The Making of Modern Gasoline

Currently, ASTM D 4814 is the official standard specification for automotive spark-ignition engine fuel. There are several test methods encompassed in the D 4814 Specification. Here is the part that affects us as antique vehicle owners…

Octane Quality
Gasoline is most commonly rated by its Antiknock Index (AKI) a measure of octane quality. The AKI is a measure of a fuel's ability to resist engine knock (ping). The AKI of a motor fuel is the average of the Research Octane Number (RON) and Motor Octane Number (MON) as determined by the formula (R+M)/2. This is also the number displayed on the black and yellow octane decal posted on the gasoline pump. Optimum performance and fuel economy is achieved when the AKI of a fuel is adequate for the engine in which it is used. There is no advantage in using gasoline with a higher AKI than the engine requires to operate knock-free.

The RON and MON of fuels are measured by established recognized laboratory engine test methods. Results of these tests may generally be translated into approximate field performance. In general, the RON affects low to medium speed knock and engine run-on or dieseling. If the Research Octane Number is too low, the car owner could experience low speed knock and engine run-on after the engine is shut off. The MON affects high speed and part-throttle knock. If the Motor Octane Number is too low, the driver could experience engine knock during periods of power acceleration such as passing vehicles or climbing hills.

The antiknock performance of a fuel, in some vehicles, may be best represented by the RON, while in others it may relate best to the MON. Extensive studies indicate that, gasoline antiknock performance is best related to the average of the Research and Motor Octane Numbers. The RON of a fuel is typically 8 to 10 numbers higher, than the MON. For instance, an 87-octane gasoline typically has a MON of 82 and a RON of 92.

Volatility
Gasoline is metered in liquid form, through carburetors (in our case), and mixed with air and atomized before entering the cylinders. Therefore, it is very important that a fuel's tendency to evaporate is controlled to certain standards. A fuel's ability to vaporize or change from liquid to vapor is referred to as its volatility. Gasoline that is not volatile enough (a common occurrence in the 1960s) results in poor cold start and poor warm up drivability as well as unequal distribution of fuel to the cylinders in carbureted vehicles.

So called "dirty fuels" can contribute to crankcase and combustion chamber deposits as well as spark plug deposits.

Gasoline that is too volatile (typical of the mid 1980s) vaporizes too easily and may boil in fuel pumps, lines or in carburetors at high operating temperatures. If too much vapor is formed, this could cause a decrease in fuel flow to the engine, resulting in symptoms of vapor lock, including loss of power, rough engine operation, or complete stoppage. Fuel economy could also deteriorate and evaporative emissions could increase.

In order to assure that fuels possess the proper volatility characteristics, refiners adjust gasoline seasonally providing more volatile gasoline in the winter to provide good cold start and warm up performance. In the summer, gasoline is made less volatile to minimize the incidence of vapor lock and hot drivability problems and to comply with environmental standards. Adjustments are also made for geographic areas with high altitudes. This is done because it requires less heat for a liquid to boil at higher altitudes.

The Missing Lead Additive
Most all, antique vehicles, as well as certain farm machinery and marine equipment, do not have hardened valve seats. Originally…in these vehicles, metal-to-metal contact between the exhaust valve and exhaust valve seat was prevented by a build up of lead oxides from the combustion of leaded gasoline. Unleaded gasoline provides no such protection against exhaust valve seat recession (EVSR) you at least need to be aware of the symptoms and adding a fuel conditioner is a good protective measure to protect your antique engine.

Ethanol Properties
The Ethanol added to gasoline is the same alcohol used in alcoholic beverages except it is 200 proof (100% alcohol) It also has a low percentage of hydrocarbon added to encourage you or your relatives not to drink it.

In the U.S. gasoline typically contains 10% ethanol and today is referred to as E10, as opposed to gasohol as it was referred to in the 1980s. Other countries such as Brazil blend ethanol at up to 25%. Fuel grade ethanol that is blended at up to 10% in gasoline must meet the specifications set forth in ASTM D 4806 "Standard Specification For Denatured Fuel Ethanol For Blending with Gasoline For Use As Automotive Spark Ignition Engine Fuel". While most components used in gasoline do not have their own ASTM specifications, fuel grade ethanol does.

Ethanol alcohol attracts water. It picks up moisture throughout the fuel system. In the early gasohol era, this sensitivity to water led to problems because service stations often had water in the bottom of their underground tanks. Officially… the petroleum industry is well aware of these considerations and companies using ethanol have implemented procedures to eliminate moisture in underground storage tanks. It is best to check the fuel you buy to see for sure if there is water in your fuel, especially if you are going to place your antique vehicle in storage for longer than 60 days.

The addition of 10% ethanol will typically contribute 2.5 or more octane numbers to the finished blend. The addition of ethanol increases vapor pressure by up to 1.0 psi although refiners may make other alterations to limit vapor pressure to comply with federal regulations. Ethanol is approximately 35% oxygen (which is part of the source of vapor lock when we use modern gasoline in our antique vehicles) so a 10% blend would contain approximately 3.5 weight percent (w%) oxygen that improves combustion properties.

Ethanol is often confused with methanol. These two alcohols have distinctly different characteristics. Unlike ethanol, methanol is very toxic. Ethanol provides better water tolerance and better fuel system compatibility and contains less oxygen than methanol. Methanol causes a significant increase in volatility (which is why it is used in race cars and performance applications) while ethanol results in only a slight increase.

Fuel Volatility

In the mid 1980s the vapor pressure of much of the gasoline was in excess of what automobile fuel systems were designed to handle during hot weather. This led to a rash of hot drivability / hot restart problems. It was during this time frame that ethanol began to see more widespread use and therefore these problems were often attributed to ethanol. In reality, many fuels of that era, including hydrocarbon only fuels, were of unacceptably high vapor pressure.

Hot drivability/hot restart problems are primarily warm weather problems. Today, the EPA regulates the vapor pressure of all gasoline during the summer months (June 1 to September 15 at retail) resulting in maximum permitted vapor pressures ranging from lower than 7.2 psi to 10.0 psi depending on the type of gasoline and area in which it is sold. Therefore hot drivability and hot restart problems such as vapor lock and fuel foaming have been largely eliminated (except for antique vehicles) for modern cars and trucks. All of us who drive antique vehicles with five pounds of fuel pump pressure still experience drivability issues. The alcohol in the fuel also dries out gaskets in the carburetor and fuel system. The alcohol can also cause damage to rubber fuel lines and the rubber diaphragms in mechanical fuel pumps. We buy less than one percent of the gasoline sold in the United States so we are pretty far down on the food chain.

Octane

High compression engines tend to have high cylinder temperature that sometimes causes the fuel to ignite before the piston reaches top dead center. You experience that as engine knock.
Increasing the octane in gasoline will cause the fuel to burn slower and ignite at a higher temperature when the piston is at top dead center. Lower compression engines, those below 8 to 1 compression generally do not have the pre ignition problem so running a higher octane in a low compression engine can in some cases reduce the engine performance because of the slower burning fuel and higher ignition temperature.

Follow The Money

Did you ever wonder how they got the oil companies to go to all of the extra work to deliver alcohol gas to the service stations? It is called a federal tax credit at it has been going on for nearly 30 years. It cost us taxpayers 30 billion dollars in fiscal year 2011. It works like this…

The ethanol tax credit provided a credit against Federal gasoline taxes that is worth 51 cents for every gallon of ethanol blended into the gasoline pool. For a typical gasoline blend with 10 percent ethanol, the credit reduces the Federal excise tax (18.4 cents per gallon) by 5.1 cents, resulting in an effective tax rate of 13.3 cents per gallon for the blender. This tax credit has been in effect since 1978, and while it has been adjusted both up and down, it has consistently been extended until 2012 when it was finally allowed to expire and was not renewed.

In case you are wondering if the oil companies suddenly got religion when they did not put up much of a fight for the tax credit they were loosing…well they got something better in exchange, a federal mandate that all motor fuels sold in the United States shall contain at least ten percent alcohol. What that did was guarantee the demand for blended alcohol fuel, which in the long run will be worth more than the tax credit. So it looks like we will have blended alcohol fuel around for a long time to come.