Alternative Fuel Technologies:

A Crash Course

A look at the alternative fuel technologies on the market and how those technologies will affect the servicing of cars in automotive shops.

By Andrea Betts Menendez

Though they may seem revolutionary to modern consumers, alternative fuels are nothing new. Early tractors ran on kerosene; Henry Ford's Model T ran on both gasoline and ethanol. But with environmental, economic and political concerns reaching a fevered pitch – and with more than $1.5 billion in government backing – alternative fuel vehicles are making a comeback. Is your shop prepared to service them?

Alcohol-based fuels such as ethanol have been used for more than 100 years. Because they burn cleaner than petroleum-based fuels and can be produced domestically, their adoption in automotive systems is growing rapidly. Here, class participants at the National Alternative Fuels Training Consortium (NAFTC) look at the differences between gasoline and ethanol. Photo Credit/NAFTC

From Crops to Cars

A revival of Ford's dual fuel concept, flexible fuel vehicles can use either gasoline or a mixture of gasoline and ethanol, the most common of which is E85 (85 percent ethanol). Made from grains like corn, ethanol appeals to the public because it stimulates American farming while reducing emissions and foreign oil consumption.

"We hope that in eight to 10 years, every vehicle will be a flexible fuel vehicle," said Phillip Lampert, executive director of the National Ethanol Vehicle Coalition. General Motors Corp., Ford Motor Co., DaimlerChrysler AG and Nissan are among the automakers currently pumping out these bi-fuel vehicles.

According to Lampert, E85 is transparent to the driver and the technician. "No special tools or training are needed," he said. "Obviously, there

are specific diagnostic codes, but it's a very standard type of engine. Very little has been modified."

Fuel rails, connectors, pumps, and injector tips may differ slightly from those in traditional gas vehicles. For this reason, Lampert said that E85 is not recommended for use in non-flexible fuel vehicles.

Biodiesel, another plant-based fuel, can be used in any diesel vehicle. Produced primarily from soybean oil, biodiesel rivals traditional diesel in range, horsepower, torque, and fuel economy while producing fewer emissions. Maui-based Pacific Biodiesel creates its supply from food preparation oils that would otherwise end up in landfills.

NAFTC training courses offer participants thorough, expert and hands-on instruction. Shown here are CNG Cylinder Inspection Course participants inspecting a cylinder tank for safety. Photo Credit/NAFTC

Biodiesel also requires no special equipment or technician training. "Engines made prior to around 1993 may need special attention if rubber material was used in the hoses, fittings and rings," said Donnell Reheagan, chief operating officer of the National Biodiesel Board. "You could see degradation of these materials when biodiesel is used. Engines made after that time have synthetic materials that are compatible with biodiesel use."

Diesel Redefined

The classic alternative fuel, diesel, is being revamped. Beginning in September, the Environmental Protection Agency (EPA) will require most diesel to be ultra low in sulfur (less than 15 parts per million), allowing automakers to use advanced devices like particulate traps and catalytic converters to pare down emissions. Combining such exhaust treatments with technologies like common rail fuel injection, improved combustion chambers, variable injection timing, complex computer controls and turbochargers, "clean diesel" vehicles offer increased fuel economy and enhanced performance.

And they're easier on the lungs. Clean diesel may well clean up our highways, as it promises to dramatically reduce the exhaust produced by heavy-duty trucks and buses. Mercedes-Benz, Volkswagen and Jeep are currently producing light-duty clean diesels, but the technology's not cheap, which will narrow its market. With the introduction of ultra-low sulfur diesel (ULSD), the price of this fuel should also rise.

Considerable education is necessary to work on these vehicles. "The technology involved in clean diesel vehicles is pretty advanced compared with what a typical diesel technician would be used to," said Bruce Amacker, independent technical trainer and owner of Turbo Training. Amacker suggests that technicians get training to learn how the systems work, obtain factory diagnostic information and scan tools and consult outside resources like iATN, training videos and books.

A tank with a metal hydride inside can hold three times more hydrogen than can be stored as a compressed gas in the same space.

Transition Technologies

Perhaps the most talked-about automobile of late is the hybrid. Hybrids use two or more power sources – typically an electric motor and an internal combustion engine. In a full hybrid like the Toyota Prius, Toyota Highlander or Ford Escape, a computer alternates between the two, determining which power source best fits the driving style. The electric start provides more torque and instantaneous power, and a regenerative braking system harnesses the energy created by braking to charge the electric motor.

While hybrids are surging in popularity, limited supply and two powertrain systems make them pricey. But Congress's one-time tax credit deduction should encourage progressive consumers by helping offset the cost.

The most cutting-edge hybrids, like Ford's Model U, substitute the traditional internal combustion engine with a hydrogen-fueled one. Toyota just delivered five such versions of the Prius to southern California, where a fledgling hydrogen infrastructure is emerging.

Hydrogen can be derived from a variety of sources, including petroleum, alcohol fuels, natural gas and nuclear power. It can also be extracted from water using a process called electrolysis. General Electric Co. (GE) recently announced the development of a

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machine that can produce hydrogen through electrolysis at a reduced capital cost. However, hydrogen poses some storage challenges and will require a hefty infrastructure investment, whereas plant-based fuels can easily be added to fuel stations.

Proper training and safety precautions are required when servicing and repairing both hybrid and hydrogen systems.

"Any technician should be sure to look at the service manual from the manufacturer," said Al Ebron, executive director of the National Alternative Fuels Training Center (NAFTC). "That's extremely important because each hybrid is different."

Likewise, the major components are located in different places. Before servicing any hybrid vehicle, techs should know where the internal combustion engine, the 12-volt battery, and the service disconnect are, he said. High-voltage cables are orange for easy recognition.

Working with hydrogen also demands education and caution. A flammable gas, hydrogen is colorless and odorless so vehicles should be serviced in a location free of ignition sources with the appropriate ventilation systems and sensors to detect leaks. Frank Lynch of Hydrogen Components Inc. recommended working outdoors if there is no suitable indoor location. "An inexpensive flammable gas detector should be available to each technician who works on a hydrogen vehicle," he added.

Hydrogen is lighter than air and must be stored in tanks with pressures around 5,000 psi. To work on any part of the fuel system, the pressure must be relieved by safely ventilating the hydrogen gas, said Lynch. "Technicians who have had training with compressed natural gas (CNG) vehicles already know how to do this," he says.

A thorough leak inspection should follow any repairs. "The smallest of leaks should not be accepted in a hydrogen system," he cautions. (For more tips on working with hybrids, please see the June 2005 issue of *AutoInc.*, which can also be found online at www.autoinc.org.)

NAFTC offers more than courses and workshops. Shown here, Nick Wagoner, an NAFTC instructor, provides participants with natural gas cylinder inspection training. Photo Credit/NAFTC

The Road Ahead

Many believe that hybrids and hydrogen internal combustion will ultimately usher hydrogen fuel cell vehicles into the mainstream. The fuel cell is a battery technology that uses hydrogen and oxygen to create an electric current, the only byproducts of which are heat and water vapor. Fuel cells are stacked in a vehicle, as each cell produces less than one volt. Without a traditional engine, automakers will have more design flexibility, but most existing fuel cell vehicles have hybrid-like structures. Some of the latest prototypes even use hybrid technologies like regenerative braking. Nearly 100 fuel cell vehicles are already on the roads in California.

Technicians who can work on hybrids and natural gas or hydrogen vehicles will be well prepared for working on fuel cells. "The fuel cell vehicle is an electric vehicle, so the most important thing is for the independent service technician to be fully versed in electronic basics and electric vehicle diagnostic techniques," said Paul B. Scott, chief scientific officer of ISE Research.

"The key safety issues are the high voltage, high current issues of hybrid vehicles combined with the high pressure storage common to natural gas vehicles," said Scott, who helped developed a fuel cell bus. "Mechanics certified for and experienced in natural gas operations should transition very easily into working with hydrogen-fueled vehicles."

Robert Wichert, technical director of the US Fuel Cell Council, believes that while safety should be a top priority when working on any new technology, hydrogen may ultimately be easier to live with than gasoline. "Gasoline is quite dangerous," he points out.

Several auto manufacturers make natural gas-powered vehicles available to the consumer today. The need for qualified technicians to service and maintain these vehicles is growing rapidly. Photo Credit/NAFTC

The opening of an E85 station in Fort Wayne, Ind. Photo Credit: National Ethanol Vehicle Coalition – www.E85Fuel.com

"With sufficient training and knowledge, technicians will probably end up being safer in the long run."

Ebron agreed. "If you were to introduce gasoline right now, and we had been driving on natural gas or some other fuel, you would not get the general public to accept gasoline as a fuel. But we've been using it so long that everybody's OK with it. None of us likes change," he added. "But once technicians go through our training, they see that the fuels and systems out there are very safe – safer, in fact, than gasoline."

The National Alternative Fuels Training Consortium consists of 30 training centers and 70 affiliates around the country and offers 20 courses in alternative fuel, some of which will soon be offered online. Headquartered at West Virginia University, NAFTC is the only national training organization dedicated to alternative fuel vehicles.

Other sources of training and information include industry organizations, some local colleges and technical schools, parts supplier Web sites, and independent instructor Web sites that sell books and training videos.

A hydrogen station opens in Chino, Calif., Feb. 18, 2005. The private station is not part of the California Hydrogen Highway Network Blueprint Plan. That plan calls for the development of a network of hydrogen stations throughout California to help increase the transition to a sustainable hydrogen economy.

"It's good to have factory training and information, like service manuals on disk, but unfortunately the factory training on these topics leaves something to be desired," observed Amacker. "Outside training provides information that the factories don't want to talk about, like pattern failures and how to diagnose them."

One issue raised by critics of alternative fuels is how much fossil fuel is used in production and refining processes – an issue that many producers are working to resolve. "Plants and the companies that design them are constantly looking at ways to limit their electricity use, as it ultimately lowers their production costs," said Robert White, deputy director of the National Ethanol Vehicle Coalition. "One of the ideas that is currently being implemented is burning corn stalks to power the plant." Renewable energy sources like wind, hydropower and other biogases are also an option.

To be truly viable, the successful alternative fuel vehicle will have to be relatively affordable and run on a substance whose cost, energy content and accessibility rival that of gasoline – no small feat. But given the public's desire to reduce our reliance on petroleum, change is certainly in the forecast for manufacturers, drivers and service technicians alike. ai

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Common Alternative Fuel Terms

Alternative-Fuel Vehicle (AFV) – As defined by the Energy Policy Act, any dedicated, flexible-fueled, or dual-fueled vehicle designed to operate on at least one alternative fuel.

Biodiesel – A plant-based fuel that rivals diesel fuel.

Clean Air Act (CAA) – The original Clean Air Act was signed in 1963. The law set emissions standards for stationary sources (e.g., factories, power plants). The CAA was amended several times, most recently in 1990. The Amendments of 1970 introduced motor vehicle emission standards (e.g. automobiles, trucks). Criteria pollutants included lead, ozone, CO, SO_2, NO_x and PM, as well as air toxics. In 1990, reformulated gasoline (RFG) and oxygenated gasoline provisions were added. The RFG provision requires use of RFG all year in certain areas. The oxygenated gasoline provision requires the use of oxygenated gasoline during certain months, when CO and ozone pollution are most serious. The regulations also require certain fleet operators to use clean-fuel vehicles in 22 cities.

Clean Diesel – An evolving definition of diesel fuel with lower emission specifications, which strictly limit sulfur content to 0.05 weight percent; in California, aromatics content is further limited to 10 volume percent (for large refiners).

Dedicated Vehicle – Operates solely on fuel. Generally, dedicated vehicles provide superior emissions and performance results because their design has been optimized for operation on only one fuel.

E85 – An alternative fuel that is a combination of 15 percent gasoline and 85 percent denatured ethanol. Made from various grains such as corn, it is a popular option as it promotes American farming and reduces emissions.

Fuel Cell – An electrochemical engine (no moving parts) that converts the chemical energy of a fuel, such as hydrogen, and an oxidant, such as oxygen, directly to electricity.

Hybrid-Electric Vehicle – A vehicle that is powered by two or more energy sources, one of which is electricity. HEVs may combine the engine and fuel system of a conventional vehicle with the batteries and electric motor of an electric vehicle in a single drive train.

Source: U.S. Department of Energy