Autogas Part II

The more we learn about autogas the better we like it. The key to safety and success lies with adhering to the STC.

by Mike Berry

Last month we discussed the primary points of using autogas in aircraft from the supply side. That is, the differences in how autogas was handled getting it to its destination compared to avgas.

The upshot was that there is no real, unbroken string of quality control with autogas. It is shipped down a common pipeline in a generic form, and any changes made to suit local brands and local requirements are made at the tanker truck level.

Conversely, avgas never travels down cross-country pipelines and is always under some form of specific control, so regardless of the part of the country you are in or time of year, avgas is the same. What this means is that the individual autogas user is responsible for final quality control of the gas they put in their airplane. Testing for octane level, alcohol or water in the fuel and Reid vapor pressure are tests a user can do relatively easily and cheaply.

Skipping these tests can be gambling with the engine. Because of the possible variation in autogas and need to check individual batches, as well as the fact that airplanes were not certificated with autogas from the factory, virtually all manufacturers—from engine and airframe makers to refiners are loathe to concur with autogas use in airplanes. Some to the point of denying warranty coverage.

The issue revolves around liability, as another unknown element is being added to the fuel quality control chain—the pilot. There is no question autogas can be safe if given the proper checks and handling by the person fueling the plane.

As an example of what can happen, we recently were contacted for advice by a seaplane pilot who had fueled up at a marina on a cross-country. Due to extraordinary water contamination of his fuel, his engine was ruined after takeoff followed by an emergency landing.

If you want to avoid this outcome yourself, and are fueling up with autogas, particularly at a place such as a marina or unknown gas station, checking is a must.

If you mix enough water in the fuel, it can do more than just stop the engine—it can destroy it by detonation. This poor fellow suffered broken engine mounts and holed pistons.

Lastly, we emphasized the importance of having updated valve train components in any engine in which autogas was going to be burned. Modern valves, guides and seats are more tolerant of the absence of lead so that they will not burn up prematurely.

The absence of lead does have a positive benefit in spark plug life and keeping deposits at a minimum compared to leaded fuels.

With well over **50,000** STCs out there, there is no question autogas has a solid future in lower compression engines—provided the rules are followed. Next, we will discuss the importance of obtaining and following the STCs, as well as address **82** unleaded.

Stick With the STC

It is important to obtain an auto-gas STC for your specific airframe and engine combination and abide by the limitations of the STC. If there is no STC for your particular model of plane, even if you have an approved engine, do not use autogas as your aircraft most likely has a problem with vapor-lock from the engine/airframe interface.

An engine may be approved, and an airframe may be approved, but the two together may not work acceptably for using autogas.

One of the most common causes is the less than straightforward intake air designs of certain airframe-engine combinations. Remember your engine is primarily an air-burner. Consider that **16** gallons of air are used to burn a gallon of gas, nominally.

Peterson Aviation is the big kid on the autogas STC block with over **30,000** STCs in circulation. The EAA

Praise the EAA

The EAA deserves special recognition from autogas users for sticking by their guns when virtually the entire aviation establishment was against them in getting autogas approved for aviation use in low octane engines,

It’s been I 8 years now since these first recognized pioneering efforts took place, and while the engine and airframe makers are still dead set against autogas, the reason cannot be attributed to any real problems with autogas. The FAA’s specific findings point to no statistically significant safety related issues with regard to autogas use. Those naysayers who spout alarming accident numbers are simply including autofuel users regardless of the cause of the accident or whether the airplane was operating with an approved STC or not. The old saw is: There are lies, dammed lies and statistics. With a little effort they can say about anything you want.

Inadvertently, the refiners have helped the aviation users by improving the consistency and quality control of autogas in order to eliminate the early problems fuel injected autos had with older formulations of gas causing fuel injector clogging. In effect the refiners “refined” their standards to assure their motoring customers were retained. They saw early on that fuel injection would be the predominant system for autos as it has become.

Bucking the system can be both rewarding and frustrating to the EAA mavericks willing to stick by their guns, and the job is not over—at least not from a public education sense, or solving the future needs of the 300,000 or so mandatory users of 10011. The aviation community would possibly never have gotten to first base without their help. A tip of our collective cap is off to these autogas pioneers.

is second with perhaps 20,000 more. The remaining few thousand are from small, specialty type companies seeking aircraft STCs not covered by the two big players.

Material Considerations

In addition to general problems with the use of autogas outlined by all aircraft and engine manufacturers of quality control, alcohol or other additives in fuel, and high vapor pressures, engine manufacturers have identified high upper cylinder and valve wear as a problem when unleaded fuel is used during the break-in process. Note below there is an easy solution to this issue.

There are many problems associated with aircraft engine fuel period, not just autogas. Some problems are a result of the disappearance of 80/87-octane fuel and the substitution of 100LL fuel.

When an engine cylinder is repaired or overhauled, an owner should be certain that the latest style, high quality valves, compatible valve guides and valve seats are installed that are designed for use with 100LL fuel. As an additional benefit of the new hardware, the valve train is more tolerant of unleaded fuel use.

After repairs to cylinders are accomplished such as grinding valve seats, valve refacing, or installing replacement parts such as valve guides, it is important to break in these new parts for approximately 25 hours with leaded fuel to provide some lubrication before using lead-free fuel.

Problems with excessive lead from bOLL fuel use in engines originally designed for use with 80-octane fuel have almost disappeared due to new replacement parts designed for 100-octane fuel use.

Alcohol in autogas when used in aircraft has caused numerous problems such as fuel leaks and fires due to rapid deterioration and swelling of rubber gaskets and seals. Fuel tank quantity floats made of cork and/or composite materials are attacked by the alcohol in fuel and allow particles to float in the fuel, clogging fuel screens, plugging carburetors, etc.

Sloshing compound used in many fuel tanks to seal leaks also reacts with the alcohol, causing fuel leaks and fuel system contamination.

Marvel Schebler carburetors that have the old composite floats are damaged by 100LL fuel as well as autogas and are particularly sensitive to alcohol in the fuel. Aircraft owners should have the newest metal float installed.

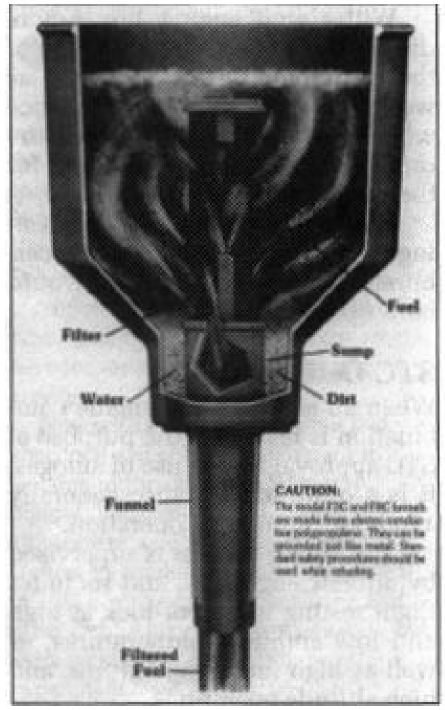
Stromberg carbs such as used in the TCM-C and A 65/75/85 models that have an old style of neoprene-tipped float needle in the carburetor is attacked equally by 100LL and autogas and should be replaced with the newest style needle.

Swollen float needle tips cause a lean mixture and eventual engine damage. Cessna aircraft with rubber-tipped fuel strainer plungers are also damaged by the use of autogas with alcohol and frequently leak after a short time of use with an autogas/alcohol mix.

Most recently a “malfunction” appeared in the FAA alerts describing a Piper aircraft that caught fire in flight due to a leaking fuel strainer gasket that was swollen by the use of alcohol mixed with autogas. The pilot was able to turn off the fuel to stop the fire and save himself but he was forced into becoming a glider pilot.

Any rubber part such as fuel lines, fuel cells, and 0-rings in fuel selectors are subject to damage from alcohol mixed in the fuel. In addition to problems associated with

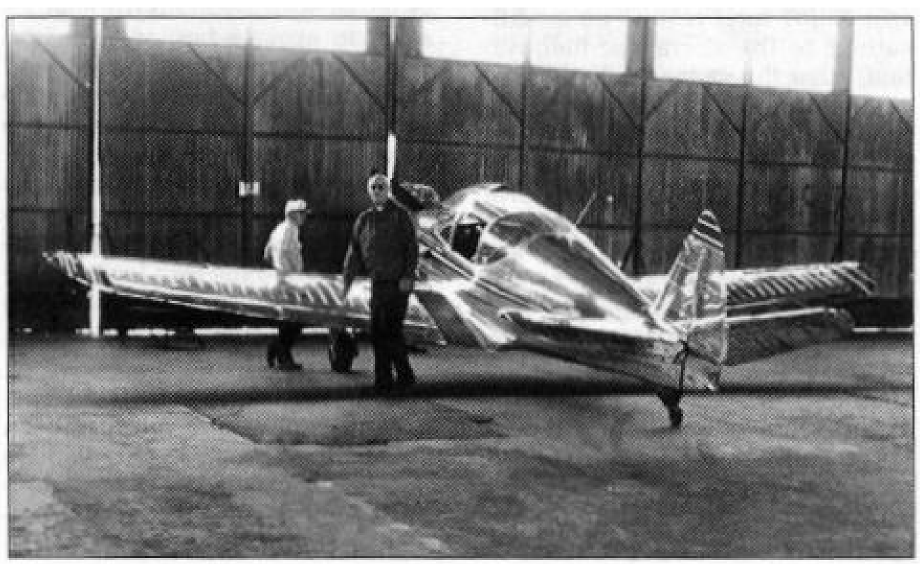
alcohol in autogas, oxygenated fuels have been tested and shown to provide



This funnel is designed to trap water and other contaminants you may encounter in autogas (or avgas) of unsure origins. It’s widely available at low cost such as from Aircraft Spruce.

3 to 5 percent less BTU output than avgas, thus decreasing range somewhat.

This BTU output reduction is not a problem for modern automobiles since they use computer-controlled fuel injection and spark advance, thus allowing the fuel mixture to be altered to counteract this reduction with no apparent loss of maximum power.



This gent is a happy camper as his airplane was certified for use with autogas during the early phases of model testing. Petersen archive photo.

With aircraft engines this is more difficult as testing, and alteration of the carburetor settings and jets, as well as changes to the spark advance would be required to achieve the original maximum power output for the specific fuel used.

This is not practical as the testing, and changes to the engine, carburetor, and spark advance would be costly.

STC Details

When an airframe and engine combination is tested for the purpose of STC approval for the use of autogas, it is a quite lengthy test; generally 150 hours or more of operation.

The testing process is supervised by aircraft engineers, and includes flight testing for vapor-lock at high and low ambient temperatures, as well as high fuel temperatures, and high altitude operations.

Detonation testing is accomplished to determine if an engine can operate without damage during operation at 100% power for periods totaling over 100 hours.

To obtain an STC for your aircraft is a simple process in most cases, since most eligible, engine-airframe combinations have been tested already.

You must have your aircraft serial number, N number, and engine serial number and type available. Call the STC holder with this information, and complete the financial transaction. STCs are not transferable, so the STC that you purchase stays with the plane and cannot be "shared" with others. STC prices are variable.

Most aircraft that were certified with 80/87 fuels require no modifications to the aircraft or fuel system, other than a tag applied to the engine, and decals applied to the fuel tank filler openings identifying the type of approved fuels.

The "paperwork" (FAA form 337) must be approved by an IA or other authorized individual approved to return an aircraft to service after a "major alteration."

While this may seem silly in this case, it is important for a mechanic to determine whether this modification is appropriate in consideration of already installed modifications such as aftermarket turbochargers, electronic ignition systems, or higher compression pistons installed in the case of Lycoming 0-320 engines converted to 160-hp models.

The Unison LASAR ignition system is not approved for use with autogas STC'ed aircraft and engines, so the autogas STC would become invalid with this installation, and the use of 100L avgas would be required.

Some Piper PA-28 160, 161, 180 and 181 models that originally used 91/96-octane fuel are Petersen STC approved for use with autogas but require modifications to the fuel system, such as the replacement of the original electric fuel pump and installation of an additional fuel pump as well as the replacement of a fuel line fitting, and restrictions to the use of the right fuel tank for takeoff and landing.

Many radial engine-equipped planes are approved for the use of autogas. However, the radial engines as well as Franklin engines seem to operate best with a mixture of 75% unleaded autogas and 25% 100LL avgas so as to provide some lead for lubrication of the valves and upper cylinders.

These older engines do not have hardened valves and valves seats appropriate for use with 100% unleaded fuel, so the lead is necessary in this case to prevent premature wear of these components.

82 Unleaded Fuel (82UL)

Recently, 82-octane fuel has been approved for use in engines that are STC'ed for use of low octane auto-gas. Those engines that were originally approved for the use of 91/96-

octane fuel and require high-test autogas by STC are not approved for use of this 82UL fuel.

The EAA has available decals (reference bulletin 2000-1) that replace previously installed autogas placards displaying 82UL as an approved fuel. The FAA has determined that some type of recertification testing was necessary regarding the approval for use of 82UL fuel since it is an entirely different fuel than 80/87-octane avgas.

Basically, 82 unleaded is generic autogas from the "pipeline" that has none of the additives; in addition, it has tighter specs (9-psi max vapor pressure) for use with aircraft. The higher volatility of this 82UL fuel is one major factor that does not permit the blanket replacement of 80/ 87 fuel with 82UL, convenient though such a replacement might be for most owners.

STCs allowing the use of low octane autogas have been extended to the 82UL fuel based on testing – good news for many of the 50,000 plus U.S. holders of autogas STCs.

The general complaint from engine manufacturers is that the 82UL fuel still has a higher vapor pressure than the current avgas or 80/ 87 avgas, and is only useful in a relatively small number of engines that were originally designed for use with 80/87-octane fuel. However, it is unfortunate that the 82UL fuel is not readily available at the consumer level as of this writing, as it solves many problems associated with autogas for aircraft use.

One suspected reason for this non-availability other than the relatively new approval, is that FBOs have not asked for the fuel from suppliers. Since 82UL fuel is auto-gas, it is available at the wholesale level.

However, FBOs are reluctant to stock 82UL, as the amount of perceived demand relative to the demand for 100LL is low. It is a matter of economics and making a return for the investment; this is the principal reason for the disappearance of 80/8 7 fuel.

There is still an unfilled void for the 300,000 users restricted to the use of 100LL fuel. It has been reported ~ that 30 percent of aircraft using avgas consume about 70 percent of the 100LL fuel.

Large aircraft that use 100LL fuel

contribute in a big way to this demand. This helps to ensure that 100LL fuel or its equivalent will be available as long as this demand continues.

With the eventual reduction and possible elimination of leaded fuel, aircraft engine and aircraft manufacturers will be required to find an alternate fuel or in some way deal with the reduction in lead used to boost octane levels to 100 in traditional avgas.

This reduction in lead is not a threat in the near term but dates as soon as 2006 have been rumored as the cutoff for leaded fuel, although some in the industry have doubts this cutoff will ever come to pass.

Investigation on this issue with engine manufacturers has suggested a willingness to work on a solution to this problem as the need arises.

Textron-Lycoming, in fact, has done testing and continues to do testing with alternate fuels, not to mention a major development in electronic ignition systems.

Test cell operations done with unleaded aviation fuels (specifically for aircraft) have exhibited good results with a specially formulated 9l-octane unleaded aviation fuel recently approved by the Swedish civil aviation agency.

This fuel has been approved for use with certain models of Lycoming engines (including engines that originally used 91/96 octane avgas) and is now being used in certified aircraft in Sweden.

The recent unleaded avgas operations with this specific unleaded fuel have been very promising with up-per cylinder and valve wear. It is important to differentiate this fuel from automotive fuel.

Bottom Line

With all the information provided above in this and part-one of this article last month, the conclusion can be drawn that it is safe to use autogas within the limitations set forth by the STC holders.

Some things had to be learned the hard way, such as making sure the proper valve train components were installed, but things have pretty well sorted themselves out.

Working with the STC holders is one way to assure you have the latest information on optimal operating protocols and updates.

Make sure your airplane is, in fact, eligible the STC. Unapproved use of autogas in a similar, but not STC eligible plane is a very dangerous practice. Make sure you obtain the STC so you know exactly what the requirements are. This, in addition to being the legal and safer way to do things, also will help ensure no hassles with insurance companies if ever needed.

When proper precautions are observed such as maintaining fuel cleanliness, checking for alcohol and contaminant-free fuel, and occasional checks for vapor pressure during change of seasons, you can successfully operate your STC approved aircraft with autogas.

Mike Berry, an airline captain and IA, is a frequent contributor to LPM.

Hangar Talk on 100LL

While we have pointed out some potential problems with consistency in autogas such as possible variations in vapor pressure, we are less than thrilled with 100LL avgas 'erstwhile surgical level of manufacture and traceability. What has sparked that concern are the inputs over time from our readers as well as personal experiences with 10011 having a lack of consistent uniformity other than being blue and burning. These inputs have taken several forms from detonation incidents in perfectly maintained and flown planes to strange deposits on plugs and other combustion chamber areas, to vapor lock incidents from planes using 10011 exclusively, How do you explain deposits so heavy and concentrations of carbon and lead buildup in combustion chambers of properly adjusted aircraft? Deposits so heavy as to cause continual leaks in valves and rings frozen into place? Or a plane that operates fine in California on one brand of gas, moves to another part of the country and runs terrible: then returns, only to run fine again?

Another example. Incidents of surging occur with any other brand of gas other than Texaco IOOLL on a TRI82RG—just like clockwork,

The ultimate resolution of this problem was interesting and enlightening. ~s it turns out, maintenance done on the carburetor had resulted in the float being adjusted a tad low, creating a lean condition at full throttle.

The reason the Texaco fuel ran perfectly was that the specific gravity of the Texaco fuel had a slightly lower specific gravity than typically found. Thus, the float swam lower in the fuel, allowing for a higher float bowl level. Other 182s have had similar lean conditions, which begs the question of how much tolerance does this engine have for variations in 100LL specific gravity?

Now we'll be the first to admit that Anecdotal evidence is tantamount to working in the realm of UFOs and Bigfoot, but bear with us, please. The 182 incidents spurred one of the 1PM staffers to conduct his own experiment in 100LL specific gravity, realizing that other factors may be at work as well, but there were limits to this simple experiment.

Favors were called in and samples of 10011 avgas were obtained from all over the country, and the measured specific gravity varied from .670 to .720, with most reports falling in the.700 range on the West coast and .71 5 on the East coast. Is this enough of a difference to matter? For a perfectly adjusted engine, probably not, but for those a bit off it could be problematic—especially since people don't usually expect any measureable variations in avgas when troubleshooting an engine problem.

How much can this little variation Mean in terms of carburetor adjustment? If you look at an old chart from the I940s where they felt this was important to know, specific gravity from .675 to .720 meant up to 3/32-inch variation in float adjustment for a Stromberg carburetor. Never rule fuel out as a possible source of the problem, and make sure your carburetor is adjusted right on the money.