Fuel Cell Application in Material Handling for a Green Warehouse


Dr. Ewald Wahlmüller
Fronius International GmbH
Research Energy Cell
Günter Fronius Str. 1
4600 Wels-Thalheim, Austria

Hannes Schöbel
Linde Material Handling GmbH
Innovative Drives
Carl-von-Linde-Platz
63743 Aschaffenburg, Germany

WE HAVE THREE DIVISIONS
AND ONE PASSION:
SHIFTING THE LIMITS.
FRONIUS - WHAT WE DO

We create new technologies and solutions for monitoring and controlling energy by shifting the limits of what is possible.

BATTERY CHARGING SYSTEMS
Economical, flexible, unique

SOLAR ELEKTRONICS
We must revolutionise the energy supply of our planet

WELDING TECHNOLOGY
We master the arc like no other
<table>
<thead>
<tr>
<th>Product Family</th>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fronius Energy Cell Product Family</td>
<td>EC 25/50F</td>
<td>PEM FC 2/4 kW 24/48VDC</td>
</tr>
</tbody>
</table>
| | EC Home / Backup | PEM FC 2,6 kW 48VDC  
PEM Elektrolyse  
8kW 48VDC / 400VAC  
165bar, 80°C |
| | HyLOG Fleet 26F | PEM FC – Batterie Hybrid 2.6/11 kW 24VDC |

- Serial production / Market development
- Product development / Pilot installations
- Pilot production / Demonstration
WHAT WE DO

Linde Material Handling is the only Full-Liner of the intralogistic industry worldwide and leader of the European market. Linde MH provides:

CUSTOM SOLUTIONS

73 series with over 170 various types of trucks

INNOVATIVE PRODUCTS

E-Log-Biofleet project

CUSTOMER INTIMACY

In Germany alone, 53 service points with 210 sales consultants and 1300 service technician
CHALLENGES IN INTRALOGISTICS

/ System performance
/ Maintenance and service life
/ Energy efficiency & emission standards
/ Globalization

DO YOU KNOW THAT?
Time consuming battery changes and maintenance
DO YOU KNOW THAT?
Costly battery charging space and infrastructure
DO YOU KNOW THAT?
Corroded or broken batteries
Market needs

Industries:
- Food industries
- Third-party logistics
- Automotive industries

Customer needs:
- Vibration
- Thermal reliability/ -shocks
- Moisture/ corrosive substances

Outside influences:
- Fleet applications
- Performance/ energy consumption
- Durability etc.

Constancy environmental conditions

Constancy Vibrations

Measurement in g

Time
TWO STRONG PARTNERS, ONE GOAL
Linde MH and Fronius at the CeMat Hannover 2011
HyLOG Fleet / E-LOG-Biofleet Project

Objectives

- Development, certification and demonstration of a warehouse tow truck fleet (12 vehicles) with fuel cell range extender
- Installation, authority approval and demonstration of indoors and onboard bio-hydrogen refuelling of the warehouse truck fleet
- CO2 neutral generation of bio-hydrogen using reformed biogas as source of energy
- Environmental and socio-economic assessment of the innovative and sustainable warehouse logistic application
- Preparation for enhanced market entry
E-LOG-Biofleet: Milestones

Prototype Development

Prototype Installation

Fleet Test 12 Vehicles

Market Entry

M1 Prototype for Test at Fronius and Customer site 2010 - 2012

M2 Industrial Prototype April/May 2013

M3 Preseries +2013
E-LOG-Biofleet Opening Ceremony 7th June 2013

@ DB Schenker, Linz Hörsching

attendance of: Bundesminister Doris Bures, DB Schenker: Kurt Leidinger, OMV: Gerhard Roiss, Fronius: Elisabeth Engelbrechtsmüller-Strauss, Klaus Fronius
E-LOG-Biofleet / HyLOG-Fleet vs. HyLOG

- HyLOG-Fleet target
  - High power density (+62%)
  - 4PzS battery equivalent (-20%)
  - Onboard / indoor refuelling (<3min / 200bar)
  - Fit warehouse application conditions
  - Certification: EN62282-5-1:2007

HyLOG Tow Truck (2006)
Fronius HyLOG-Fleet 26F

- Peak Power (continuous): 11kW (2.6kW)
- Peak Current: 450A
- H2 Tank: 23L, 200bar, 6 kWh(el)
- Onboard/Indoor Refuelling: <3min
- Onboard Battery: High Power Lithium Ion
- Nominal System Voltage: 26.4V
- Operating Temp. Range: +2 to +60°C
- Dimension L/W/H: 786/310/630 mm (4PzS Tray)
- Weight: 180kg
- Certification: EN 62282-5-1:2007 (Portable FC Systems), 97/23/EC (PED), EMC 2004/108/EC, EN 61508 Ed. 2.0 (functional safety), IEC 62133 Ed. 2.0 (secondary cells)
## Fronius HyLOG-Fleet 26F vs. Lead Acid Battery

<table>
<thead>
<tr>
<th>Type</th>
<th>Lead Acid</th>
<th>Status</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension Tray 4PzS L/W/H</td>
<td>786/310/630</td>
<td>786/310/630</td>
<td>786/310/630</td>
</tr>
<tr>
<td>Nominal System Voltage [V]</td>
<td>24</td>
<td>26,4</td>
<td>26,4</td>
</tr>
<tr>
<td>Current max. [A]</td>
<td>450</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>Charging / Refuelling [min]</td>
<td>&gt;500</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Lifetime @ Pnom=2,6kW [h]</td>
<td>4.400</td>
<td>5.000</td>
<td>&gt;10.000*</td>
</tr>
<tr>
<td>Energy Capacity [kWh(el)]</td>
<td>9,6</td>
<td>6</td>
<td>9,6</td>
</tr>
<tr>
<td>Weight [kg]</td>
<td>360</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Operating Temperature [°C]</td>
<td>-10 to +60</td>
<td>+2 to +60</td>
<td>-10 to +60</td>
</tr>
</tbody>
</table>

*to be confirmed

---
Advantages HyLOG Fleet Technology

- Increased productivity and flexibility due to
  - Fast refuelling and Increased availability
  - Maximum lifetime
  - Reduced maintenance and space demand
  - Vehicle operation condition monitoring
  - Improved cold store operation
- Energy management capability
  - Diversified energy sources (electricity / natural gas / hydrogen)
  - Renewable energy integration
- No emissions
Bio-Hydrogen Infrastructure E-LOG-Biofleet

/ Onsite H2 Generation and Refuelling System
/ Onsite H2 Reforming from Biogas 0,45 kgH2/h
/ H2 Compression and Storage 350bar
/ Refuelling Time <3 min (>400kW)
/ Refuelling Nozzle WEH TK16/17

/ Indoor Refuelling Standards
/ ÖVGW G97 NGV filling stations - Design, production, installation and operation
/ VdTÜV MB514 / 04.2009: Compressed gases, Requirements for hydrogen fueling stations
WTW-GREENHOUSE GAS EMISSIONS
(Preliminary Results)

Reduction potential due to increased life time of fuel cell

* Example biomethane/biogas from mix energy crops and manure (most common biogas plants in Austria)
Business Case

- Large fleet size
- High productivity requirements
- Multiple shifts
- High electricity cost
- Low cost hydrogen accessible
- High labour cost
- Greenfield project?
SUMMARY

Hydrogen and fuel cells technologies are attractive to solve major challenges in the material handling industry.

The E-LOG Biofleet project provides a first model for indoor refueling under European standards and legislature.

Fuel Cell technology has the potential not only to green material handling systems but also to improve performance and economics.