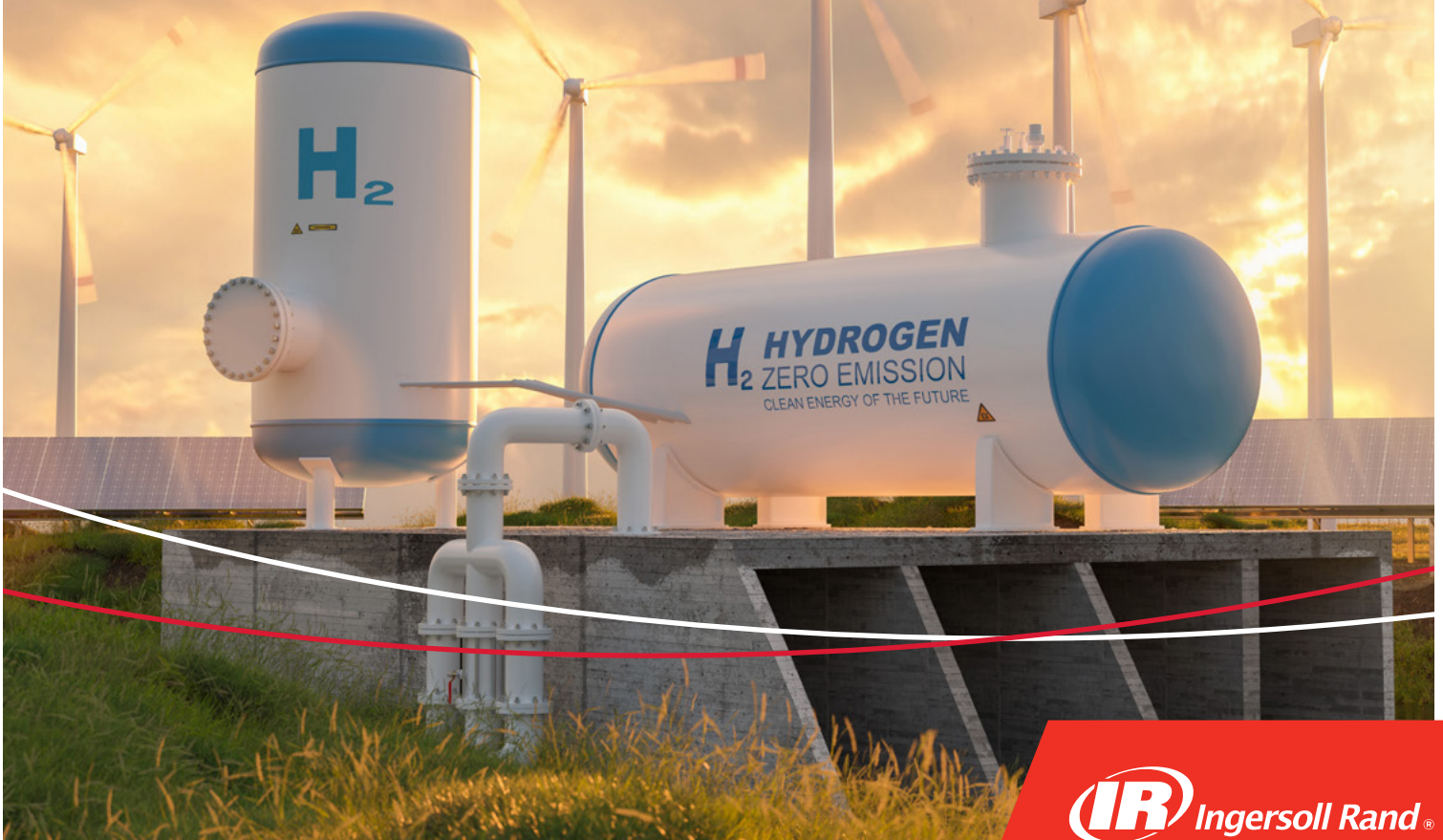


Efficient Hydrogen Blowers and Compressors

COMPLETE SOLUTIONS FROM
PRODUCTION TO CONVERSION

Hydrogen



Solutions



Hydrogen is the most common element in the universe, but it's seldom found on its own because it naturally combines with other elements. To use pure hydrogen, we need to extract it from compounds, such as those found in natural gas, coal, or water. The way we obtain hydrogen and the related by-products give us different types of hydrogen, typically identified by color names like grey, blue, turquoise, and green - each with its own environmental implications.

As the climate crisis intensifies, the most critical aspect of hydrogen, however, is that it emits only water vapor when used for power generation, marking it as a clean energy source with the potential to significantly reduce our dependence on fossil fuels and advance us towards a more sustainable future.

At Ingersoll Rand, we see how hydrogen applications are in contemporary energy strategies. With the global aim of achieving carbon neutrality by 2050, we step up to provide essential solutions for industries transitioning away from fossil fuels. By focusing on the development and deployment of hydrogen production and conversion technologies, Ingersoll Rand is not just supporting the reduction of carbon emissions but is actively shaping a sustainable and resilient energy future.

Partner

End-to-End Partner for Hydrogen Energy

Ingersoll Rand harnesses the collective expertise of brands like Emco Wheaton, MSG, Nash, Belliss & Morcom, Haskel, Delair, Elmo Rietschle, Hibon, Garo, Roots, Milton Roy, Ingersoll Rand Engineered Solutions, YZ Systems, Reavell, Wittig and others to deliver seamless end-to-end support throughout the hydrogen value chain.

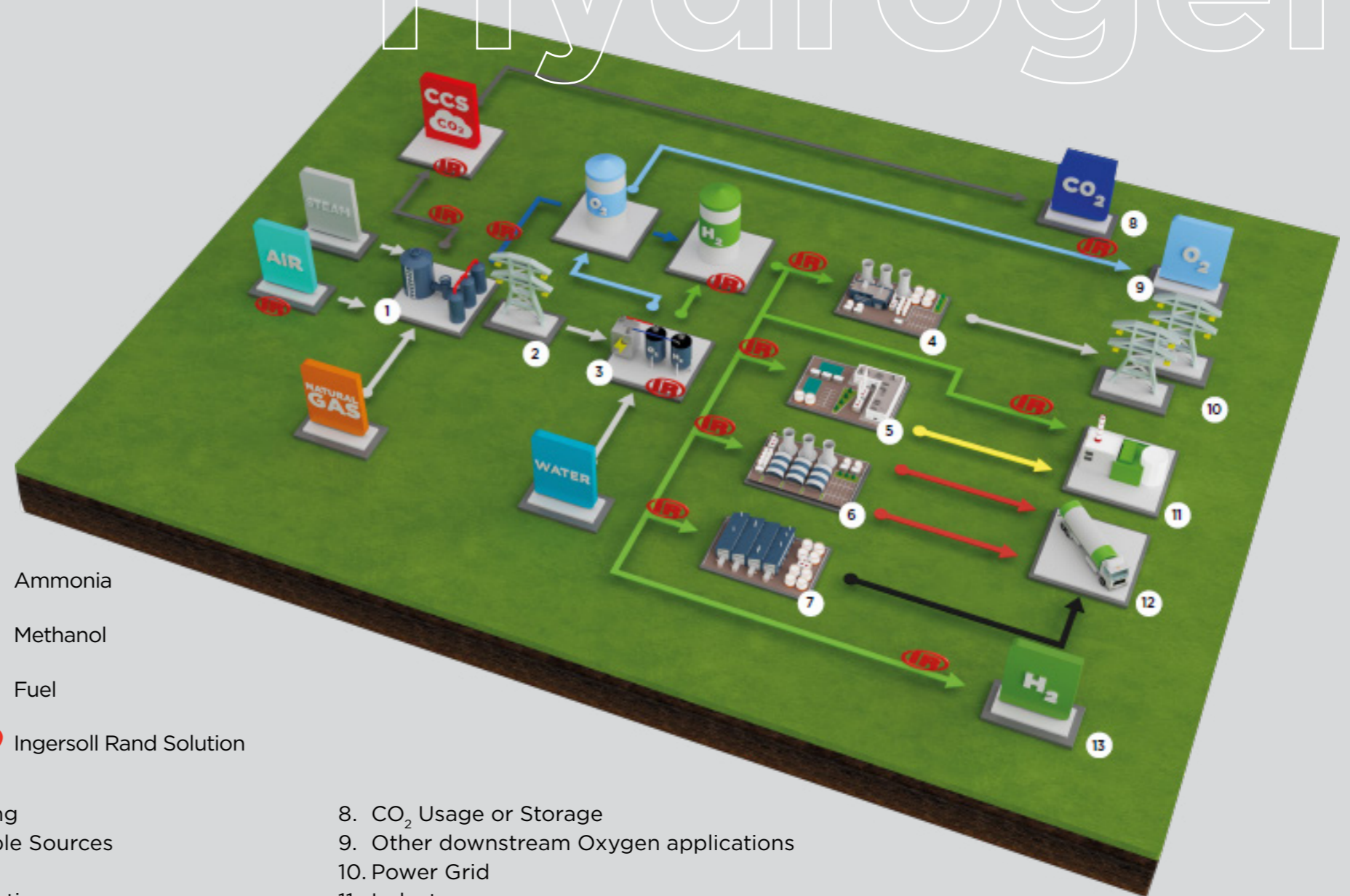
This collaboration ensures that each step, from production to distribution, is optimized with specialized, high-quality solutions. The result is a streamlined approach that enhances efficiency, reduces complexity, and drives performance, propelling the transition to a low-carbon future.











The Role of Blowers and Compressors in Hydrogen

Blowers and compressors are essential in hydrogen production, maintaining precise pressures for optimal electrolysis, and in conversion, compressing hydrogen for efficient storage and transport. These reliable systems ensure seamless pressure management and gas circulation, facilitating hydrogen's safe and effective distribution in the energy sector.

Hydrogen



- | | |
|---|---|
|  CO ₂ |  Ammonia |
|  Oxygen |  Methanol |
|  Green Hydrogen |  Fuel |
|  Blue Hydrogen |  Ingersoll Rand Solution |

- | | |
|---------------------------------------|--|
| 1. Steam Methane Reforming | 8. CO ₂ Usage or Storage |
| 2. Electricity from Renewable Sources | 9. Other downstream Oxygen applications |
| 3. Electrolysis | 10. Power Grid |
| 4. Secondary Power Generation | 11. Industry |
| 5. Hydrogen & Nitrogen Synthesis | 12. Mobility |
| 6. Methanol Synthesis | 13. Other downstream Hydrogen applications |
| 7. Refineries | |

Hydrogen Production Methods and Colors

Hydrogen is generated through different industrial processes, leading to a classification system that assigns different 'color' labels to each type of hydrogen:

Production

Green hydrogen is produced through the electrolysis process. It consists of splitting water into hydrogen and oxygen using an electric current powered by a renewable source such as wind, solar or hydroelectric energy.

Process: Water Electrolysis
Carbon Impact: No



Renewable Energy

Process: Methane Pyrolysis
Carbon Impact: No release of carbons in the atmosphere, solid carbon produced

Turquoise hydrogen is produced through methane pyrolysis, which involves the thermal degradation of methane into hydrogen gas and solid carbon through the addition of extreme heat. The solid carbon can then be used in downstream industrial applications or stored without contributing to global warming.

Grey hydrogen is produced from natural gas in a process called steam methane reforming. Methane and steam are mixed under high pressure and temperature to produce pure hydrogen and carbon monoxide. In a process called water-gas shift reaction, more steam is added to the carbon monoxide to produce carbon dioxide and more hydrogen. The resulting CO₂ is emitted into the atmosphere.

Process: Steam Methane Reforming (SMR), then Water-Gas Shift Reaction
Carbon Impact: Carbon Dioxide (CO₂) gas is released into the atmosphere



Fossil Energy

Process: Steam Methane Reforming (SMR), then Water-Gas Shift Reaction
Carbon Impact: Carbon Dioxide (CO₂) gas is sequestered underground

Blue hydrogen is the "net-zero" version of grey hydrogen. The carbon dioxide created from the water-gas shift reaction is captured and sequestered underground through the available CCS processes and technologies, preventing its release into the atmosphere.



Electrolysis

Electrolyzers Types

Electrolyzers, specialized devices that facilitate the electrolysis process, rely on blowers and compressors to manage pressure and flow, ensuring efficient and consistent hydrogen production within these systems.

Depending on process conditions, three main electrolyzer technologies rely on compressors and blowers for gas pressure control and flow.

PEM Electrolyzers

PEM electrolyzers use a solid membrane, rapidly responding to changes in electricity supply, ideal for renewable sources. Compressors here maintain precise pressure, crucial for the membrane's efficiency and the system's overall hydrogen output.

Alkaline Electrolyzers

Alkaline electrolyzers are a time-tested technology using a liquid solution to facilitate electrolysis. Blowers and compressors circulate this solution and manage the gases produced, ensuring steady operation and safety.

Solid Oxide Electrolyzers

Solid oxide electrolyzers use high temperatures to lower the electricity needed for water splitting, enhancing efficiency. Compressors for these systems are built to endure the heat, ensuring consistent performance and optimal hydrogen production.



Conversion

Hydrogen Conversion

Hydrogen conversion transforms hydrogen into more manageable forms like ammonia and methanol, facilitating easier storage and transport. Blowers and compressors are central to this process, providing the necessary pressure to drive chemical reactions and ensuring efficient gas circulation. These devices support the safe and streamlined conversion, making hydrogen a versatile energy carrier.

Ammonia

Compressors increase hydrogen to the high pressures required for its reaction with nitrogen in the synthesis of ammonia. This is a key step in the production of ammonia, a stable hydrogen carrier that's easily liquefied and transported.

Methanol

For methanol production, compressors supply hydrogen at the pressures needed to react with carbon dioxide. Blowers maintain optimal gas flow, crucial for producing methanol, which serves as both a fuel and an industrial chemical.

Transport

Hydrogen Transportation

Transporting hydrogen is a key step in its journey from production facilities to where it's needed. It can be moved in several forms - either as a high-pressure gas, a liquid at very low temperatures, or within other chemical compounds. Trucks, pipelines, and even ships are used to move this clean energy source to fuel stations and industries, paving the way for a more sustainable future.

	BLOWERS	COMPRESSORS	TRANSPORT
	HIBON - ROOTS ELMO RIETSCHLE	NASH / GARO WITTIG	EMCO WHEATON
GAS PRODUCTION			
H2 circulation from electrolyser	●	●	-
O2 circulation from electrolyser	●	●	-
GAS DISTRIBUTION AND CONVERSION			
Gas loading and unloading	-	-	●
Nitrogen generation	-	●	-
H2 conversion into Ammonia or Methanol	-	●	-
Ammonia conversion into H2	●	●	-
GAS END USAGE APPLICATION			
H2 refueling stations and H2 dosing	-	●	●
Fuel or Air/O2 injection into fuel cells	●	-	-
Other H2 applications in Industry and Refinery	●	●	●

Loading Arms in Hydrogen Transportation

A loading arm is a pivotal piece of equipment in hydrogen transportation, designed to move this energy source safely between storage tanks and transport vehicles. Its articulated structure allows for smooth and precise connections, even with the diverse configurations of transport vessels.

For hydrogen's specific needs, these arms are built to handle extreme pressures and temperatures, with materials chosen for their durability against hydrogen-induced brittleness. Their role is essential, as they ensure a secure transfer process, minimizing the risk of leaks and promoting the safe adoption of hydrogen as a clean energy resource.



At Ingersoll Rand Engineered Solutions, we deliver the most reliable Engineered-to-Order (ETO) solutions by prioritizing your specific needs at every step:



UNIQUE REQUIREMENTS

We take the time to fully understand your application through comprehensive research, ensuring the best-fit solution for your project.



TECHNOLOGY FOR YOU

We select the most suitable and advanced technologies, customized to meet your precise specifications.



MULTI-BRAND EXPERTISE

Our portfolio of brands enables us to confidently manage even the most complex projects, providing a broad range of innovative solutions tailored to your needs.



END-TO-END SUPPORT

From concept to installation, we offer innovative, safe, and meticulously engineered solutions, partners throughout the entire project lifecycle.



GUARANTEED PERFORMANCE

Our in-house testing facilities ensure each design solution meets your highest standards for performance and quality.



UNMATCHED EXPERTISE

With over 300 years of combined experience, we ensure reliable, repeatable quality on every project.



GLOBAL REACH

No matter where your project is, we deliver engineered systems to any corner of the world, backed by a commitment to excellence.

Offering

Comprehensive Solutions at a Glance



Main risks associated with hydrogen are:

Leaks: hard to handle due to the gas low density and molecules size.

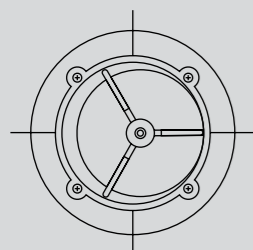
Explosions: in the presence of oxygen and an ignition source.

Material embrittlement: over time, the gas molecules diffuse into solids and mechanically weaken them.

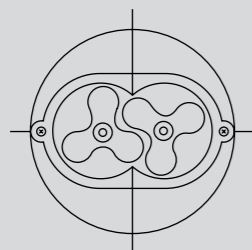
Rotating equipment designed for hydrogen service requires high quality materials and precise tolerances to prevent and mitigate the above mentioned risks.

Ingersoll Rand Engineered Solutions acknowledges these critical considerations and incorporates them into the design and manufacture of their hydrogen blowers and compressors to deliver superior performance.

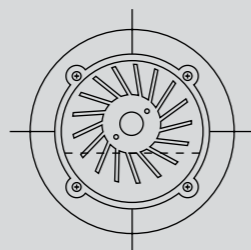
Our Technologies



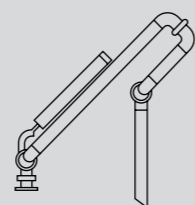
ROTARY VANE



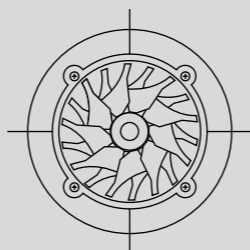
ROTARY LOBE



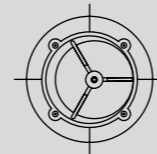
LIQUID RING



LOADING ARMS



HIGH-SPEED RADIAL

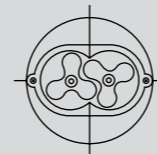


ROTARY VANE COMPRESSORS

Rotary Vane Compressors are known for their simplicity and reliability. They use a series of vanes in a rotating cylinder to compress gases. These compressors provide consistent flow and pressure, with minimal pulsation. They are also relatively compact, making them suitable for installations where space is at a premium.

BENEFITS:

- Low maintenance needs due to fewer moving parts.
- Continuous duty cycle for constant operation.
- Good inlet flow control for varying hydrogen demands.

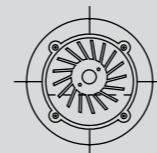


ROTARY LOBE BLOWERS

Rotary Lobe Blowers are well-suited for handling large volumes of air or gas at low to medium differential pressures. Their design allows for minimal wear since the lobes do not come into contact with each other.

BENEFITS:

- Ability to handle various gases, including corrosive or explosive types.
- High-volume flow rates.
- Durable construction with minimal wear.

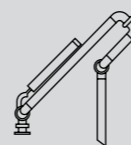


LIQUID RING COMPRESSORS

Liquid Ring Compressors use a liquid sealant, typically water, to create a compression seal. They are especially useful in applications where gas streams are wet or contaminated. The liquid ring acts as a filter, capturing impurities.

BENEFITS:

- Capable of handling wet or contaminated gas streams.
- Robust and simple design for ease of maintenance.
- Reliable performance under variable operating conditions.

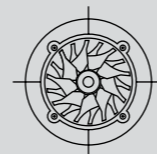


LOADING ARMS

Loading arms are essential tools in the transfer of liquids and gases, and they play a crucial role in the efficient and safe handling of hydrogen fuel. Designed to connect storage tanks to transportation vessels, these arms ensure a secure and controlled transfer process.

BENEFITS:

- Unmatched reliability for consistent hydrogen flow.
- Enhanced safety features to protect against hazards.
- Compliance with strict industry standards for secure operations.



HIGH-SPEED RADIAL BLOWERS

High-speed radial blowers stand out for their efficient, clean, and quiet gas movement capabilities. These blowers are engineered for optimal performance with a minimalistic design, ensuring seamless integration into numerous applications, including air injection and fuel recirculation within Solide Oxide Fuel Cells.

BENEFITS:

- Unrivalled energy efficiency for cost-effective operation.
- Low-maintenance design for reliable service.
- Compact construction for flexible installation options.

Our Brands

WITTIG



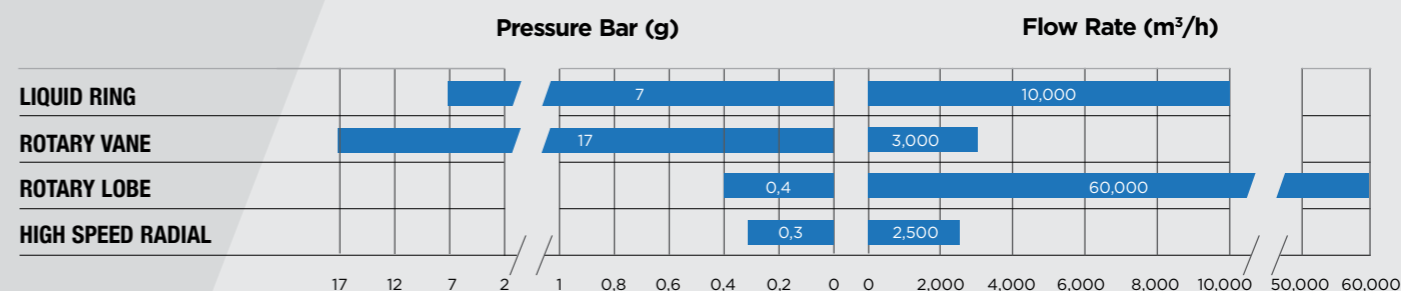
hibon

ROOTS



NASH

EMICO
WHEATON



Partner

Your Trusted Partner

Ingersoll Rand is a trusted partner in the hydrogen sector, backed by extensive R&D and engineering expertise. Our commitment to high-quality products, engineered-to-order solutions, and a customer-centric approach ensures that every step of the hydrogen process is supported by durable and efficient technology.

Clients benefit from a multi-technology offering, ensuring the right fit for every hydrogen challenge. Ingersoll Rand's integrated approach bypasses traditional limitations, providing efficient and cost-effective hydrogen technologies.

As the world moves forward in its fight against climate change, Ingersoll Rand's blowers, compressors and loading arms will continue to be vital components in the hydrogen infrastructure. Our role in ensuring the reliability and effectiveness of hydrogen generation, conversion, and transport makes them indispensable allies in the quest for a cleaner, more sustainable future.



www.ingersollrand.com/hydrogen

