

HYDROGEN FUEL CELLS POWER THE FUTURE OF LIFT TRUCKS

By Steve Medwin, manager of advanced research, The Raymond Corporation

Today, it seems like everyone is buzzing about alternative and renewable energy sources, and the materials handling industry is no different. Research is helping the industry lead the way in developing new energy options, the most promising of which is the implementation of hydrogen fuel cells in electric lift trucks.

Hydrogen is a readily available industrial gas, but special equipment is required to compress the gas to the pressure needed to fuel lift trucks, and a hydrogen dispenser is needed to refuel the lift trucks. Currently, these requirements may make fuel cell technology cost-prohibitive for many facilities, but research indicates that it has the long-term potential to generate significant cost savings. Early research findings demonstrate that, in comparison with lead-acid battery-powered lift trucks, hydrogen fuel cell lift trucks maintain comparable performance while significantly reducing refueling time and increasing productivity.

Fuel Cell Research

In January 2007, The Raymond Corporation (Greene, N.Y., U.S.A.) began a two-year study on the performance of hydrogen fuel cells in lift trucks and the development of indoor hydrogen fueling stations in a real-life manufacturing environment. With a contract from the New York State Energy Research and Development Authority (NYSERDA) and the New York Power Authority (NYPA), Raymond converted its Greene manufacturing facility into a “living lab.” Raymond is testing hydrogen fuel cell-powered *Raymond*[®] lift trucks in real manufacturing applications. An indoor, fast-fill hydrogen refueling system also has been installed [\[see Figure 1\]](#). Raymond’s research has provided some initial analysis of the benefits of hydrogen fuel cells and has helped direct the next phases of ongoing fuel cell research.

Why Fuel Cells?

In a high-use lift truck application, lead-acid batteries typically last only one shift, and the recharge cycle is long because batteries generally take one shift to charge and

another to cool down. A three-shift operation will then require three batteries per truck, in addition to space in the facility for storage and recharging. It also can take up to 20 minutes to remove and replace a battery from the same truck model. Plus, as the battery discharges, voltage drops and lift truck performance is degraded [see Figure 2].

In contrast, Raymond's research demonstrates that hydrogen fuel cells rapidly refuel in only a couple minutes, offering the potential for higher operator productivity. A facility can install multiple fuel stations around the site that feed from a central tank, and the use of hydrogen eliminates the need for a battery room for battery storage and recharging. Additionally, the voltage delivered by a fuel cell remains constant until the fuel is depleted. In Raymond's research study, hydrogen fuel cell-powered lift trucks were found to have equivalent braking distances and maximum travel and lift speeds compared with battery-powered trucks, so performance is comparable using either energy source. The added benefit of hydrogen is that it is environmentally clean. Water and heat are the only byproducts.

Although fuel cell-powered lift trucks are not yet rated for the low temperatures of freezers, fuel cells also could perform better than battery-operated lift trucks in cold storage. When lift trucks with lead-acid batteries are driven in freezers, the range and performance of the truck is reduced. Performance is maintained in a lift truck with a fuel cell because the voltage and current remain the same at cold temperatures.

Lift Truck Evolution

Raymond's research indicates that converting to hydrogen fuel cell-powered lift trucks will eventually impact lift truck design. In today's electric lift trucks, the battery also acts as part of the counterweight. Hydrogen fuel cell components do not weigh the same as heavy lead-acid batteries, so additional weight must be added to the fuel cell unit, and this weight must be distributed within the fuel cell system so the center of gravity is the same as that of the battery it replaces. Currently, fuel cells are being used as drop-in replacements for batteries or only minor truck modifications are made to accommodate the fuel cell [see Figure 3]. The next step in lift truck design is to modify the existing truck platform so new trucks can ship with a fuel cell option, and the fuel cell components would be distributed in an optimum way around an existing truck. Future lift trucks may have the fuel cells wholly incorporated into the design of the truck from the original concept.

There are still many other areas of fuel cell research that are being tested, monitored and analyzed. Raymond's research is evaluating the following areas:

- ◆ Operation details of the hydrogen infrastructure and refueling
- ◆ Hydrogen consumption and refueling frequency
- ◆ Reliability, maintenance and repairability of fuel cell systems
- ◆ Voltage delivered by a fuel cell and how it compares with the specifications for all the electrical components and options on a lift truck

These areas, among others, must be analyzed before the materials handling industry comes closer to using hydrogen fuel cell-powered lift trucks in everyday applications.

Other companies also are studying fuel cells and evaluating their potential in the materials handling industry. National associations, such as the Industrial Truck Association (ITA), are reviewing the technology with the Fuel Cell Working Group. NYSERDA has created a Fuel Cell Advancement team to support New York state companies in the development of fuel cell systems and projects.

Making the Switch

There are several steps that warehouses and distribution centers can take today to learn more about fuel cell technology. To better prepare for this emerging technology, facility managers can talk to lift truck dealers and manufacturers about fuel cells to find out if available units will work with their fleets and their facility's needs. They can investigate the costs of hydrogen and a hydrogen infrastructure to evaluate whether it would be cost-effective to implement the technology. They also can consider important issues related to integration, such as electrical and mechanical interfaces; and stability and counterweight.

It is important to start considering now the integration of hydrogen fuel cell-powered lift trucks into lift truck fleets. This technology shows the potential to be adopted rapidly in the materials handling industry, as the industry is working toward realizing the benefits of a cleaner, more productive energy source for lift trucks.

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About the Author

Steve Medwin is the manager of advanced research at The Raymond Corporation and is responsible for the investigation and evaluation of fuel cells for forklift trucks. He has been at Raymond since 2001, when he was hired as a test engineer. He has been actively working on fuel cell technology since 2004. Medwin is the inventor on nine U.S. patents and more than 15 patents issued worldwide.

Referenced Images

Figure 1:



Figure 2:

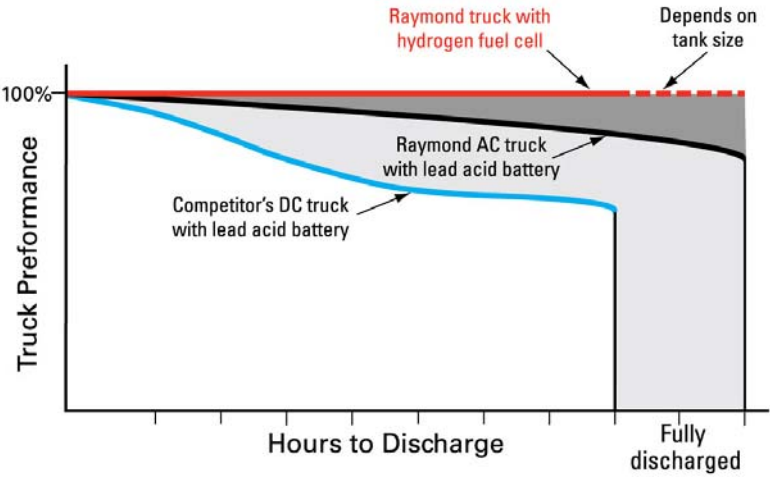


Figure 3:

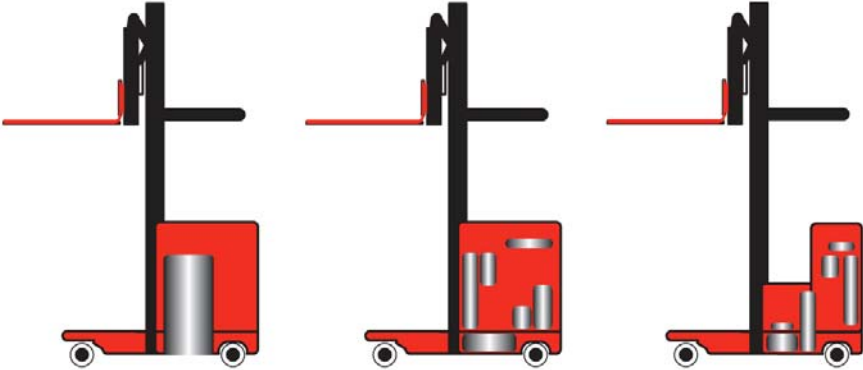


Figure 1:
Battery Replacement

Figure 2:
Existing Platform
Modification

Figure 3:
Concept Design