HYDROGEN INFRASTRUCTURE SOLUTIONS
THE LOHC COMPANY

A hydrogen fueled society
– truly sustainable and emission-free.

The Hydrogenious LOHC Technologies GmbH is a pioneer and global industry leader in the field of hydrogen storage in Liquid Organic Hydrogen Carrier (LOHC) materials. The patented technology enables safe and efficient storage of hydrogen in an easily transportable oil, thus eliminating the need for pressurized hydrogen tanks.
Hydrogen is a central vector in a future renewable energy system. But it is also the smallest and the lightest molecule, making its storage and transport difficult and inefficient.

The LOHC technology changes the way we handle hydrogen! Liquid Organic Hydrogen Carriers (LOHC) are liquid oils that can chemically store hydrogen at high storage densities under ambient conditions. Our LOHC oil enables high-capacity hydrogen transport in the existing infrastructure for fossil fuels. The LOHC oil is hardly flammable and non-explosive eliminating the risk of large-scale hydrogen storage and transport.
THE LOHC MATERIAL

SAFE
- No molecular hydrogen
- Hardly flammable and non-explosive, even when loaded with hydrogen

EASY
- Ambient storage conditions
- Handling of a liquid oil from -39 °C to 90 °C
- Transportable in existing infrastructure for fossil fuels

EFFICIENT
- High storage density of 630 Nm³H₂/m³ LOHC
- No self-discharge over time
- High cycle stability of carrier liquid
THE LOHC CONCEPT

• Dehydrogenation: Chemical release of hydrogen molecules from the LOHC via a continuous catalytic process
• Endothermic reaction requires about 12 kWh$_{th}$/kgH$_2$ heat at ~300 °C

• Hydrogenation: Chemical bonding of hydrogen molecules to the LOHC via a catalytic reaction in a continuous process
• Exothermic reaction at 30 bar, generating about 9 kWh$_{th}$/kgH$_2$ heat at >200 °C
HYDROGEN HANDLING MADE EASY

HYDROGEN GENERATION

- Steam methane reforming
- Coal gasification
- By-product hydrogen
- Hydrogen-rich gases

INDUSTRIAL HYDROGEN

RENEWABLE ENERGIES

- Wind
- Solar
- Hydro
- Biomass

ELECTROLYSIS

HYDROGEN UTILIZATION

- Flat glass production
- Metal refining
- Chemical processes
- Fertilizer production

INDUSTRY SUPPLY

HYDROGEN REFUELING

- Large capacity hydrogen refueling stations
  - Bus depots
  - Captive fleets
  - Trains & Trams
THE STORAGE UNIT

- Optimized for continuous hydrogen storage in LOHC
- Ideal for large-scale hydrogen storage processes
- Easy hydrogen logistics and low operating costs

THE RELEASE UNIT

- High safety and flexible hydrogen storage capacity
- Ideal for medium to large-scale hydrogen demand
- Reduced footprint and easy on-site installation

Mid - to - large scale hydrogen storage from industrial and renewable sources

Hydrogen supply for H₂ refueling stations, chemicals, agriculture, metals, glass, electronics, pharmaceutics, food, etc.
The Storage Unit is designed to store hydrogen in the LOHC oil. The process is optimized for continuous operation and high efficiencies. During the exothermic storage reaction high-temperature heat is produced, which can be used on-site. Depending on the required storage capacity, the systems are available as containerized (C-Series) and skid-based (S-Series) solutions. From StorageBOX to StoragePLANT we have the right product to meet our customer’s demands.

LOHC Hydrogenation
Chemical bonding of hydrogen molecules to the liquid carrier oil

THE STORAGE UNIT
THE STORAGE UNIT

Key Benefits

- Optimized for continuous hydrogen storage in LOHC
- Ideal for large-scale hydrogen infrastructure
- Designed for long-life operations and low maintenance
- High safety and high hydrogen storage capacity
- Low footprint and easy on-site installation

C-SERIES
Containerized systems for medium scale projects and application piloting

KEY FEATURES
- Easy on-site installation
- Predefined footprint
- Marginal site preparation

S-SERIES
Skid-mounted systems for large-scale hydrogen storage

KEY FEATURES
- Large-scale industrial design
- Designed for direct coupling with SMR or large-scale electrolysis
# C-SERIES

## The StorageBOX

### BASIC CONFIGURATION

<table>
<thead>
<tr>
<th>StorageBOX 10</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen capacity*</td>
<td>10 Nm³/h // 0.9 kgH₂/h</td>
</tr>
<tr>
<td>LOHC production*</td>
<td>20 l/h</td>
</tr>
<tr>
<td>Heat demand*</td>
<td>9 kW&lt;br&gt;</td>
</tr>
<tr>
<td>Load range</td>
<td>50 – 100 %</td>
</tr>
</tbody>
</table>

* under nominal load

| **Footprint** | 20 foot container |
| **Inlet hydrogen stream** | 30 – 50 bar, 99.99 % purity |
| **Inlet LOHC stream** | ≥ 0.1 barg, T ≥ 15 °C |
| **Power connection** | 400 V AC, 3 phase, 50 Hz |

# S-SERIES

## The StoragePLANT

### BASIC CONFIGURATION

<table>
<thead>
<tr>
<th>StoragePLANT 5tpd</th>
<th>StoragePLANT 12tpd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen capacity*</td>
<td>5 t/d // 210 kgH₂/h</td>
</tr>
<tr>
<td>LOHC production*</td>
<td>4500 l/h</td>
</tr>
<tr>
<td>Heat production*</td>
<td>1900 kW&lt;br&gt;</td>
</tr>
<tr>
<td>Load range</td>
<td>30 – 100 %</td>
</tr>
</tbody>
</table>

* under nominal load

| **Footprint** | Skid-based |
| **Inlet hydrogen stream** | 30 – 50 bar, 99.99 % purity |
| **Inlet LOHC stream** | ≥ 0.1 barg, T ≥ 15 °C |
| **Power connection** | 400 V AC, 3 phase, 50 Hz |
The Release Unit is designed to release hydrogen from the LOHC oil. The process is optimized for continuous operation and long-term stability. The endothermic hydrogen release process requires heat, which can be supplied by high-temperature waste-heat, natural gas, electricity or hydrogen. The systems are available as easy to install containerized systems (C-Series) and skid mounted solutions (S-Series), ideal for hydrogen refueling stations and industrial supply.
THE RELEASE UNIT

Key Benefits

C-SERIES

- Containerized systems for medium scale projects and application piloting
- Key Features
  - Easy on-site installation
  - Predefined footprint
  - Marginal site preparation

S-SERIES

- Skid-mounted systems for large-scale hydrogen release
- Key Features
  - Large-scale skid mounted design
  - Designed for industrial processes and large hydrogen refueling stations

Optimized for continuous high purity hydrogen release from LOHC
Ideal for medium to large-scale hydrogen demand
High safety and high hydrogen storage capacity
Low footprint and easy on-site installation
Underground storage at hydrogen refueling stations possible
# C-SERIES

## The ReleaseBOX

### BASIC CONFIGURATION

<table>
<thead>
<tr>
<th>ReleaseBOX 10</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrogen outlet</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10 Nm³/h // 0.9 kg₃/H₂/h</td>
<td></td>
</tr>
<tr>
<td><strong>LOHC demand</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20 l/h</td>
<td></td>
</tr>
<tr>
<td><strong>Heat demand</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12 kW&lt;sub&gt;th&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td><strong>Load range</strong></td>
<td>50 – 100 %</td>
<td></td>
</tr>
</tbody>
</table>

*under nominal load

| **Footprint** | 30 foot container | |
| **Inlet LOHC stream** | ≥ 0.1 barg, T ≥ 15 °C | |
| **Power connection** | 400 V AC, 3 phase, 50 Hz | |

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# S-SERIES

## The ReleasePLANT

### BASIC CONFIGURATION

<table>
<thead>
<tr>
<th>ReleasePLANT 1.5tpd</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrogen outlet</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.5 t/d // 65 kg₃/H₂/h</td>
<td></td>
</tr>
<tr>
<td><strong>LOHC demand</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1400 l/h</td>
<td></td>
</tr>
<tr>
<td><strong>Heat demand</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>780 kW&lt;sub&gt;th&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td><strong>Load range</strong></td>
<td>50 – 100 %</td>
<td></td>
</tr>
</tbody>
</table>

*under nominal load

| **Footprint** | Skid-based | |
| **Inlet LOHC stream** | ≥ 0.1 barg, T ≥ 15 °C | |
| **Power connection** | 400 V AC, 3 phase, 50 Hz | |
If the subsequent process or hydrogen consumer can handle a certain amount of impurities we can operate the Release Unit with a maximized hydrogen outlet stream. The **HYDROGEN 4.0** option ensures hydrogen quality of ≥99.99%.

**HYDROGEN 5.0** In case of higher requirements regarding the hydrogen quality, we offer the **HYDROGEN 5.0** upgrade option with a hydrogen quality of ≥99.999%.

In case of using the released hydrogen as a fuel, e.g. for fuel cell vehicles, we can deliver a fuel grade hydrogen according to ISO 14687.2-2012 and SAE J2719. This **FUEL GRADE** upgrade will be integrated into the Release Unit.

**THE RELEASE UNIT OPTIONS // H₂**

**HYDROGEN OUTLET** purity

**HYDROGEN 4.0**

If the subsequent process or hydrogen consumer can handle a certain amount of impurities we can operate the Release Unit with a maximized hydrogen outlet stream. The **HYDROGEN 4.0** option ensures hydrogen quality of ≥99.99%.

**HYDROGEN 5.0**

In case of higher requirements regarding the hydrogen quality, we offer the **HYDROGEN 5.0** upgrade option with a hydrogen quality of ≥99.999%.

**FUEL GRADE**

In case of using the released hydrogen as a fuel, e.g. for fuel cell vehicles, we can deliver a fuel grade hydrogen according to ISO 14687.2-2012 and SAE J2719. This **FUEL GRADE** upgrade will be integrated into the Release Unit.

**THE RELEASE UNIT OPTIONS // H₂**

**HYDROGEN OUTLET** pressure

**LIGHT PRESSURE 10 bar**

The Release Unit operates at low pressures. For pressure requirements of up to 10 bar at the terminal point we offer our **LIGHT PRESSURE** upgrade. This option will be fully integrated into our Release Unit.

**MEDIUM PRESSURE 50 bar**

If the requested pressure exceeds a level of 10 bar, you can choose the **MEDIUM PRESSURE** upgrade which ensures hydrogen pressures of up to 50 bar at the terminal point of our Release Unit.

**HIGH PRESSURE 100 bar**

In order to use the released hydrogen for refueling of vehicles, high hydrogen pressures at the HRS (e.g. 350 or 700 bar) are required. For these purposes, we can provide a **HIGH PRESSURE UPGRADE** which ensures a hydrogen pressure of 100 bar at the terminal point of our Release Unit.
Bound to LOHC, hydrogen is stored at ambient temperature and without the need of pressurized or cryogenic vessels. Due to the liquid state and the diesel-like properties of our LOHC, the material is stored and distributed with existing mineral oil fuel infrastructure. Our LOHC is hardly flammable and non-explosive. By using standard oil infrastructure solutions, LOHC entails a cost-effective way to store and transport particularly large amounts of hydrogen in a very safe and efficient way.
TANK SYSTEMS

On-Site Storage Tank

With our expertise in LOHC technology we will provide you with the perfect storage concept for your hydrogen storage or supply demand with fully flexible hydrogen storage capacities up to multi-ton hydrogen storage in standard oil tanks.

BASIC REQUIREMENTS

<table>
<thead>
<tr>
<th>Wall</th>
<th>Double-walled or collecting tray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell material</td>
<td>No special requirements</td>
</tr>
<tr>
<td>Valves, gauges</td>
<td>PTFE, FFKM</td>
</tr>
<tr>
<td>Pressure</td>
<td>Atmospheric or slight overpressure (&lt;0.5 barg)</td>
</tr>
<tr>
<td>Inertisation</td>
<td>Inert gas (e.g. nitrogen)</td>
</tr>
<tr>
<td>Mandatory meters</td>
<td>Continuous level indicator, thermometer</td>
</tr>
<tr>
<td>Configuration</td>
<td>Manlid, bottom outlet, top outlet, pressure relief valve, full drainability</td>
</tr>
<tr>
<td>Options</td>
<td>Heating, baffles, compartments, insulation</td>
</tr>
</tbody>
</table>

Logistics and Refueling Options

The existing infrastructure of conventional fuel transportation concepts can be used to handle our LOHC material. If your on-site situation allows stationary storage tanks, you can use conventional tank trucks to deliver LOHC and refuel the on-site tanks. Alternatively we can supply you with swap body containers to transport the LOHC in batches and store it on-site.

IBC Container
1 to 3 m³

Swap Body Container
10 to 24 m³

Stationary Tank
10 to 100 m³

Underground Storage
> 10 m³

Tank Truck
15 to 30 m³

Tank Trailer
15 to 30 m³

Swap Body Container
10 to 24 m³

Underground Storage
> 10 m³