

Alternate Fuel Technologies - Ethanol and Methanol

Editor's note: This is the third in our series of articles on alternative fuels for the automotive service professional. Basic aspects of ethanol and methanol (alcohol) motorfuels and vehicles are discussed. For more information, please contact Bob Rodriguez at NATEF. Phone: 703-713-3086. E-mail: brodriguez@asecert.org.

As responsible professionals working in the automotive service industry, we owe it to ourselves and our customers to be informed about ethanol, methanol, and the unique vehicles which burn these alcohol fuels. They're part of the growing fleet of alternative fuel vehicles (AFVs) on the road today, and from the outside, they look pretty much like any other you've seen; you may have already had one in your service bay without realizing it. But once you know the differences in the fuels and the vehicles, you'll be more confident and better prepared to answer customers' questions, and to service their alcohol-fueled cars.

Both ethanol and methanol fuels are important alternatives to petroleum. They offer specific advantages for use in today's alternative fuel vehicles, and are just two of a variety of domestically supplied "renewable" alternatives to gasoline for internal combustion engines. As the name implies, renewable fuels can be "replenished."

By contrast, traditional fossil fuels like gasoline or diesel were formed over millions of years: once they're gone, they're gone!

For safety and vehicle performance reasons, however, OEs go to great lengths to optimize the vehicle for ethanol and methanol's unique properties.

For example, the manufacturer may modify compression ratio, cam profile, piston and head design, cooling system, and spark plug heat range. Additionally, injectors, AIR systems, and catalytic converters are likely to be redesigned and calibrated for alcohol fuel. Without advancing the ignition timing, gasoline-dedicated engines cannot take advantage of the higher octane ratings of ethanol or methanol. Because alcohol fuels provide less lubricity than gasoline, valves and/or seats, pistons, and other parts may be hardened, and special lubricants may be specified along with more frequent service intervals. Recalibration of the power-train control module (PCM) is required for optimum management of fuel, OBD-II and emission systems.

Chemical attack is another concern for engineers who design alcohol-fueled vehicles. Gasoline fuel system components—injectors, O-rings, fuel lines, hoses and tanks—could possibly be ruined if exposed to high concentrations of alcohol.

ethanol (E85), or methanol (M85) with gasoline. Unlike dedicated-gasoline vehicles, an FFV's fuel management system must constantly adjust for varying fuel viscosity, energy content, octane and other factors. For example, Chrysler's FFV mini-van (with the 3.3 liter engine) relies on the O₂ sensor to provide input to the PCM for fuel trim and timing adjustments. Ford uses a separate "fuel sensor" to determine alcohol content and fuel temperature for making PCM calculations. (See Ford schematic.)

Fuel handling

Alcohol fuels (unlike gasoline) easily absorb water. Extra care should be taken to prevent snow or rain from dropping into fuel tanks where water

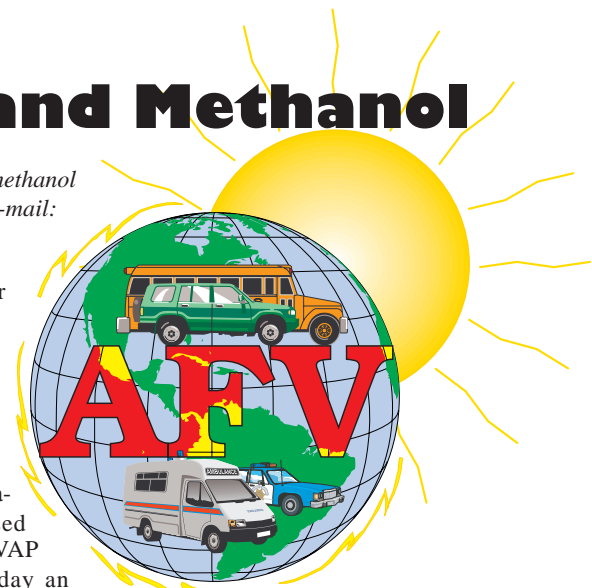
increased fuel injector pulse width during cold weather alcohol startups. On the other hand, during hot weather, alcohol's higher latent heat of vaporization means increased demands on the EVAP system. On a hot day an FFV's engine may be running mostly on fuel tank vapors. You'll find a much larger EVAP canister on-board an alcohol vehicle.

The real world

Ethanol is sold mostly in the cornbelt states - that's where the present feedstock is. Methanol is more

environmental and economic advantages to your customers, and you'll enhance your image as an informed professional in the business. Most of all, you'll be better prepared to diagnose, service and repair this unique breed of alternative fuel vehicles.

A future TechNews edition will focus on gaseous fueled alternative fuel vehicles.



Starting in 1998 all 3.3 liter equipped Chrysler Town & Country, Dodge Caravan and Plymouth Voyager mini-vans are FFVs. Note the FFV logo on the door.



Environmental and feedstock considerations

As a technician you are concerned about tailpipe emissions: 5-gas readings will verify that both ethanol and methanol burn relatively clean compared to gasoline: HC and CO emissions are lower for both fuels, and NO_x emissions are lower due to cooler burning of alcohol, yet a problem of aldehyde emissions remains a challenge.

From a global perspective, alcohol fuels reduce greenhouse gas emissions. According to the DOE, substituting ethanol for gasoline would reduce the production of greenhouses by 35-46%, and according to the American Methanol Institute, substituting methanol for gasoline would cut greenhouse gas emissions by 50%.

Ethanol may soon be economically produced from waste feedstock like corn stover, normally left in the field after corn is harvested, or waste sugar (bagasse) which is normally landfilled or burned. Yard clippings and tree and pulp mill wastes are other possible ethanol feedstocks. Agricultural and forestry "energy crops" like rice straw, wheat, milo, hay, and straw may be grown specifically for ethanol production. The Coors Brewery in Golden, Colorado has partnered with two other companies to recycle its 22 million gallons per year of "beer spillover"—otherwise wasted 7% alcohol condensate—into a pure ethanol gasoline additive.

Methanol is principally produced from natural gas, or from coal or residual oil. Future sources include energy crops like grasses and trees. Industrial and municipal waste may also be used to produce methanol.

FFVs Currently Available

If you want to see an E85 flexible fuel vehicle close-up, watch for these. Note: FFVs look like any other vehicle, and OEs may not aggressively advertise them as FFVs—check the fill cap or the owner's manual to be sure.

OE	Year	Model	Engine
Chrysler	1998 and newer	T & C, Caravan, Voyager	3.3 liter
Ford	1996 and newer	Taurus	3.0 liter
Ford	1999 and newer	Ranger	3.0 liter
Chevrolet	2000	S-10, Sonoma	2.2 liter
Mazda	2000	B 3000	3.0 liter

Source: U.S. DOE's Alternative Fuels Data Center

You may already be familiar with ethanol and methanol. Ethanol was commonly blended with gasoline as a fuel extender during the gas shortage in the '70s when a 10% ethanol blend known as gasohol was sold. Since the phase-out of lead, refiners sometimes blend high-octane ethanol with gasoline as an octane improver. Sometimes ethanol serves as an oxygenate in reformulated gasoline (RFG) to lower CO emissions. Methanol on the other hand is probably best known as the racing fuel for Indy cars and as a de-icer.

Both ethanol and methanol are alcohol based, but they should not be confused with one another. They come from different feedstocks and thus have somewhat different properties which affect engine operation. Ethanol is often called grain alcohol and is principally made from fermented corn, but it is denatured to prevent human consumption. Methanol is known as wood alcohol and is principally made from natural gas, but feedstocks like forest residues and municipal waste can also be used to produce methanol.

Ethanol and methanol engine/system requirements

Some in the aftermarket may claim to have burned ethanol fuel successfully without modifying engine parts or engine re-tuning.

Methanol especially will attack certain metals; both fuels will possibly soften or dry elastomers, polymers and coatings leading to the possibility of contaminated fuel and fuel system component failures, or worse yet: hazardous fuel leaks. It is imperative, despite their similar appearance, that you use only replacement parts designed and intended for alcohol fueled vehicles.

Vehicles in the marketplace

In some countries, neat (100%) ethanol/methanol is widely used in dedicated E100/M100 vehicles. Here in the U.S. you'll see flexible fueled vehicles or FFVs (see FFV chart). These look like dedicated gasoline vehicles, but can burn a mixture of up to 85%

in the fuel will cause gasoline-alcohol blend phase separation, leading to "water bottoms" in the tank and subsequent driveability problems. Unlike gasoline, alcohol is easily absorbed into the human body; thus ingestion, inhalation and exposure of the skin to alcohol fuels should be avoided. Neat (100%) alcohol fuel burns cooler than gasoline and with very low luminosity (difficult to see in sunlight), so a fire would be difficult to spot. But the gasoline-alcohol blend, i.e. E85 & M85, makes flames more visible. Because alcohol fuels are water soluble, a small fire may be doused with water; a larger fire is extinguished with dry chemical or with foam.

Fuel properties

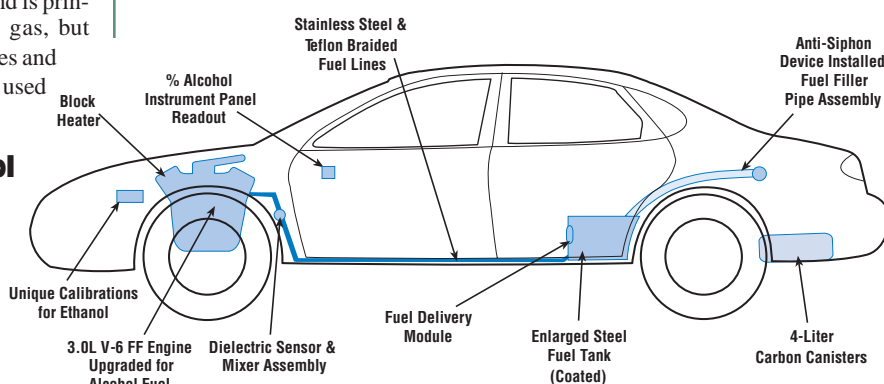
Alcohol fuels offer both advantages and disadvantages to vehicle performance. Ethanol, and especially methanol, fall short on Btu energy content compared to gasoline. This translates to an estimated 27% to 30% loss of vehicle miles-per-gallon traveled compared to gasoline; it's even worse for methanol. On the positive side, with ethanol and especially methanol's higher octane ratings, vehicle operators are impressed with improved torque and horsepower over much of the engine speed range.

Extreme cold-weather starting is difficult with alcohol fuel due to its lower RVP, so OEs may recommend using a winter blend of up to 30% gasoline, for colder climates. At least one OE equips its FFVs with block heaters and programs the PCM for in-

difficult to find. Locating either an ethanol or methanol filling station can be a challenge, but if you or your customer needs to find one, check the web for AFDC's refueling site map, the alcohol fuel associations' websites, or with your alcohol fuel producers. Obviously, as more FFVs are purchased and driven, more refueling sites will appear. Federal and state fleets, fuel providers and utilities, are now mandated to use alternative fuel vehicles which include alcohol-burning FFVs. Numerous financial incentives exist to promote such purchases, and cost/payback models are available "on-line" for fleet owners, managers and operators wishing to explore the alternative fuel choices; go to the [www.ccities.doe.gov] website for more information.

The increased use of alternate fuels will help America to achieve energy independence and reduce fossil fuel defense spending. As an automotive service professional, you may not see many AFVs just yet, but they are finding their way into the marketplace. In the meantime, you may wish to learn all you can about alternate fuels, and flexible fuel vehicles using ethanol or methanol. In so doing, you'll be able to explain their envi-

E85 Ford Taurus Flexible Fuel Vehicle



Ethanol (C₂H₅OH) & Methanol (CH₃OH): Pros & Cons

Pros	Cons
Higher octane than gasoline (R+M)/2=100	Degrades zinc, brass, lead, alum. etc.
Increase of HP & torque (~5% or more)	Lower energy ratio (E=93%; M=66%)
Fewer VOC compounds	Lower RVP; difficult cold starting ¹
Cleaner burning/less deposits	May require special motor oil & service
Lower tailpipe emissions of HC & CO	Toxic, aldehyde emissions, low flame luminosity
Dries water in gas line and tank	Water soluble ²
Renewable	Limited availability/distribution

¹ Cold starting—At least one OE recommended that fuel providers supply a higher gasoline blend with ethanol (E70) during the winter, and equipped its FFV vehicles with engine block heaters.

² Absorbs water—a blend of 10% ethanol in gasoline can hold almost 4 teaspoons of water per gallon in solution. That can be good news for preventing gas line freeze up, but bad news if the station operator hasn't kept his tanks free of moisture.