

## Control Valve Solutions for Cleaner Hydrogen Energy



### Hydrogen Is Becoming a Trending Energy Carrier

Hydrogen is the most abundant element on earth and is seen as the fuel of the future as it does not emit carbon dioxide. The hydrogen industry is experiencing tremendous growth with governments and private organizations investing their time and efforts in developing new technologies to produce and use hydrogen in power generation, transportation, and as feedstock in refineries and petrochemical plants.

Emerson's extensive portfolio is designed to address the quality and performance needs required by customers within the growing hydrogen market.

With our solutions, customers can expect innovative, extensively tested, precise and reliable products designed for the most demanding hydrogen applications.

Moreover, Fisher™ control valves have been used for hydrogen services in Petrochemical and Refining industries for over 50 years. Emerson has solid application experience not only with materials and process needs based on various pressures and temperatures, but also with emergent technologies such as hydrogen electrolyzer.

**Hydrogen Value Chain**

Control valves are used throughout the entire hydrogen value chain, from production and transportation to end-use, since they are key to achieving plant efficiency. At Emerson, we have extensive experience in providing the optimal solution for control valve requirements.

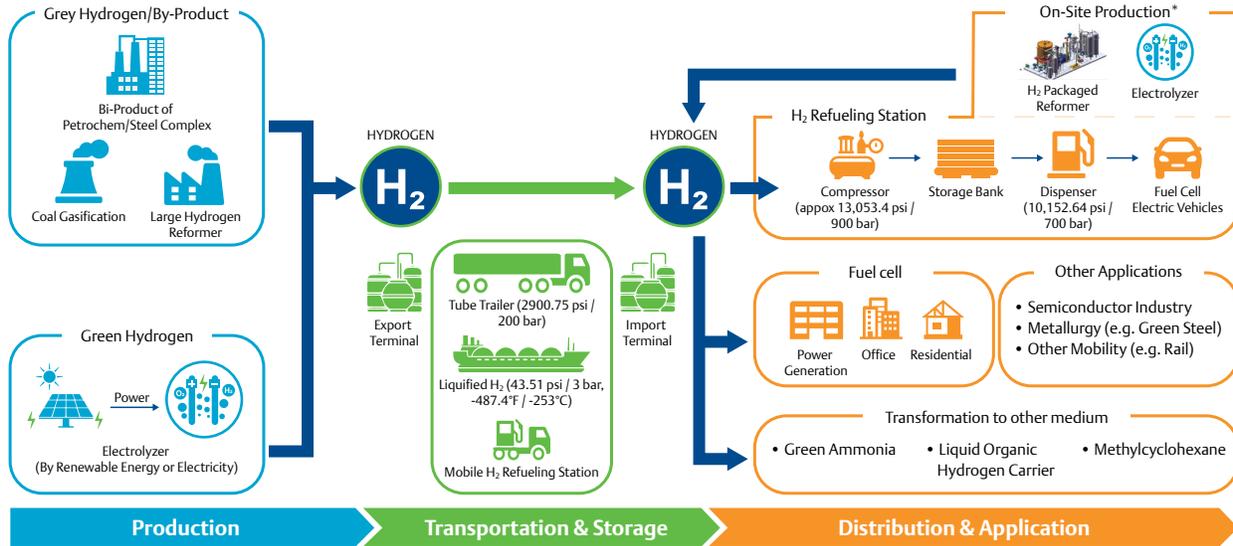


Figure 1. Hydrogen Value Chain Diagram

**Production Methods**

Hydrogen does not occur naturally in its free form as pure hydrogen; it is always combined with other elements and exists as water (H<sub>2</sub>O) or fossil fuels (CH<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>). Thus, a chemical process reaction is required to isolate it. In recent years, new technology has surfaced to enhance the chemical process, utilize different energy sources to reduce emissions, and achieve the most efficient and cleanest way to produce hydrogen.

The hydrogen produced is classified in the summary table below.

Source	Feed Stock / Energy Source	Technology	CO <sub>2</sub> Emission	Colour of Hydrogen
Water	Wind, Solar, Hydro, Geothermal	Electrolysis	Minimal	Green Hydrogen
	Nuclear			Pink Hydrogen
	Grid		Medium	Yellow Hydrogen
Fossil Fuels	Natural Gas / Coal	Reformer/Gasification + Carbon capture and storage	Low	Blue Hydrogen
	Natural Gas	Pyrolysis	Low	Turquoise Hydrogen
		Reformer	High	Grey Hydrogen
	Brown Coal	Gasification	High	Brown Hydrogen
Black Coal	Black Hydrogen			

Table 1. Production Methods



### Hydrogen Transportation

After production, there is a need for hydrogen to be transported to its intended end-use. There are three methods to do so when it is in its gaseous state:

1. Hydrogen gas can be compressed at a high pressure, e.g. 4351.13 psi / 300 bar, 7251.89 psi / 500 bar, or 10,152.64 psi / 700 bar, and transported in cylinders or tubes inside trucks.
2. It can be liquified at a temperature of  $-489.2^{\circ}\text{F}$  /  $-254^{\circ}\text{C}$  and transported in specially designed trucks or marine carriers.
3. Hydrogen gas can be converted into other stable form chemicals and transported using conventional transport systems (trucks and marine carriers).
  - a. React with nitrogen to form ammonia ( $\text{NH}_3$ )
  - b. React with an aromatic compound to form a liquid organic hydride

### Hydrogen End-Uses

Refineries, petrochemical complexes, steel plants and other industry segments that need hydrogen will transform to produce hydrogen in greener ways and continue to use it for their processes as a feedstock.

The transportation segment will use hydrogen when cars and trucks use fuel cell technology to generate electricity and power vehicles.

Hydrogen will be used in power generation. Today, there are two ways to utilize hydrogen in power generation. The first is to blend it with natural gas in power plants that run on gas-fired turbines. The second is to utilize fuel cell technology and produce power. In future, we can have gas turbines that run on 100% hydrogen.

**Emerson Control Valve Solutions for Hydrogen Value Chain**

Emerson has supplied Fisher and Baumann™ control valves for various segments within the hydrogen value chain for many years. The following table shows the different processes and recommended control valve solutions for each application in the hydrogen value chain.

UNIT	PROCESS	APPLICATION	GLOBE VALVES		ENGINEERED PRODUCTS		BUTTERFLY VALVES
			Baumann	Fisher GX	Fisher easy-e™	Fisher HP series	Fisher 8500 series
Steam methane reformer	Steam generation	Boiler feed water valve					
		Feed gas control valve					
	Reformer	Feed gas compressor anti-surge control valve					
		Reformer steam to natural gas ratio control valve					
	Shift convertor	Shift convertor temperature control valve					
		Convertor vent valve					
	Pressure swing adsorption - Hydrogen purification & separation	Feed gas valve					
		Dump/purge valve					
		Purge supply control valve					
	Carbon capture and storage	Final product / Re-pressurization valve	Final product / Re-pressurization valve				
Lean solvent feed valve							
Rich amine let down valve							
Steam generation		Lean solvent pump recirculation valve					
	Treated flue gas vent valve						
	Carbon dioxide compressor anti-surge control valve						
Green Hydrogen	Electrolysis - Alkaline water electrolysis, Polymer electrolyte membrane, Solid oxide electrolysis cell	Gas control valve (Hydrogen, Oxygen)					
		Electrolyte (Potassium hydroxide, Sodium hydroxide)					
	Electrolysis - Alkaline water electrolysis	Water control valves					
	Electrolysis - Polymer electrolyte membrane	Ultra pure water control valve					
	Electrolysis - Solid oxide electrolysis cell	Super heated steam valve					

**LEGEND:**

Proposed solution Noise Cavitation Noise and outgassing

Table 2. Key Applications and Emerson Solutions

UNIT	PROCESS	APPLICATION	GLOBE VALVES		ENGINEERED PRODUCTS		BUTTERFLY VALVES
			QR CODE		QR CODE		QR CODE
			Baumann	Fisher GX	Fisher easy-e	Fisher HP series	Fisher 8500 series
Liquefaction & storage		Hydrogen compression					
		General service utility valves					
		Gaseous nitrogen valves					
		Liquid nitrogen valves					
Transport - Ammonia	Syngas unit	Syngas flow control valve					
		Syngas compressor anti-surge valve					
	Ammonia reactor	Ammonia separator level control valve					
	Ammonia chiller unit	Refrigerant flow control valve					
	Ammonia chiller unit	Chiller level control valve					
	Flash drum	Ammonia let down valve					
Transport - liquid organic hydrogen carriers	Liquid organic hydrogen carrier (Hydrogenation: Toluene - Methylcyclohexane)	Feed gas control valve					
		Toluene gas control valve					
	Liquid organic hydrogen carrier (Dehydrogenation: Methylcyclohexane - Toluene)	Feed gas control valve					
		Toluene, Hydrogen gas control valve					
Compression station	Hydrogen compressor station	Hydrogen Pressure Control Valve					
	Electrolysis - Alkaline water electrolysis	Electrolyte (Potassium hydroxide, Sodium hydroxide)					
	Electrolysis - Alkaline water electrolysis	Water control valves					
	Electrolysis - Polymer electrolyte membrane	Ultra pure water control valve					

**LEGEND:**

Proposed solution Noise Cavitation Noise and outgassing

**Table 2. Key Applications and Emerson Solutions** (continued)

**Emerson's Sustainability Efforts**

Emerson is deploying environmental sustainability strategies and accelerating decarbonization across the globe. The company has established a target to reach net zero greenhouse gas (GHG) emissions by 2045. We support and enable our customers' decarbonization and environmental sustainability efforts through hydrogen.

**Emerson**

Marshalltown, Iowa, 50158 USA  
Sorocaba, 18087 Brazil  
Cernay, 68700 France  
Dubai, United Arab Emirates  
Singapore 128461 Singapore  
www.Emerson.com

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