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AUTO FUEL . . . QUESTIONS & ANSWERS

On August 6, 1982, Federal Aviation Administrator J. Lynn Helms became the first American to legally pilot a "standard category" aircraft fueled with unleaded auto gas. The STC (Supplemental Type Certificate) that made the brief flight around the EAA Convention site in a Cessna 150 possible was the result of years of research and testing conducted by the non-profit EAA Aviation Foundation. Since that historic flight, the use of auto fuel has been approved (with an EAA STC) for more than 334 different aircraft models. The burgeoning auto fuel fleet now includes some 15,000 American aircraft owners who are flying on readily available, inexpensive auto fuel. Over 220 FBOs across the country provide mogas for their customers. These numbers are growing every day.

With the growth of the number of aircraft able to legally use mogas and the growth of our own auto fuel research programs, interest in the use of auto fuel for aviation applications has grown as well. We receive dozens of questions each week from aircraft owners, EAA STC holders and the mass media. Many of them ask the same questions. Harry Zeisloft, Director of Research and Development at EAA's Kermit Weeks Flight Research Center, has developed a document known as Field Information 8502, which answers the 11 most asked questions about auto fuel use in aircraft. We know you will find this report both interesting and informative.

IS IT ALL RIGHT TO MIX AVGAS AND AUTO GAS?

Aviation gasoline and unleaded automotive gasoline may be mixed in any proportion. Any mixture containing unleaded automotive gasoline must be operated in accordance with the placards or precautions established for unleaded automotive gasoline.

CAN AN AIRPORT RESTRICT ME FROM FUELING MY OWN AIRCRAFT?

Not and continue to be eligible for Federal Aid. They may, however, require that you conform to their safety regulations.

In accordance with guidelines per FAA AC 150/5190-2A, section 4.d: "Any unreasonable restriction imposed on the owners and operators of aircraft regarding the servicing of their own aircraft and equipment may be considered as a violation of agency policy. The owner of an aircraft should be permitted to fuel, wash, repair, paint and otherwise take care of his own aircraft, provided there is no attempt to perform such services for others. Restrictions which have the effect of diverting activity of this type to a commercial enterprise amount to an exclusive right contrary to law. Local airport regulations, however, may and should impose restrictions on these activities necessary for safety, preservation of airport facilities and protection of the public interest. These might cover, for example, restrictions on the handling practices for aviation fuel and other flammable products, such as aircraft paint and thinners; requirements to keep fire lanes open; weight limitations on vehicles and aircraft to protect paving from overstresses, etc."

CAN ALCOHOL, METHANOL AND ETHANOL BE USED?

Do not use fuel which contains alcohol. It is not compatible with materials in your fuel system and will cause malfunction of the fuel delivery system. There is a simple test to determine significant alcohol content in fuel. Write EAA and ask for **Field Information No. 8501** for details on how to do it yourself.

THE AKI IS ONLY 85 IN SOME STATES — IS THAT A LEGAL FUEL?

The octane number requirement for any engine is reduced with reduced ambient temperatures and increased altitude. Therefore, Mountain States are permitted to market fuel at lower octane numbers than others. In terms of the STC, the approved fuel must have an 87 antiknock index rating. This may mean that sometimes in mountainous states, premium fuel should be used. In this case the minimum octane number according to DOE surveys will be at least 84 MON (equivalent to avgas octane number). Using regular unleaded automotive gasoline with an 85 AKI could possibly result in a minimum octane number of 79.1 MON. This difference is probably not significant, but in order to maintain a larger conservative margin, EAA requested approval of autogas with a minimum 87 AKI.

HOW DO I DETERMINE THAT THE GAS I USE MEETS ASTM D-439?

In many states the law requires compliance with D-439 or its equivalent. Major fuel suppliers, that is, those who generally have their name on the product from well head to retailer, can be expected to comply since this is a rather broad specification and in wide use. The Department of Energy Reports, which are issued twice a year, show that most fuel in the entire United States conforms completely to the specification requirement, and in those cases where there is some excursion, it is in non-critical areas. For example, octane numbers have always been higher than 80 octane avgas.

If further reassurance is necessary, a sample of gas to be used can be taken to a State Testing Lab, or a State University may also provide a chemical breakdown to conform conformance for a nominal fee. The American Petroleum Institute publishes a survey of State laws indicating which States require conformance by law. At the present time 36 States require compliance with D-439, and/or have written their own requirements around the specification D-439.

Product exchange arrangements among oil companies requires conformance to at least D-439 specification requirements. It simply is not practical for oil companies to market non-conforming fuels in a limited market area.

HAVING CORK FLOAT PROBLEMS . . . IS IT RELATED TO THE USE OF AUTOGAS?

Cork floats in older aircraft were coated with a varnish sealant. Newer fuel, 100 low lead avgas and automotive gasoline have higher aeromatics than 80 octane aviation gasoline and may attack old varnish. This leads to problems of gasoline absorption by the cork and particles of varnish getting into the fuel system and possibly plugging metering jets in the carburetor.

Newer polyurethane varnish does not have this problem. If you suspect an older varnish coating, it would be best to recoat it with a polyurethane type of varnish.

If your fuel system has been performing satisfactorily with long term use of 100 low lead avgas, then it should be satisfactory with no changes using automobile gasoline.

WHY ARE TWO STC'S NECESSARY FOR MY AIRCRAFT?

The engine must be able to use the fuel with no problems. The airframe must be able to deliver the fuel to the engine with no problems. Aircraft and engines must at least duplicate original type certification testing applicable to powerplant and engine. The EAA chose to do more than required in the Federal Air Regulations and also selected the longer 500 hour flight test for approval rather than the engine block testing. The Cessna 150 program extended over 24 months and included periods of hot weather and cold weather testing, with seasonal variations in automobile gasoline volatility. The FAA defined the change in fuel from aviation gasoline to automotive gasoline as a major change. Therefore, under present Federal Air Regulations supplemental type certification is required.

WILL THERE BE ENOUGH VALVE LUBRICATION USING UNLEADED AUTOGAS?

We expect greater extended engine life and more time between overhauls with the use of unleaded regular autogas. We have over 500 hours of flight test time on each of the following aircraft — Cessna 150 with a Continental engine, Cessna 182 with a Continental engine, Piper Cherokee PA-28-140 with a Lycoming engine and a Cessna 172 with a Lycoming engine. All aircraft performed very satisfactorily in actual flight tests for EAA and FAA, and in engine teardown inspection. Our tests indicated no adverse wear problems with the use of unleaded autogas.

Small engines from the 1940's were designed for fuels with octane ratings of 63 and 73 octane. These fuels contained no lead at that time. There were valve sticking problems in some engines which were resolved by the manufacturer issuing service instructions to change the valve seat angle and to replace soft valve seats with hard seats. This had been done so many years ago that there is little likelihood of an engine still in existence which has the original soft seats and old valve seat angles. Thus unleaded autogas with its low lead content of .05 grams per gallon, has been satisfactory in these engines. The use of 100 low lead avgas with its very high lead content compared to the need for these engines, has caused many problems as outlined in AC 91.33. Other engine manufacturers, in order to minimize valve problems caused by the excessive lead content of 100 low lead avgas, have increased valve stem diameters and added hardened inserts for the valve seats. Both of these changes favored the use of a gasoline with a very low lead content also, and as pointed out above, showed normal wear characteristics in the EAA's 500 hour flight test program.

WHY IS THE EXHAUST STACK OF MY ENGINE BLACK WITH SOOT AFTER USING AUTOGAS?

A black soot is the natural by-product of burning unleaded gasoline and is to be expected. It is not an indication of a rich mixture. It does not indicate an internal build up nor potential for spark plug fouling.

EXPLAIN AKI AND OCTANE NUMBER?

The number which is posted on automobile service station pumps is not a true octane number. It is what is called an "antiknock index" number (AKI). This number is the average of two octane numbers arrived at by two different kinds of tests. One is called the ASTM Research Method and is often abbreviated R or RON. The other is the ASTM Motor Method, M or MON. The antiknock index number on the pump is then this average, or R plus M divided by 2 equals AKI. A rule of thumb is that the Motor Method octane number (MON) is approximately six points less than the AKI. The significance of the MON is that this is identical to the octane number for aviation gasoline. Specification D-439 for automobile gasoline requires a minimum of 82 MON when the posted number is 87 AKI or more.

When the EAA requested approval from the FAA the request was for an AKI number of 87 to insure a safety margin of 2 octane numbers over the approved rating for aviation gas for these 80 octane engines.

The Department of Energy semi-annual report giving data on gasolines selected at random throughout the United States shows that for more than 20 years the lowest octane number measured for automobile gasoline in the U. S. has been **more** than 80 octane by the Motor Method, which is, of course, the aviation method. So, for 80 octane aircraft engines the octane rating of even the lowest octane automobile gasoline is more than adequate.

ISN'T VAPOR LOCK OR DETONATION A PROBLEM WITH UNLEADED AUTOGAS?

As outlined in the previous discussion regarding octane number, detonation will not be a problem when using any grade of autogas with an aircraft engine approved for the use of 80 octane fuel.

Vapor lock is always a problem to consider regardless of what kind of fuel is being used. Vapor lock has occurred under some conditions while aircraft were using aviation gasolines. When using autogas, vapor lock is an important consideration because autogas has been designed to facilitate engines starting in the winter time and thus has a higher volatility in winter months. In the test work done by the EAA, this winter fuel of high volatility was used in the high summer ambient temperatures. This combination represents the most adverse conditions for the formation of vapor lock. There are other important considerations, the effect of high ambient temperatures, very high engine operating temperatures and high fuel temperatures under conditions of takeoff with high volatility fuel. This combination of circumstances is difficult to maintain because when a fuel is heated, vapor is driven off which in turn reduces the volatility of the remaining fuel. Thus in our test work it was necessary to refrigerate fuel before loading the aircraft fuel tank, heat soaking the engine and compartment by high power operation, and then attempting to keep the fuel cool and the airplane hot to demonstrate satisfactory performance of the fuel system during the critical takeoff period.

Another area of concern is high altitude vapor lock. All EAA flight test programs have included an evaluation of the adverse combination of volatility and temperatures, plus demonstrated climbs to the service ceiling of the aircraft (which in the case of the Cessna 182 was 21,034 feet density altitude), and to also include some periods of cruise at altitudes above 7000 feet. Each airplane which we have flown in our 500 hour flight test program successfully completed these tests.

If you have any questions about mogas that haven't been answered by this report, contact the EAA Kermit Weeks Flight Research Center, Wittman Airfield, Oshkosh, WI 54903-3065 or call 414/426-4800.