„DLR-Wabentank – Shape Adaptable and Modular CNG Storage“
07.11.2014, Magna-Helmholtz Research Day, Bad Homburg

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1. Social Challenge

- We are reaching the limits of oil extraction
- Climate change is taking place
- Growing population, concentrated in megacities

Vehicle Concepts

- Lower energy consumption
- Reduced CO₂ emissions by using CNG
- Reduce NOₓ emissions by using CNG
- Alternative and renewable energy sources
- …
2. CNG as a mid-term possibility

- By using CNG (100% biomethane) as a sustainable and low emission fuel a low emission future is possible
- Why is CNG barely in use?
3. Technology

Tanks with a wide range of packaging variations are needed and an enabler for CNG-Vehicles

State of the Art

<table>
<thead>
<tr>
<th></th>
<th>CNG 1</th>
<th>CNG 2</th>
<th>CNG 3</th>
<th>CNG 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liner</td>
<td>Metal</td>
<td>metallic</td>
<td>metallic</td>
<td>Non metallic</td>
</tr>
<tr>
<td>Winding</td>
<td>-</td>
<td>Hoop wrapped</td>
<td>Fully wrapped</td>
<td>Fully wrapped</td>
</tr>
</tbody>
</table>

Innovation through ➔ lightweight material

Basic Concept – DLR-Patent

Innovation through ➔ design

Variability in the use of the available space

-Mercedes Benz E-Class: -ca. + 38% Volume demonstrated
3. Technology – DLR-Wabentank
A hybrid and shape adaptable high pressure storage

Shape adaptable, modular construction leads to significant volume gain (> 30% possible)
4. New Production Approach Type 3
Modular and Fully Scalable High Pressure Storage

Aluminum production → Welding each cell → Winding each cell → Assembly → 3D-Winding

4. New Production Approach Type 3
Modular and Fully Scalable High Pressure Storage

Aluminium production

Welding each cell

Winding each cell

Assembly

3D-Winding
## 5. Project Progress

<table>
<thead>
<tr>
<th>Progress</th>
<th>Validated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liner</strong></td>
<td>• Gas tight&lt;br&gt;• Strain at failure OK</td>
</tr>
<tr>
<td><strong>Monocells</strong></td>
<td>• Burstpressure&lt;br&gt;• Pressure cycles</td>
</tr>
<tr>
<td><strong>Winding non-rotational cells</strong></td>
<td>• Non rotation-symmetric winding</td>
</tr>
<tr>
<td><strong>Gas-connector</strong></td>
<td>• Burstpressure&lt;br&gt;• Pressure cycles</td>
</tr>
<tr>
<td><strong>3D-Winding</strong></td>
<td>• Validated in Oktober 2014</td>
</tr>
</tbody>
</table>
6. DLR-Patent Potential

- The production of the first modular-free-shapeable CNG tank

\[
\begin{align*}
\rightarrow \text{Increasing range} & = +15\% \ (2 \text{ vessels}) \\
\rightarrow \text{m/V} & = +30\% \ (\text{vehicle}) \\
\rightarrow \text{€} & = \text{ca.} \ 0,46\text{kg/l} \\
\rightarrow \text{€} & = \text{ca.} 18\text{€/l} \ (\text{first calculations})
\end{align*}
\]

- DLR-Patent is able to be incorporated at any stage in the vehicle development process
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