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Cambridge Crude—*The Liquid Fuel in a New Battery Architecture*

The future automobile will run on electricity not gasoline! If you think that this is a relatively new idea you are very wrong. One hundred seventy-five years ago, the press and most people were sure that an electric-powered vehicle was superior to one that ran on gasoline. A very long time ago, cheap gasoline refined from crude oil killed off the electric car. Cambridge Crude, the nickname of a new Massachusetts Institute of Technology (MIT) liquid battery recharging system, might be the serendipity that brings the electric vehicle (EV) back to dominate the auto industry.

The stumbling blocks to EVs have always been driving range, recharging speed, and recharging infrastructure. Truth be told, driving range disappears as a roadblock to a pure EV future if a new recharging infrastructure could be developed that lets you pump a liquid electric charge into your EV at the same speed as a gasoline fill-up. Can you imagine your local gas station having a line of pumps designed specifically to refill electric cars? (See Photo 1.)

The MIT researchers have named their new battery design the *semi-solid flow cell*. In this battery, electric energy is stored as a liquid. When the energy in the liquid runs down, the battery can be restored to a full charge by pumping out the old liquid and then pumping in a new batch of fully charged liquid. The liquid, which everyone will probably call Cambridge Crude, isn't discarded because it only needs to be recharged. Recharging of this liquid will take place at the refueling station using special recharging equipment that will be part of the overall system. The restored-to-full-electric-potential solution will then be held in the refueling station's storage tanks until it is exchanged with the liquid from another vehicle.

At this time, the new battery looks more like a laboratory experiment than an automobile battery system. (See Photo 2.) A fully functional prototype will be ready for testing sometime in 2013. It will include the car, battery refueling pumping system, the recharging station system, and the storage tanks for charged and discharged solutions. Cambridge Crude fuel is basically a very thick electrolyte solution that contains a very large suspension of tiny lithium-ion particles. (Refer to Photo 2 again.)

Probably, the less you know about standard battery design, the easier it will be for you to understand how the battery will work. The plus side and minus side of this battery (the cathode and the anode) are liquids

Jessica Nunes

Photo 1—Prototype of a Cambridge Crude pumping station

that contain a suspension of tiny floating lithium-ion particles. The semi-solid flow cell battery will store the cathode and anode solutions in separate storage tanks. (See Fig. 1.) A pump causes the two thick solutions to slowly flow through the system and meet at a thin permeable membrane. This membrane allows only the charged ions in the solutions to cross the barrier. When they combine, they create a chemical reaction that generates electricity. The

Dominick Reuter for MIT

Photo 2—The black liquid in the container is Cambridge Crude. The laboratory bench experiment shown was performed at MIT to serve as a proof of concept that the semi-solid cell battery generates lots of electricity.

electricity turns the motors that then move the car. When the solutions are at rest, no electricity is generated. The faster the solutions move, the stronger the chemical reaction and, therefore, the larger the amount of electricity generated—which means more motor torque or speed. (Refer to Fig. 1 again.)

The battery design is now based on lithium-ion chemistry. Lithium is the same rare earth element that you will find in the newest cell phones, iPads, and notebook computer batteries. Of course the semi-solid flow cell infrastructure is completely

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different than any battery that is now on sale.

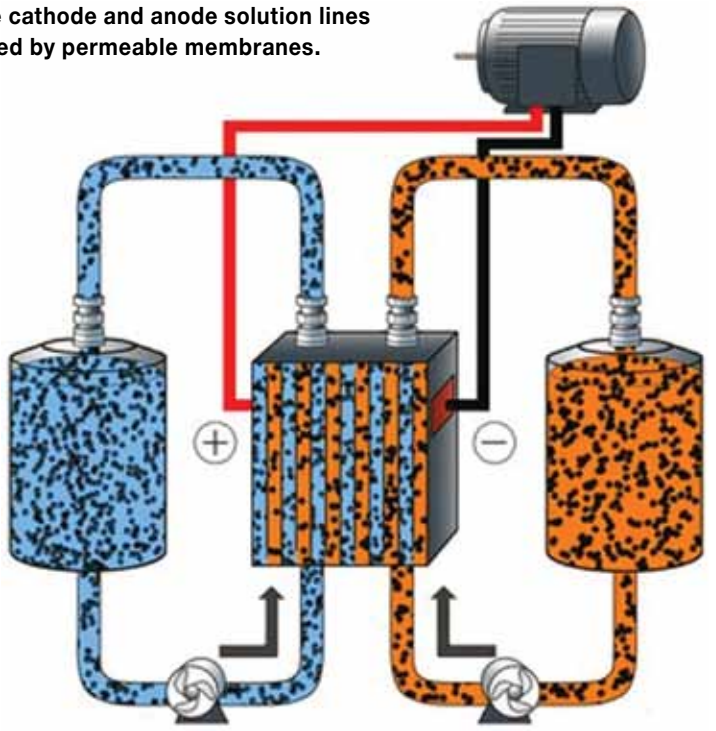
Research on this new battery technology has been funded by the U.S. Department of Defense, U.S. Department of Energy, and MIT. The goals that researchers still hope to achieve include finding other ion chemistries that are less expensive to use and ramping up the technology for industrial and transportation use. This mission will be performed by 24M Technologies, a new MIT spin-off. It is also believed that this technology can be used to store energy generated by solar cells, windmills, and other facilities that at times generate more electricity than demand requires.

Recalling the Facts

1. What makes this recharging system faster than the current method used to recharge an EV?

2. If this battery system proves worthy of full adoption, what impact will it have on the environment, the price of gasoline, and world politics? td

Fig. 1—The chamber in the middle is the place where the chemical reaction that generates electricity takes place. The diagram shows multiple cathode and anode solution lines separated by permeable membranes.



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