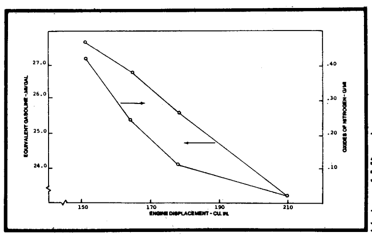
Linda Garmon reports from Arlington, Va., at the Institute of Gas Technology Conference on Nonpetroleum Vehicular Fuels

Aluminum cells: Going the distance

The prospect for the electric car as an alternative to the conventional, petroleum-fueled vehicle traditionally has been cursed with severe range limitations. Even the most optimistic forecasts — predicting the development of electric cars that would permit ranges of 100 miles between rechargings — have seemed dim compared with the "unlimited" distance capabilities of conventional engines. Now, however, with the recent advances made on aluminum-air cells for electric vehicle propulsion, the curse of the restricted range may be lifted.

John Cooper and co-workers of Lawrence Livermore National Laboratory in Livermore, Calif., now are in the process of "scaling up" a small, model aluminum-air fuel cell that they believe has one- to three-thousand-mile range potential. The aluminum-air fuel cell succeeds where other cells — lithium-air and zinc-air, for example — have failed because of its high energy per unit weight. In addition, the aluminum is in the form of replaceable plates, making the system a "rapidly refuelable" one, Cooper explains. Cooper and colleagues expect the first scaled-up aluminum-air powered electric car in five to seven years. Meanwhile, researchers must iron out other wrinkles — such as cost and acceleration capabilities — before the electric car can become a feasible alternative to petroleum-fueled vehicles.

Hydrogen: School of hard NO_x



Univ. of Miami

"Ultralean" may sound like the name of a new diet craze or the latest look in the fashion world, but to Mike Swain of the University of Miami the term describes a hydrogen-fueled engine that can reduce emissions of oxides of nitrogen (NO_x).

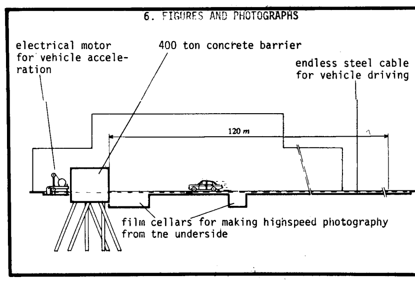
NO_x emissions have long been a major concern in the operation of hydrogen-fueled engines. Now, however, Swain and co-workers have detailed a computer analysis of a theoretical hydrogen engine that can reduce NO_x emissions. In the computer study, the researchers determined the extent to which a hydrogen-powered engine — modeled after a Pontiac Sunbird — can be "leaned out."

A lean engine operates with a smaller fuel-to-oxygen ratio than is specified by the stoichiometry — or element proportions — of the chemical equation for a fuel-burning engine. The excess oxygen lowers the temperature of combustion, which in turn reduces NO_x emissions. Leaning out a gasoline engine has its limitations, though: Too much oxygen will simply put out the fire. But a hydrogen engine, Swain and colleagues have found, can be ultraleaned so that NO_x emissions virtually disappear.

An ultralean hydrogen engine, however, is a weaker engine in terms of power output. To compensate for this drawback, the volume, or displacement, of the engine must be increased. Unfortunately, a larger, heavier engine is, of course, a less fuel-economy-minded engine. This trade-off — reduction of NO_x emissions for a less fuel-economy-minded engine — was quantified in Swain's computer project. As illustrated in the graph, a hydrogen-powered engine displaced to 210 cubic inches will severely reduce NO_x emissions. Unfortunately, as the lower line of the graph indicates, increased engine displacement lowers the equivalent miles per gallon capability of the engine.

The Miami researchers now are working with their theoretical hydrogen-fueled engine in an attempt to change the rules of the reduced-NO_x-emissions-for-lower-performance trade-off. Their goal is to design a hydrogen-powered engine that lowers NO_x emissions without sacrificing fuel economy.

LPG testing: Up against the wall



Research Inst. for Road Vehicles

In crash simulations reminiscent of the gruesome demonstrations filmed for driver's education classes, the Research Institute for Road Vehicles in Delft, The Netherlands, has put liquefied petroleum gas (LPG) to the test.

LPG as an alternative to petroleum fuels has the advantage of low cost and low emissions and can be used in conventional engines with only minor modifications. A major drawback to the use of LPG, however, is the requirement that it be stored as a compressed gas at high pressure. "It has been noticed that when ...the use of LPG is started in cars, people are scared of LPG," says Peter van Sloten of the Research Institute for Road Vehicles. "Some tend to call the LPG tank a bomb."

So, the research institute set out to test LPG tanks in collisions. The crash tests were conducted on a full-scale crash facility consisting of a vehicle pulled by an electrically powered cable. This crash system enabled cars to collide with a 400-ton concrete barrier at a maximum speed of 62.1 miles per hour. Now, numerous crash tests have been conducted, and researchers at the institute conclude that the LPG tank is able to withstand all impacts without leakage of the tank. Furthermore, the researchers found that an LPG tank in direct fire can maintain low pressure — relative to burst pressure — through the controlled release of the gas from a safety relief valve.

The use of LPG is still cause for concern, though, because of the possibility of large spills of the gas at LPG storage or unloading facilities. The U.S. Department of Energy, therefore, has asked researchers at Lawrence Livermore Laboratory in Livermore, Calif., to study the environmental impact of a large-scale LPG spill. The California research laboratory now is preparing to conduct a large-scale spill at a Nevada test site.

An alternative as lovely as a tree?

Brazil's reforestation program, which began about 20 years ago, was a huge agricultural success. Economically though, because of the slumping paper market, the program created a problem for the government — a surplus of wood.

Soon, however, Brazil's National Alcohol Program (PROALCOOL) will pull the government out from underneath its woodpile: PROALCOOL is planning to use the wood to make alcohol fuels. Six processing plants that will use wood as a feedstock — or raw material from which alcohol can be made — are now being built in Brazil. The facilities should be producing alcohol fuels in 18 months, says Jose Moreira, who is at Princeton University in New Jersey on leave from the University of São Paulo.

Alcohol fuel production is not new to Brazil: Alcohol from sugar cane has been produced since 1975 (SN: 7/29/78, p. 73; 6/23/79, p. 404). Studies investigating energy invested versus energy return, however, have shown that wood as a feedstock is five to seven times more energy efficient than sugar cane.

The use of wood as a precursor to alcohol fuels is not universally beneficial, Moreira says. Countries that use advanced agricultural machinery and fertilizers extensively, for example, are not net energy producers in alcohol fuel programs. Also, nontropical countries must contend with the increased sensitivity of gas-alcohol blends to water when the temperature is low. Still, the alcohol-from-wood process should be considered by less developed tropical countries, Moreira maintains.