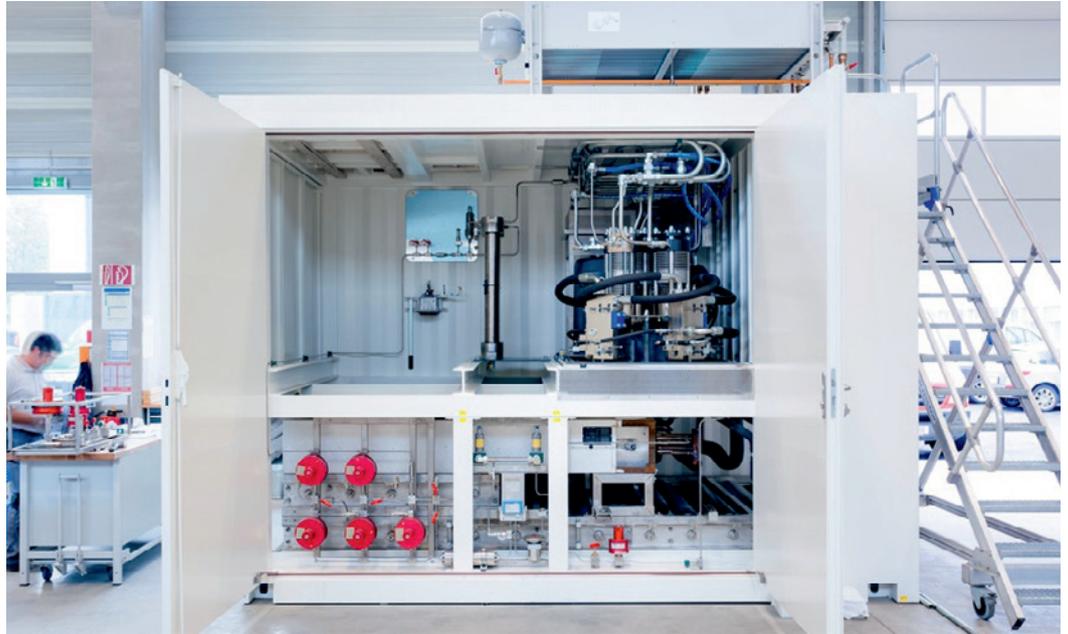


Hydrogen technologies.

The ionic compressor IC90 (90 MPa).



Ionic compressor IC90

Description Ionic compression technology leads the way to the next generation of hydrogen fuelling. It is a high-performance solution that has an approved design and is easy to operate. It allows for quick, safe, highly efficient and economical fuelling of hydrogen vehicles at 35 or 70 MPa.

The basic principle is the replacement of the conventional metal piston with a specially designed, nearly incompressible ionic liquid. The gas is compressed in the cylinder by the up-and-down motion of the liquid column, similar to the reciprocating motion of an ordinary piston. The ionic compression technology has been approved and is already in operation at several hydrogen fuelling stations around the world. The IC90 uses a five-stage compression concept which meets the latest SAE J 2601 fuelling standard and allows for continuous, fast and high-performance fuelling of hydrogen vehicles at considerably reduced operating costs.

Design The setup consists of either a cryogenic liquid or compressed gaseous hydrogen tank, or an on-site production unit for hydrogen supply. The compression station is built into a transportable steel container. The electrical system and the compressor/storage compartments are separated by a gas-tight wall. All controls and electrical power switch gear are located in the electronics compartment. A pressure discharge vent is located in the roof of the gas compartment.

In order to use stored pressure and compressor capacity in the most cost-efficient manner, the station has a three-bank cascade system. It consists of three pressure storage banks (buffer sections), in which the hydrogen for the fuelling is stored. Subsequently, the fuelling can be carried out through Linde's external 35/70-MPa hydrogen dispenser.

Fuelling The initial vehicle pressure is determined by a test pulse. Based on this test measurement and taking the ambient and hydrogen temperature into account, the final vehicle target pressure is calculated. The fuelling process starts with the equalisation of the low-pressure bank, followed by the equalisation of the medium-pressure and the high-pressure bank. The selection of the bank system is based on the pressure ramp.

After fuelling, the station automatically switches to recharge mode and fills the 100-MPa storage banks. The specific energy required for 70-MPa fuelling is 2.7 kWh/kg (including cooling, depending on inlet pressure). All vehicles are fuelled with pressure ramp rise control over the fuelling rate, according to SAE J 2601 specifications. The quantity of hydrogen dispensed is recorded using a mass flow meter with support for standard trading systems.

Control and automation system

- Safe and fast fuelling is achieved by a PLC-based automation system:
- Optimised software reflecting the experience of numerous fuellings
 - A touch-panel-based operator system is used to monitor all processes
 - Online access to the entire control system and data acquisition are supported
 - Remote diagnostics and maintenance is part of the operating strategy

Safety concept

- Designed and built according to global technical standards, Linde's ionic compressor is adapted to region-specific codes and standards (e.g. US, EU). Linde's hydrogen safety concept for vehicle fuelling includes:
- Initial pulse and hold, then continuous leak testing of the vehicle during fuelling
 - All hydrogen components are located in a gas-tight compartment
 - Hydrogen gas detection in confined areas, earthquake detection
 - Automatic emergency shutdown (ESD) shuts down station, hydrogen supply and any co-located fuel supplies
 - Ultra-low cold-fill technology allows for fast-fill fuelling and prevents overheating of vehicle storage systems

Technical data

	Compressor station
Dimensions (L x W x H)	4.2 x 2.7 x 2.6 m (14-ft container)
Weight	17.5 t
Electrical requirements – system	105 kW
Noise level	75 dB(A) in 5 m
Inlet pressure	0.5 to 20 MPa
Approx. throughput, single line (maximum)	33.6 kg/h
Approx. throughput, double line (maximum)	67.2 kg/h
Maximum operating pressure	100 MPa
Target fuelling pressure	70 MPa at 15 °C
Ambient operating temperature	-30 °C to 45 °C
Energy requirement at 70 MPa (depending on inlet pressure)	2.7 kWh/kg H ₂ from 0.5 to 90 MPa
	Dispenser
Flow rate measuring	Mass flow meter
Maximum flow rate	60 g/s at 35 MPa, 60 g/s at 70 MPa
35-MPa maximum delivery pressure	43.9 MPa
70-MPa maximum delivery pressure	87.6 MPa
Nozzle temperature at 70 MPa	-40 °C
Fuelling protocol	SAE J 2601
Fuelling nozzles	Various options (including IRDA)

Competitive advantages

- Close to 100 percent energy conversion efficiency
- Low energy consumption
- Very small number of moving parts
- Reduced wear and long service life
- Little maintenance effort and low costs
- Low material costs
- Low noise emission
- Conformity with newest fuelling standard SAE J 2601

Linde AG

Linde Gases Division, Seitnerstrasse 70, 82049 Pullach, Germany
 Phone +49.89.7446-0, Fax +49.89.7446-1230, www.linde-gas.com