EB 0802

FUEL ALCOHOL

FUEL ALCOHOL: BASIC FUEL PROPERTIES

The use of alcohol fuels in any engine is subject to a number of constraints that are a result of their basic properties. Table 1 lists a few of the properties of gasoline, ethanol, methanol, and diesel.

Compared to gasoline, ethanol contains about 61% as much energy per unit weight or about 65% as much energy per unit volume. Similarly, methanol contains about 46% as much energy per unit weight or about 49% as much energy per unit volume. Another key difference between alcohol fuels and conventional fuels is the heat of vaporization, which represents the amount of heat required to evaporate one pound of fuel. Note that ethanol requires 361 BTU/lb, or about 2.5 times as much energy as gasoline, and methanol requires 474 BTU/lb or 3.3 times as much energy. Combining these factors with the correct air/fuel ratio yields a value of nearly 4.2 times as much vaporization energy needed for ethanol as compared to gasoline and 7.8 times as much for methanol.

Phase Separation

Phase separation at low temperatures or in the presence of water is a basic problem with alcohol blends. Both methanol and ethanol are completely miscible in water and in gasoline as long as there is no water present. The presence of only 0.1 to 0.2% water in an ethanol-(Methanol)-

Table 1. Fuel Properties

		200 (proof)		
	Gasoline	**Ethanol**	**Methanol**	**Diesel**
Chemical Formula	C_8H_{18}	C_2H_5OH	CH_3OH	$C_{16}H_{34}$
Molecular Weight	114	46	32	226
Boiling Point (^oF)	90-410	173	149	340-560
Specific Weight (lb/gal)	5.8-6.5	6.59	6.6	7.0
Lower Heating Value				
(BTU/lb)	18,900	11,600	8,664	19,047
(BTU/gal)	116,485	76,152	57,182	133,332
Latent Heat of				
Vaporization (BTU/lb)	142	361	474	115
Research Octane Number	85-94	132	136	10-30
Motor Octane	77-86	106	105	10-30
Cetane Number	10 to 20	-20 to 8	–	50
Stoichiometric Mass				
Air/Fuel Ratio	14.76	9.01	6.47	–
Ignition Temperature	220	420	450	220

Cooperative Extension

College of Agriculture Washington State University Pullman
In cooperation with the United States Department of Agriculture.
Issued in furtherance of the Acts of May 8 and June 30, 1914, by
Washington State Cooperative Extension, J. O. Young, Director

gasoline mixture will result in phase separation. The results are that the alcohol-water mix will settle to the bottom of a vehicle's fuel tank or carburetor and an extremely lean mixture will be fed to the engine. The engine is thus running on alcohol alone and will in all probability malfunction. This phase separation problem is even more critical with diesel fuel. At 70°F, a 10% blend of ethanol-diesel would tolerate only 0.13% water, even less at 40°F. Although there are some reports of no separation problems encountered when mixing 160-190 proof ethanol with gasoline, these cases usually involve little or no storage time between mixing and consumption, and involve mixtures with relatively high levels of agitation and moderate air temperatures.

Fuel Handling Problems

The alcohols discussed present several problems in the fuel storage and distribution system and in vehicles. The solvent action of these alcohols tends to loosen gum-bound deposits of rust and sediment and deposit them in the fuel filters. In methanol-rich fuels, and to some extent with ethanol blends, some plastics and rubbers used in the fuel system may experience some degradation, especially polyurethane and polyester-bonded fiberglass. Methanol and ethanol are both highly corrosive to magnesium. If phase separation does occur severe corrosion of steel and terne alloys (used to coat fuel tanks) can result.

Saturated vapor over pure methanol and ethanol is flammable and thus is an explosion hazard. Methanol is extremely toxic and pure methanol has little odor or taste so that one could be unaware of dangerous exposures. Ethanol is less toxic, but the denaturing elements make it extremely toxic. The effects of pure alcohols on human tissues are burning, dehydration, and degreasing. It is not recommended to use alcohols as solvents for cleansing hands or equipment.

References

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