THE LOHC COMPANY
The Hydrogenious 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.
THE LOHC TECHNOLOGY
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 (dibenzyltoluene) 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.

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 CONCEPT
- Hydrogenation: Chemical bonding of hydrogen molecules to the LOHC via a catalytic reaction in a continuous process
- Exothermic reaction at 30 bar, generating about $9 \text{ kWh}_{\text{th}}/\text{kg}_{\text{H}_2}$ heat at $>200 \degree \text{C}$

HYDROGEN STORAGE

- Dehydrogenation: Chemical release of hydrogen molecules from the LOHC via a continuous catalytic process
- Endothermic reaction requires about $11 \text{ kWh}_{\text{th}}/\text{kg}_{\text{H}_2}$ heat at $\sim300 \degree \text{C}$
- On-demand hydrogen release with high hydrogen purity
THE LOHC MATERIAL
SAFE

- No molecular hydrogen
- Hardly flammable and non-explosive, even when loaded with hydrogen
- Non-toxic and not classified as hazardous good (ADR, etc.)

EASY

- Ambient storage conditions
- Handling of a liquid oil from -39 °C to 390 °C
- Transportable in existing infrastructure for fossil fuels

EFFICIENT

- High storage density of $630 \text{Nm}^3_{\text{H}_2}/ \text{m}^3_{\text{LOHC}}$
- No self-discharge over time
- High cycle stability of carrier liquid
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 HANDLING MADE EASY
HYDROGEN UTILIZATION

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

INDUSTRY SUPPLY

MOBILITY

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

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

- Optimized for continuous hydrogen storage in LOHC
- Ideal for large-scale hydrogen storage processes
- Easy hydrogen logistics and low operating costs
→ High safety and flexible hydrogen storage capacity
→ Ideal for medium to large-scale hydrogen demand
→ Low footprint and easy on-site installation

THE RELEASE UNIT

Hydrogen supply for H₂ refueling stations, chemicals, agriculture, metals, glass, electronics, pharmaceuticals, food, etc.
LOHC Hydrogenation
Chemical bonding of hydrogen molecules to the liquid carrier oil.

THE STORAGE UNIT

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.

- 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></th>
<th>StorageBOX 10</th>
<th>StorageBOX 100</th>
<th>StorageBOX 150</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrogen uptake</strong></td>
<td>10 Nm³/h // 0.9 kg₇₉/h</td>
<td>100 Nm³/h // 9 kg₇₉/h</td>
<td>150 Nm³/h // 13.5 kg₇₉/h</td>
</tr>
<tr>
<td><strong>LOHC production</strong>₉</td>
<td>16 l/h</td>
<td>160 l/h</td>
<td>240 l/h</td>
</tr>
<tr>
<td><strong>Heat production</strong>₉</td>
<td>8 kW₉</td>
<td>80 kW₉</td>
<td>120 kW₉</td>
</tr>
<tr>
<td><strong>Load range</strong></td>
<td>50…100 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

₉ under nominal load

<p>| | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Footprint</strong></td>
<td>10 foot container</td>
<td>20 foot container</td>
<td>20 foot container</td>
</tr>
<tr>
<td><strong>Inlet hydrogen stream</strong></td>
<td>30…50 bar, 99.99 % purity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inlet LOHC stream</strong></td>
<td>≥0.1 barg, T ≥ 15 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power connection</strong></td>
<td>400 V AC, 3 phase, 50 Hz</td>
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</tbody>
</table>
S-SERIES
The StoragePLANT

BASIC CONFIGURATION

<table>
<thead>
<tr>
<th></th>
<th>StoragePLANT 500</th>
<th>StoragePLANT 1500</th>
<th>StoragePLANT 5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen uptake(^a)</td>
<td>500 Nm(^3)/h // 45 kg(_{\text{H}_2})/h</td>
<td>1500 Nm(^3)/h // 135 kg(_{\text{H}_2})/h</td>
<td>5000 Nm(^3)/h // 450 kg(_{\text{H}_2})/h</td>
</tr>
<tr>
<td>LOHC production(^a)</td>
<td>800 l/h</td>
<td>2400 l/h</td>
<td>8000 l/h</td>
</tr>
<tr>
<td>Heat production(^a)</td>
<td>400 kW(_{\text{th}})</td>
<td>1200 kW(_{\text{th}})</td>
<td>4000 kW(_{\text{th}})</td>
</tr>
<tr>
<td>Load range</td>
<td>50…100 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) under nominal load

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), ideal for hydrogen refueling stations and industrial supply. Larger, skid-based solutions are currently under development and will be brought to the market soon.

**LOHC Dehydrogenation**
Release of hydrogen molecules from the liquid carrier oil.

**THE RELEASE UNIT**

- 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
Containerized systems for medium scale projects and application piloting.

KEY FEATURES

→ Easy on-site installation
→ Predefined footprint
→ Marginal site preparation
# C-SERIES

## The ReleaseBOX

### BASIC CONFIGURATION

<table>
<thead>
<tr>
<th></th>
<th>ReleaseBOX 10</th>
<th>ReleaseBOX 150</th>
<th>ReleaseBOX 250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen outlet&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10 Nm&lt;sup&gt;3&lt;/sup&gt;/h // 0.9 kg&lt;sub&gt;H2&lt;/sub&gt;/h</td>
<td>150 Nm&lt;sup&gt;3&lt;/sup&gt;/h // 13.5 kg&lt;sub&gt;H2&lt;/sub&gt;/h</td>
<td>250 Nm&lt;sup&gt;3&lt;/sup&gt;/h // 22.5 kg&lt;sub&gt;H2&lt;/sub&gt;/h</td>
</tr>
<tr>
<td>LOHC demand&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16 l/h</td>
<td>240 l/h</td>
<td>400 l/h</td>
</tr>
<tr>
<td>Heat demand&lt;sup&gt;c&lt;/sup&gt;</td>
<td>10 kW&lt;sub&gt;m&lt;/sub&gt;</td>
<td>150 kW&lt;sub&gt;m&lt;/sub&gt;</td>
<td>250 kW&lt;sub&gt;m&lt;/sub&gt;</td>
</tr>
<tr>
<td>Load range</td>
<td>50...100 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> under nominal load

<p>| | | | |</p>
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<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Footprint</td>
<td>20 foot container</td>
<td>30 foot container</td>
<td>40 foot container</td>
</tr>
</tbody>
</table>

<p>| | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Inlet LOHC stream</td>
<td>≥0.1 barg T ≥ 15 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power connection</td>
<td>400 V AC, 3 phase, 50 Hz or 480 V AC, 3 phase, 60 Hz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## THE RELEASE UNIT OPTIONS // \( \text{H}_2 \)

### HYDROGEN OUTLET purity

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYDROGEN 4.0</td>
<td>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 ( \geq 99.99% ).</td>
</tr>
<tr>
<td>HYDROGEN 5.0</td>
<td>In case of higher requirements regarding the hydrogen quality, we offer the HYDROGEN 5.0 upgrade option with a hydrogen quality of ( \geq 99.999% ).</td>
</tr>
<tr>
<td>FUEL GRADE</td>
<td>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.</td>
</tr>
</tbody>
</table>
## THE RELEASE UNIT OPTIONS // \( \text{H}_2 \)

### HYDROGEN OUTLET pressure

<table>
<thead>
<tr>
<th>Option</th>
<th>Pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIGHT PRESSURE</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>MEDIUM PRESSURE</strong></td>
<td>50</td>
</tr>
<tr>
<td><strong>HIGH PRESSURE</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

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.

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.

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.
LOHC TANK & LOGISTICS
Bound to LOHC, hydrogen can be stored at ambient temperature and without the need of a pressurized or cryogenic vessels. Due to the liquid state and the diesel-like properties of our LOHC, the material can be 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.
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 capacity up to multiple-ton hydrogen storage in standard oil tanks.

### BASIC REQUIREMENTS

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

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IBC CONTAINER 1 to 3 m³

SWAP BODY CONTAINER 10 to 24 m³

STATIONARY TANKS 10 to 100 m³

UNDERGROUND STORAGE > 10 m³
LOGISTICS AND REFUELLING OPTIONS

The existing infrastructure of conventional fuel transportation concepts can be used to handle our LOHC hydrogen carrier 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 within the swap body container.

<table>
<thead>
<tr>
<th>TANK TRUCK</th>
<th>15 to 30 m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>TANK TRAILER</td>
<td>15 to 30 m³</td>
</tr>
<tr>
<td>SWAP BODY CONTAINER</td>
<td>10 to 24 m³</td>
</tr>
</tbody>
</table>