

SmartFuel® hydrogen fueling stations for the material handling market



In a just-in-time marketplace, every hour spent changing, recharging and maintaining your forklifts' lead-acid batteries eats into productivity and profit. Now there's a no-downtime alternative. Hydrogen fuel cells for material handling vehicles replace lead-acid batteries and provide safe, clean and consistent power.



But how do you keep your hydrogen-powered vehicles on the go? The SmartFuel hydrogen fueling station, part of Air Products' hydrogen solutions portfolio, is the answer. Read on to find out how you can get superior performance from your equipment and increased productivity from your people.

Flexible fueling options for any size facility

With more than 50 years of hydrogen experience, we'll help you choose the fueling solution that's best for your material handling operation. Once you choose hydrogen, our team of engineers will work with you to get your station up and running safely and on schedule.

Hydrogen Supply – Air Products offers liquid and gaseous hydrogen delivery as well as on-site production from steam methane reformers and electrolyzers. Our engineers will help you evaluate the most cost-effective mode of supply for your facility and application.

SmartFuel S150 hydrogen fueling station – This option is designed for facilities that will use up to 100 kg of hydrogen per day. This system uses gaseous hydrogen compressors to prepare the hydrogen for dispensing.

SmartFuel S7000 hydrogen fueling station – This is the option for facilities that will use more than 100 kg of hydrogen per day. This system uses Air Products' proprietary liquid hydrogen pumps, which provide high throughput, low energy consumption and require a relatively small footprint as compared to gaseous compressors of the same flow rate. The S7000 is a great system for customers that expect to grow over time or have large peak demand periods for fuel.

Each station can have multiple dispensers installed in order to give you the most convenient and efficient refueling setup. Typically, at least two dispensers are installed to enhance reliability, and all stations offer comprehensive backup options.

How it works:

The SmartFuel hydrogen fueling station

There are four primary components to all hydrogen fueling stations—supply, compression, storage and dispensing. Hydrogen may be delivered as a liquid or a gas and can even be produced at the point of use. Delivery of liquid hydrogen in North America is the most common mode of supply for material handling customers. Liquid hydrogen is delivered by tanker trucks and stored outdoors in vertical or horizontal tanks. The system vaporizes the liquid hydrogen and compresses the gas to ~7,000 psi. This high-pressure gas is stored in steel or composite tubes that are connected to the indoor SmartFuel hydrogen dispenser.

When a forklift pulls up to the dispenser, the driver simply connects the filling nozzle to the forklift's fuel cell, and the dispenser does the rest. A valve is opened at the high-pressure storage tubes, and the gas flows indoors through the dispenser and into the lower-pressure tank on the forklift. As the forklift's tank fills, the dispenser monitors the tank's pressure and automatically stops when the tank is full.

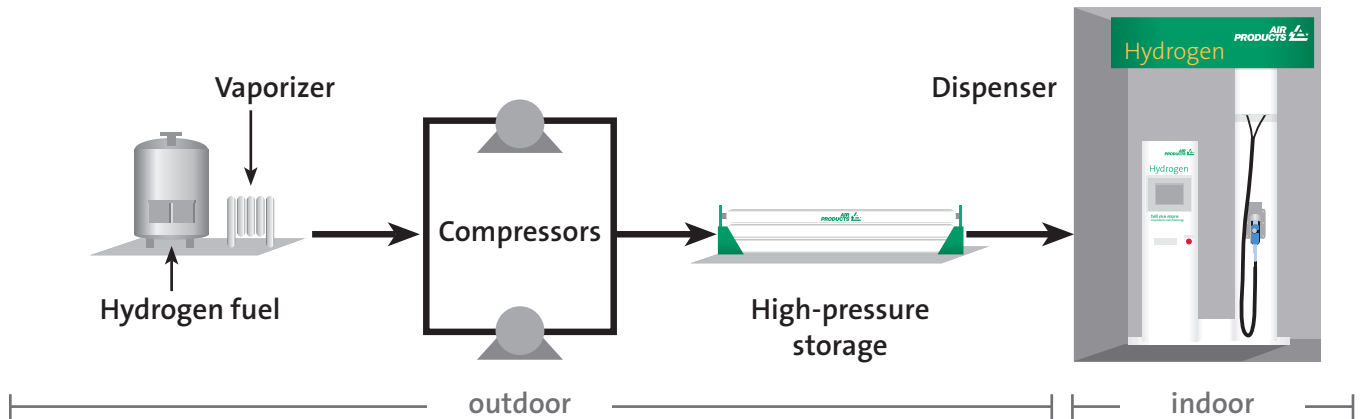


Commitment to fueling station reliability

Air Products understands that the reliability of your hydrogen fueling station is critical to uninterrupted performance of your fuel cell-powered material handling equipment. Since we installed our first material handling station in 2007, our operations team has maintained 100% supply of hydrogen to our customers' dispensers. How have we done that? By employing a multifaceted approach to ensuring reliability that includes:

- Multiple production facilities in order to help ensure uninterrupted supply.
- The broadest range of backup supply options in the industry, including the ability to deliver high-pressure hydrogen directly to the storage tubes at the fueling station. This capability is critical to supplying hydrogen to dispensers during unplanned outages of supply or compression equipment.
- Customer Service that's available 24/7 for help with deliveries, equipment and other emergencies. In fact, a dedicated team monitors our fueling stations, proactively contacts customers and dispatches technicians when a problem is detected.
- Fueling station equipment designed for reliable operations. Redundant compressors, dispensers and other critical equipment are installed to ensure uninterrupted supply.
- Comprehensive preventive maintenance programs to minimize unplanned equipment failures. Ongoing continuous improvement programs identify opportunities for optimized performance of all SmartFuel hydrogen fueling stations.
- Committed, highly trained operations personnel deployed throughout North America. These employees live within driving distance of our customers and become close allies to ensure rapid and dependable service.

Typical SmartFuel S150 Configuration



Components of a SmartFuel hydrogen fueling station

Hydrogen fuel is available in liquid and gas form. Liquid tank sizes range from 1,500 to 25,000 gallons.

The **vaporizer** converts liquid hydrogen to a gas.

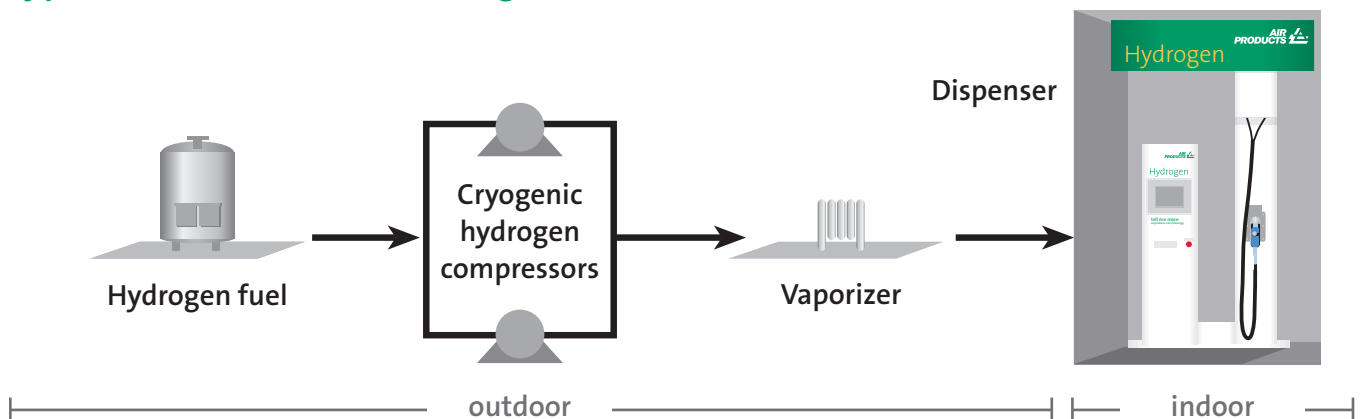
The **compressors** increase the pressure of the hydrogen gas to ~7,000 psi for

storage prior to dispensing. Compression of liquid hydrogen in cryogenic pumps requires less energy and requires a smaller footprint than gaseous compressors.

Steel or composite vessels for **high-pressure storage** safely store the hydrogen gas at ~7,000 psi.

A familiar hose-and-nozzle **dispenser** automatically fills the vehicle's fuel cell with hydrogen gas at a pressure of ~5,000 psi (350 bar). Air Products' dispensers are designed for safe, reliable operation.

Typical SmartFuel S7000 Configuration



**Handle it with hydrogen.
We'll show you how.**

With more than 50 years of hydrogen experience, Air Products is at the forefront of hydrogen energy technology development. The company has an extensive patent portfolio in hydrogen dispensing technology.

Air Products has also placed over 150 hydrogen fueling stations worldwide. Cars, trucks, vans, buses, scooters, forklifts, locomotives, planes, cell towers, material handling equipment and even submarines have been fueled with trend-setting technologies that involve Air Products' know-how, equipment and hydrogen.



Turn to Air Products for:

- Unmatched experience in hydrogen production, distribution and dispensing
- Reliable and safe gas supply from the largest hydrogen producer in the world
- Complete fueling infrastructure from supply to dispensing
- 24/7 customer service, anywhere in the United States
- Full compliance with NFPA 52: Dispenser is third-party certified by MET Labs
- 100% onstream supply since 2007

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