



Hydrogen Fuel for Material Handling

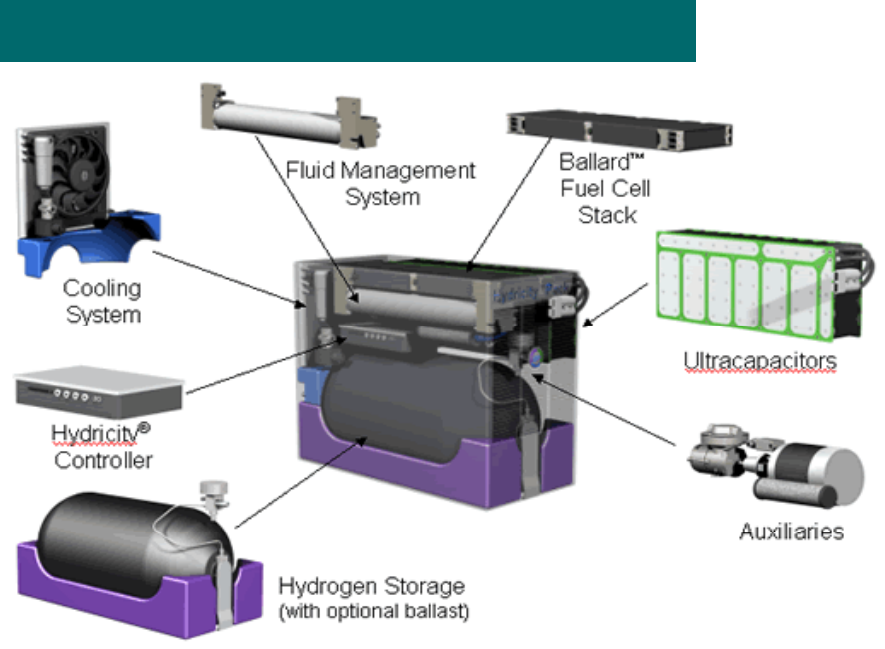
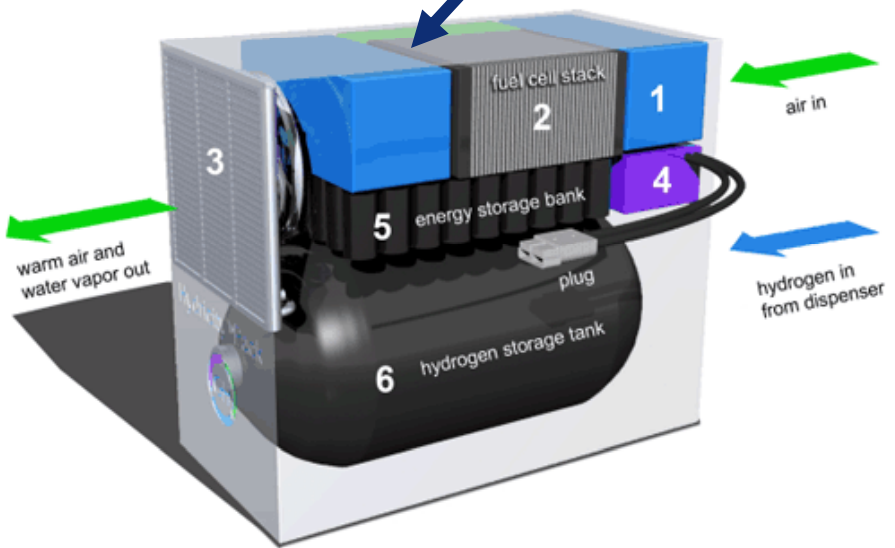
Tom Joseph



© Air Products & Chemicals, Inc., 2009
7201 Hamilton Blvd., Allentown PA 18195

Fuel Cell Packs for MHE

Form, Fit and Function Battery Replacement



Courtesy of Ballard Power Systems

MHE Classes and Pack size

	4kW	9kW	14kW
 <p>CLASS 1 Forklift</p>			 <p>32 x 38.6 x 22.7" LWH</p>
 <p>CLASS 2 Forklift</p>		 <p>38.7 x 18.0 x 30.5" LWH</p>	
 <p>CLASS 3 Forklift</p>	 <p>31.1 x 13.2 x 31.6" LWH</p>		

Value to the MHE Market

- Trend has been toward electric
 - Indoor air quality issues
- Early adopter of fuel cell technology
 - Fleet market
 - Central Fueling
 - Economic Benefits
- Replacement of batteries with fuel cell “packs”
 - Increased productivity

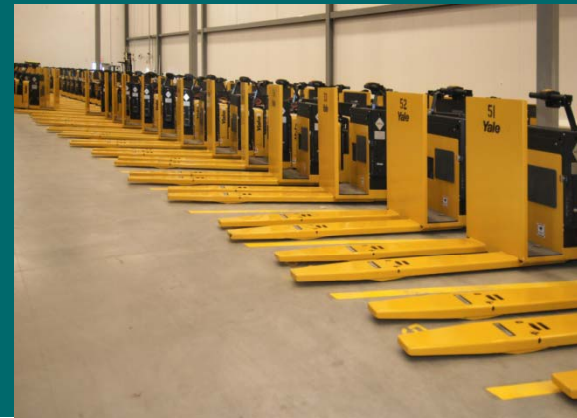


The Value Proposition!



Battery Baseline

- Less than 6 hours run-time in heavy apps
- Take up to 8 hours to recharge
- Battery rooms take up valuable floor space
- Tie vehicles to centralized battery rooms
- Vehicle downtime for battery changing
- Battery discharge voltage - machines slow down and incur motor damage



Fuel Cell Benefit

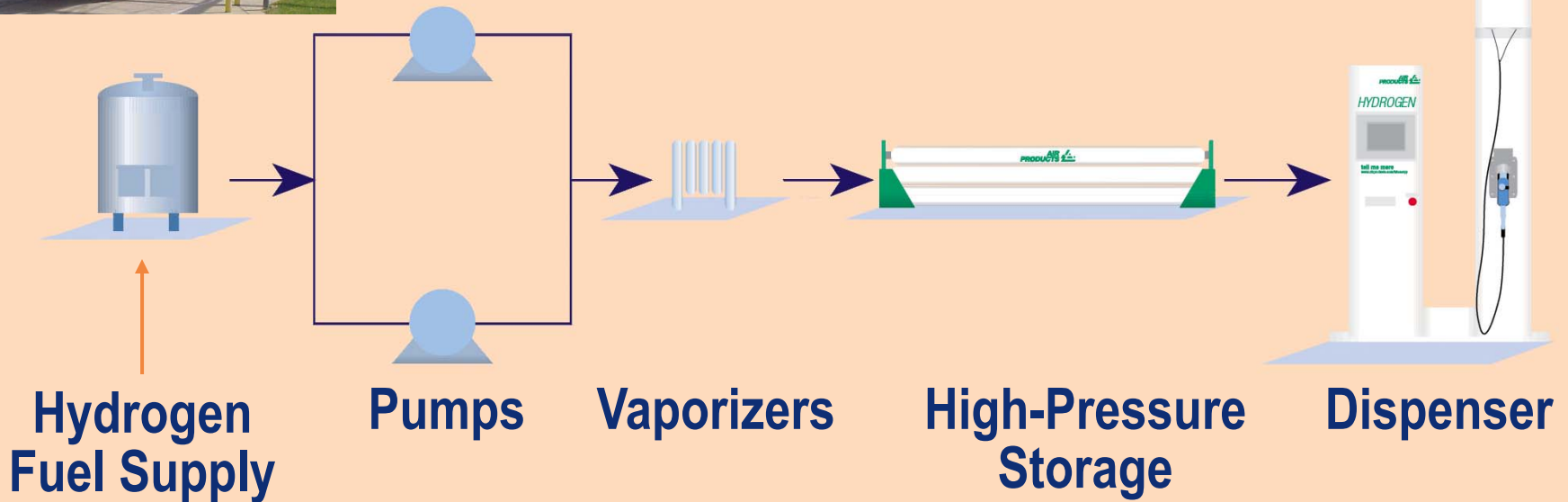
- Run 2 to 3 times as long
- Refueled in 3- 5 minutes
- No battery room required
- Fuel dispensers distributed in facility
- No battery related productivity losses
- Constant voltage, vehicles never slow down



MH Market

- Any location with a large material handling fleet
 - Forklifts, Tugs, AGV's combined
- Manufacturing Facilities
 - Auto assembly and parts
- Distribution Warehouses
- Defense Depots
 - Defense Logistics Agency

Fueling Infrastructure for MH Market



Technology Demonstration

- Typically one week to a month deployment
- Outdoor refueling
- Supported by our extensive fleet of mobile fuelers
- Customers get the “feel” of the technology
- Couple of dozen a year



Pilot Programs

- Extended demonstration – 3 months to a year
- Indoor preferred
- Anticipation of long-term deployment
- Supported through on-purpose built tube trailer supply and specialized HYDRA liquid trailers



Phased Conversions

- Manufacturing facilities
 - Conversion started in January 2007
 - Short term gas supply
 - Grow out around 30 kg/day
 - specialized HYDRA liquid trailers



Intermediate ramp up phase

- Delivered Liquid system
- Multiple dispensing nodes
- System reliability



Powering DoD Warehouse Equipment



...DLA Hydrogen Fuel Cell Pilot

Helping DDSP go GREEN



- 936 dispensing transactions in one month
- Largest user in US for indoor dispensing



Central Grocers, Inc.



- Liquid supply
- Three indoor dispensers
- Opened on 03/29/2009
- Greenfield site
- Largest FC fleet in the world

Numerous projects in the pipeline
tell me more !

www.airproducts.com/h2energy

josephht@airproducts.com