Exotic new lithium-air batteries

Greater range for electric vehicles

Imagine an electric vehicle (EV) that could be refuelled as quickly as a petrol-engined automobile, could run at least 500km at normal highway speeds, and was cheap to own and operate. Impossible, you say? Not according to Lockheed Missiles and Space Company.

by GREG SWAIN

To be a serious prospect, an electric vehicle must have an order of performance similar to today's petrol-engined cars. That demands a battery that will somehow squeeze the energy equivalent of a tank full of petrol into a light, compact, quickly rechargeable package. It's a goal that's becoming increasingly important as petroleum resources get scarcer and petrol costs rise.

Batteries that will meet the above goals are currently the subject of intensive design efforts in America and Western Europe. One of the most exciting prospects is being developed by Lockheed Missiles and Space Company, Palo Alto, California. Lockheed is working under contract to the US Energy Research and Development Administration (ERDA), and has begun a program to develop a new version of the company's patented lithium power cell.

The objective according to Dr Ernest L. Littauer, manager of Lockheed's Palo Alto Chemistry Laboratory, is a lithium-water-air battery of high energy capacity, moderate weight, and adaptable to the stop-start-standby needs of automotive propulsion.

Lockheed's studies of the high energy potential of lithium began several years ago. The company announced in 1972 that it had discovered a lithium cell that could produce levels of energy storage far greater than could be produced by conventional lead-acid batteries. That cell was fuelled with lithium and water, and was developed for a number of specialised defence applications.

The experimental cell now being investigated under the ERDA contract will be fuelled with lithium and air, operating in a water-based solution. The concept has been proven in the laboratory and tests have shown that it will produce even greater power than the earlier lithium-water cell.

The lithium-air battery is radically different from the secondary lead-acid batteries now used in automotive applications in that it is mechanically rechargeable rather than electrically rechargeable. During discharge, the lithium, water and atmospheric oxygen react to produce electricity and lithium hydroxide as the reaction product. Recharging is carried out by the addition of electromechanical fuel and, in a properly designed battery, the total refuelling time should be comparable to that of petrol-powered cars.

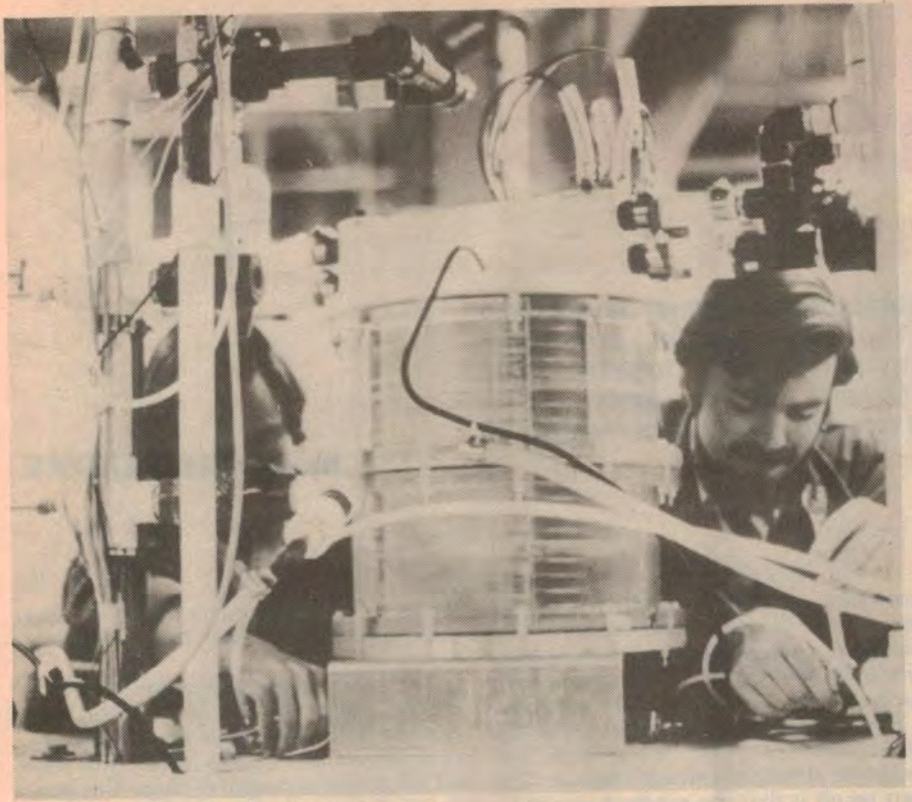
The basic scheme is this: the car would initially be stocked with sufficient metal fuel (lithium; aluminium is another candidate) for a nominal range of 1500km. Then, at more frequent intervals (500-700km, depending on convenience), the vehicle would stop at a roadside station to take on water and discharge the reaction product. At the end of the 1500km a set of new metal plates would be dropped into the fuel cell, and the cycle repeated.

The reaction product, lithium carbonate, a dry powder precipitated by flowing carbon dioxide through the residue in the battery, would be collected and recycled to produce new metal anodes.

Lockheed is also working on aluminium-air batteries, and these now seem an attractive alternative to the lithium-air cells. Both have extremely high power densities — around 6700-7700 Whr/kg when fully recharged. Compare this with the dismally low 38-40 Whr/kg of conventional lead acid batteries and you will appreciate just how dramatic this figure is.

In use, the aluminium plates of the cell are totally consumed before new plates are installed. The reaction byproduct is an air-dried powder, tri-hydrated alumina hydrargillite, which can be recycled back to aluminium metal.

Beside helping to solve the energy crisis, electrochemical batteries would have other advantages. The absence of vehicular emissions would be an attractive consideration in urban areas, for example. And the cost of ownership should compare favourably with that of petrol-engined cars.



Researchers at Lockheed Missiles and Space Company, Calif., at work on one of the company's new lithium-air batteries. Lithium-air batteries may give future electric vehicles a range of around 500km and fast refuelling capability.

However, there are still many technical problems to overcome before electric vehicles powered by fuel cells become a reality. Although it sees the development of a suitable power source as an essential first step, Lockheed says that a full examination of the feasibility of an electric car will require a multi-year effort. Such a program would include consideration of reliability, refuelling, safety, ease of operation, and overall energy utilisation.

But, as Dr Littauer says, "We must start looking at the year 2000 now; in 1990 it will be too late."

Alcohol as a fuel option

The doubling of oil prices in less than two years and the prospect of further rises is making some other liquid fuels look economically attractive. Topping the list are the alcohols, methanol and ethanol.

Blended with petrol to give a fuel containing up to 20% alcohol, they offer a number of advantages. Only minor modifications need to be made to present day car engines for them to run well.

The blend (gasohol as it is called in North America — perhaps petrohol here?) gives good performance without tetraethyl lead, a major cause of urban air pollution. And emissions of other pollutants are lower than with straight petrol.

As petrol extenders these alcohols would enable Australia to reduce its dependence on foreign oil. A recent CSIRO study has indicated that fuel alcohol equivalent to more than half of Australia's current transport requirements could be obtained using existing technology.