AVGAS FACTS AND FUTURE

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The Future of General Aviation Fuels

Currently the two principal types of fuel used in Aviation are Avgas 100LL and Jet A-1; Jet A-1 for turbine engines and Avgas for spark ignition piston engines. If you are a general aviation pilot, the one you are probably more familiar with is Avgas and it is this which we will concentrate on here.

As you may be aware, Avgas contains Tetra Ethyl Lead (TEL) - the additive which has recently been banned in automotive forecourt fuels in the European Union for environmental reasons. Although the total fuel volume used in aviation is less than 0.5% of that used in the automotive sector in Europe, there is considerable pressure from Environmental Lobbyists to remove or replace TEL in Avgas and produce an unleaded grade.

To understand what is involved, we first need to look at what benefits TEL has. As you may know from the problems with Automotive fuels, Lead compounds from TEL form a protective layer on the valve seat and prevents the soft valve seats from eroding. Without TEL small areas of a soft metal valve seat will fuse to the valve and be 'plucked' from the face of the seat.

Once attached to the valve they form an abrasive surface which further damages the valve seat. This combination of actions is known as Valve Seat Recession (VSR) as the seat of the valve is worn away and recesses into the cylinder head. The solutions to this are to either use a VSR additive or fit hardened valve seats which are resistant to this action.

VSR additives are now commonly used in Lead Replacement Petrol on automotive forecourts, however for several reasons they are not yet approved for use in aviation engines. This means that the only current method of preventing Valve Seat Recession for aviation engines using unleaded fuels would be to fit hardened valve seats. This is common in new manufacture Avco Lycoming and Teledyne Continental engines, but some older engines would need modification.

The other more significant problem with unleaded fuels is that of Octane rating.

Octane rating is a measure of how resistant a fuel is to detonation or "pinking"; the higher the Octane rating, the more the fuel / air mixture can be compressed without detonation happening. To make this clear, octane rating is not a measure of the amount energy in the fuel, but is a measure of its resistance to detonation.

The advantage or higher octane fuels is that a higher compression ratio or supercharging ratio can be used, which then leads to a higher engine cycle efficiency, which in turn means more power output for a given fuel burn. However, to confuse things further, there are four principal ways to measure Octane rating, RON, MON, Lean Mixture and Rich Mixture ratings.

Road fuels tend to be measured on a RON scale, for which unleaded fuels tend to be 95 - 98 RON but are only 85 - 87 MON. Avgas is measured on

Lean Mixture (similar to MON) but also has a Rich Mixture Octane rating.

The Lean Mixture rating is 100 octane (15 octane higher than the comparable 85 MON for unleaded Mogas) but Avgas also has a Rich Mixture rating of 130 which allows higher supercharger boost pressures to be used without detonation occurring. This is particularly a problem when using high power settings at low altitude, for example during take off.

As you can see TEL in Avgas makes a significant difference to the octane rating and without it Octane ratings would be back down to 80 - 85 Lean Mixture - the level for road fuels - instead of 100 / 130. This is not a problem for most typical modern normally aspirated engines as their compression ratios are quite modest and detonation would not be a problem with 80 - 85 Lean Mixture Octane fuel.

However, for those aeroplanes with supercharged or turbocharged engines the use of low octane unleaded fuels would not be suitable. The only way to operate these turbo engines on current unleaded technology fuels would be to significantly reduce the boost pressure of the supercharging and massively de-rate the engines. This de-rating would be so severe that many of the engines would no longer be powerful enough for the aeroplane in question.

Modern aviation unleaded fuels are currently being developed, such as 82UL in the United States. This is an 82 Octane Lean Mixture rating fuel and is approved for use in modern non turbo Avco Lycomings engines amongst others. However, it is not yet available in Europe but also not everyone can use it - your aircraft manufacturer must raise a Aircraft Modification document to approve its use.

Some new Cessnas are approved to use 82UL, but most aircraft types currently do not have manufacturer's approval. The potential quantity of Avgas piston engined aircraft world-wide that could use this grade is estimated to be around 60%, although some of these would probably need fuel system modifications prior to approval.

To date there are no additives available to replace TEL which increase the Octane rating - the additives used in automotive Lead Replacement Fuels only tackle the problem of valve seat recession and do not effect the Octane rating of the fuel. Therefore if Avgas 100LL were to disappear, the only other option currently available to owners with turbo or supercharged engines would be for the aircraft manufacturer raise a modification to replace their engine with either a turboprop or diesel engine.

This brings us on to the other recent advance in General Aviation engines; the development by several engine manufacturers of diesel engine technology. Shell is involved with all of the major prospective aviation diesel engine manufacturers and is working closely on these projects. These engines potentially offer several significant advantages over Avgas engines.

They return up to 30% better fuel economy, use Jet A-1 rather than Avgas, and have the potential to be retrofitted to many light aircraft, replacing their current Avgas type engines. The downside will be the cost of engine replacement and aircraft modification and whilst some applications may be

able to take advantage of this technology, this will not be a solution for everyone.

So in summary, Aviation engines present many unique challenges to the development of Avgas and as such there is yet no firm date to replace Avgas 100LL, but there can be little doubt that eventually Leaded Avgas will be withdrawn from use. However this does not seem likely until suitable fully developed alternatives are available; a situation that is likely to be several years into the future.