AeroShell TECH TALK

ALCOHOL IN AVIATION

In many countries, Mogas is approved by Aviation Authorities for use in a range of engine / aircraft combinations, typically those with engines that have a modest octane demand mounted in aircraft where the fuel system design reduces the risk of vapour lock. With non-microlight, Category A type aircraft, the approval for Mogas use is controlled by the issuing of Supplementary Type Certificates (STCs) in the main. These STCs allow the user to utilise Mogas as an alternative fuel to Avgas, with which the aircraft and engine combination would have been originally type certified.

Interestingly the STCs to use Mogas are an approval only by the licensing authorities (Civil or Federal Aviation Authorities); the oil companies, engine manufacturers and airframe manufacturers generally do not approve its use. For reasons covered more fully in an earlier Technical Talk, Shell has never supported of the use of Mogas in aviation applications and our concerns essentially centre on the fact that the product is poorly defined for the demands of aviation. One aspect of this, namely the ability for Mogas to contain alcohol, is even recognised as a problem within the licensing authorities and Mogas supplies containing alcohol are specifically excluded from the approval of the STCs and therefore must not be used.

Why would this be the case? On the face of it alcohols might be seen as being a beneficial component; after all it is a bio-fuel derived from plant material and so should make the fuel have a lower carbon footprint, making our flying more 'green'. Surely this is a good thing?

In fact, in a parallel process, work continues on a number of different technologies as a potential replacement for leaded Avgas. One of the possible alternatives that the Aviation Authorities are considering is an aviation grade ethanol, with the ultimate intention being to define a specification that would allow Type Certification of new aircraft to operate on such a fuel. However, this is distinct and separate from the STC process for approving Mogas in Aviation and, for ethanol-based fuels, there are still many technical barriers yet to be overcome.

One of the primary concerns associated with alcohol in aircraft fuel is that it can be aggressive to the elastomers, seals and diaphragms used in the fuel systems on aircraft, causing them to fail; of course the fuel systems, from tank to engine, have been originally designed to use Avgas. The presence of alcohol does not only adversely affect fuel tank linings, but also components within the carburettor or fuel injection system, potentially causing them to fail.

When using alcohol as a blending component in unleaded Mogas, one of the other significant issues centres on the fact that, as we all know from diluting whisky with water at the bar, alcohol and water mix. Alcohol is used not just to increase the amount of bio-component in gasoline, it also contributes to the octane performance of the finished product. Combining water with fuels that contain alcohol will tend to remove the alcohol into the water phase from where it will separate and be drained from the fuel. The removal of the alcohol in this way decreases the octane availability in the remaining fuel, and potentially takes it below the octane requirement of the engine. As we have covered in past issues of Technical Talk, having a fuel that has too low an octane rating can lead to catastrophic engine failure and remember Aviation engines generally have a much higher octane demand than an equivalent automotive engine, due to their design.

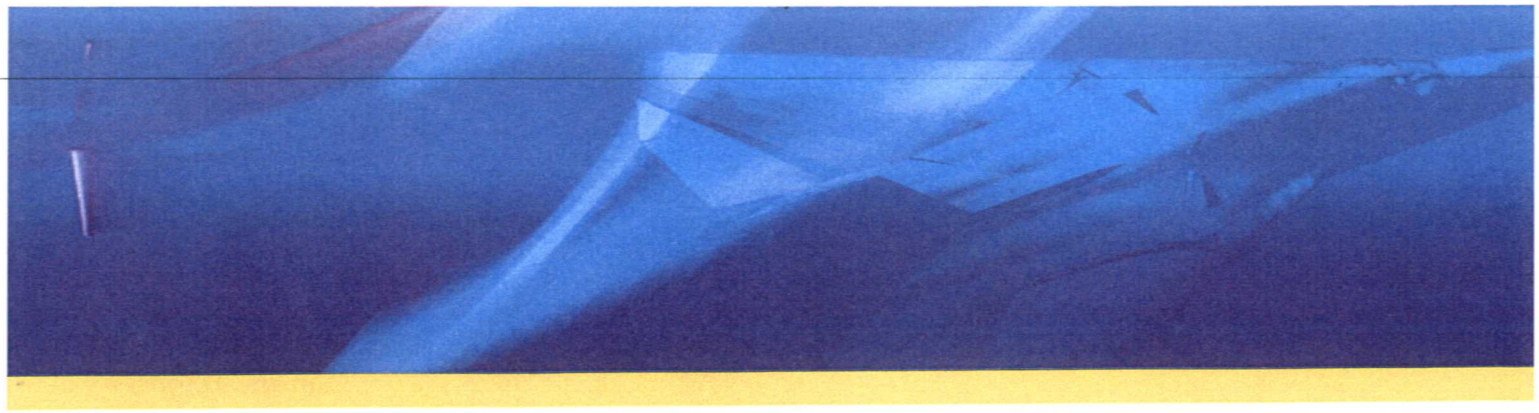
So why would water cause a problem in aviation fuel tanks and not with ground fuel use? In aviation we fly at altitude where the air pressure and temperature is relatively low, which does two things: first of all the airframe, and fuel tank become cold and secondly, as the aircraft descends, the increasing pressure forces warmer, moist air into the fuel tank where the water vapour condenses onto the fuel tank and results in water in the fuel. Of course there are also problems of utilisation – it is not infrequent for aircraft to be left unused for weeks or even months, during which time condensation, and even rain water, can accumulate in aircraft fuel tanks. These mechanisms contribute to the reason why we conduct daily water drains from fuel tanks in aviation whilst it is seldom a problem in automotive use.

The material compatibility and potential for water to remove a high-octane component from the fuel are not the only concerns. There are several other issues with alcohol-containing fuels when used in aviation applications such as their tendency to promote carburettor icing due to the high latent heat of evaporation of alcohol and as a result of all of these factors it has been decided that alcohol-containing, unleaded gasoline fuels are unsuitable for aviation use.

For these reasons pilots who have authority to use Mogas are obliged, as part of the STC approval, to test each Mogas fuelling for the presence of alcohol prior to use. I should point out that most Mogas specs, such as EN228 used in Europe, already allow the use of alcohol in the formulation without needing to declare it to the customer. This means that the fuel supplier can change the components in the fuel without notice and the only way a pilot can be aware whether or not a fuel contains alcohol is to test it. A simple way for determining the presence of alcohol in fuel is to pour approximately 10% water, followed by 90% fuel into a clear test cylinder. At this point the meniscus between the two products should be marked. The mixture should then be shaken thoroughly and allowed to settle. If any apparent increase in the water volume is observed, then it is an indication that the fuel contains alcohol and should not be used in your aircraft.

Of course many pilots who choose to use Mogas increase their risk by not even considering whether or not the fuel they are using might contain alcohol. Of course they should be aware of this fact at all times as it is one of the specific operating constraints of the approval to use Mogas; without testing, pilots are not only potentially operating outside of their approval, but also exposing themselves to uncontrolled flight safety risks.

So why have I decided to highlight the particular issue of alcohol in Mogas now? No doubt you will be aware that there is a lot of pressure on reducing greenhouse gas emissions throughout all areas of the energy sector. For this reason, many governments have issued either legislation or targets to include bio-components into ground fuels thereby reducing the percentage of fossil fuel content and reducing the net contribution to global warming. This means that in many regions, including Australia, USA and Europe, there will be an increasing bio fuel component in ground fuels. For diesel fuel, this generally means the inclusion of Fatty Acid Methyl Ethers (FAMEs), but in gasoline it means an increasing use of the alcohol ethanol, generally derived from either sugar cane or corn.



In some countries, such as Sweden, the standard Mogas supplies already routinely contain alcohol and in other countries it may be that all premium grades currently contain alcohol; however, you should be aware that, in most developed economies, the conversion is underway with different suppliers moving towards the inclusion of bio-components at different rates. This is a gradual, but increasingly common practice, normally introduced to a given market through the use of limited scale local trials, but the inclusion of bio-components will escalate resulting in the fact that in the next few years most of the Mogas supplies available in Europe, USA and Australia will contain alcohol.

This rate of change and amount of alcohol is different within different countries, but you can be sure of one thing – it is coming. Even in the USA, the 2007 Federal State of the Union Address committed the USA to a 20% reduction of greenhouse gas emissions from the use of ground transportation over the next 10 years, the decrease coming predominantly coming from the increased use of ethanol as a blending component in gasoline. This has predictions for an almost 10 fold increase in alcohol use in Mogas over the next 10 years in the USA – to a predicted 135 billion litres of ethanol by 2017.
In Europe and Australia, the targets are focussed on much shorter timeframes: in the next 3 years the target for Europe is to have 5.75% of bio components in ground fuels and in parts of Australia the mandate is for 10% by 2011.

Of course this is positive news from an environmental viewpoint, but it will mean that the sources of Mogas approved by the current aviation STCs will become increasingly scarce and what is the norm at the moment - of being able to find alcohol-free Mogas at most forecourt filling stations - will become a rarity.

This might be a good time to re-evaluate the balance of risks of using Mogas with its obvious cost benefit, but it is also a time to be aware of the increasing importance and imperative to be continually testing for the presence of alcohol for Mogas users, even if you only buy from a single forecourt source.
Of course, although generally more expensive, the alternative is to use Avgas; Avgas is not permitted, by specification, to contain any alcohol and furthermore it is formulated, stored, handled and subjected to rigorous quality assurance procedures that is have been developed purely with the safety of aviation in mind.

Happy Flying.

Shell Aviation