Fuel Cells Will Mean Extended, Pollution-Free Power for Tomorrow's Lift Trucks

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The zinc/air fuel cell is a new technology that will make it possible to run an electric lift truck for three shifts at a time, then be refueled as quickly and easily as pumping gasoline. No extra batteries, battery-hoisting equipment, or slow battery recharge and cooldown procedures are needed. The zinc/air fuel cell combines quiet, zero-emission electrical power with rapid refuelability and up to seven times the energy per pound of lead-acid batteries. No flammable fuel or expensive new infrastructure is involved. Zinc/air chemistry has been around for many decades and is currently used for applications such as hearing-aid batteries and railroad signals. Zinc/air batteries have traditionally been low power due to poor air cathode performance. The air cathode is the critical component in each cell that enables the oxygen in the air to react with the zinc and electrolyte. Recent advances in air cathodes now provide zinc/air power sources with enough power for vehicles. The lift-truck system described here could be seen on showroom floors in three years or less.

How does it work?

Like a battery, a fuel cell is a quiet, emission-free electrochemical power source. But unlike a battery, which must be recharged over many hours, a fuel cell is refueled, a process that takes just minutes. The zinc/air fuel cell produces electricity by combining tiny zinc pellets (0.5-0.8 mm in diameter) with oxygen from the air in the presence of a liquid electrolyte, potassium hydroxide. This is the same electrolyte found in alkaline disposable batteries. The amount of zinc fuel remaining on the lift truck can be accurately measured and displayed at all times.

The byproduct of the reaction is zinc oxide, a safe white powder used in skin creams and sunblock. Inside the fuel cell, in addition to the fuel cell stacks, is an electrolyte management unit that stores the zinc oxide until it is removed in the refueling process. The zinc oxide byproduct is reclaimed when the fuel cell is refueled by a zinc recycling unit, a device about the size of a large gasoline pump. Using a dual nozzle and hose, the fuel cell is both emptied of its zinc oxide byproduct and refueled with fresh zinc at the same time. The refueling process takes about five minutes. Separately, the recycling unit continuously converts the zinc oxide back into fresh zinc fuel by reversing the chemistry. The recycling system uses standard electricity to produce fresh zinc "fuel" particles of the proper size. The recycling unit is entirely above ground and requires no site modification or excavation. The entire process is closed-loop, with nothing added, discarded or wasted.

Fuel cells to fit the power needs and physical constraints of most classes of lift trucks are possible. For example, a fuel cell consisting of two 24-cell stacks could produce 4kW of continuous power at 48VDC. The addition of a small high-powered

sealed lead-acid battery could boost the peak power capability to 12 kW or more if needed. Larger lift trucks can be fitted with larger fuel cells that will still fit well within the battery cavity. The zinc/air fuel cell can be easily retrofitted into the battery cavities of most existing lift trucks.

What zinc/air fuel cells can do for you

Where the zinc/air fuel cell really excels is its energy density. A system with enough zinc fuel to equal the weight of a typical lead-acid battery on an electric rider would power the lift truck for up to nine shifts. Alternatively, this new power technology opens up the possibility of higher-performance, lighter lift trucks with weight for counterbalancing distributed where it's most effective, not where the battery requires it to be.

For example, counterbalance weight could be concentrated at the rear of the truck or the center of gravity of the truck could be lowered by installing lead plate in the floor of the battery cavity when replacing the lead-acid battery with the zinc/air fuel cell.

Another advantage of the enormous energy and easy fuel measurement of zinc/air is to allow expanded indoor/outdoor use of electric lift trucks without fear of getting stranded a long way from the battery room. Existing battery rooms can be easily converted to house zinc recyclers. Battery-hoisting equipment, spare batteries and battery chargers could be eliminated.

The economic benefits are also significant for heavy, multi-shift users of industrial utility carts. Operators usually do not swap the batteries in these vehicles for charging. Instead, many companies buy "spare" vehicles with the knowledge that some percentage of those vehicles at any given time will be unusable, since they will be plugged in, recharging. The rapidly refuelable zinc/air fuel cell gives almost 100% uptime to these vehicles. Retrofitting a battery-powered lift truck requires the installer to lift out the lead-acid batteries, drop the fuel cell into place, connect battery cables to the fuel cell, and add a refueling port.

Primary technical challenges that remain include improving air cathodes, electrolyte management, and zinc fuel management to further reduce costs and improve reliability and product life.