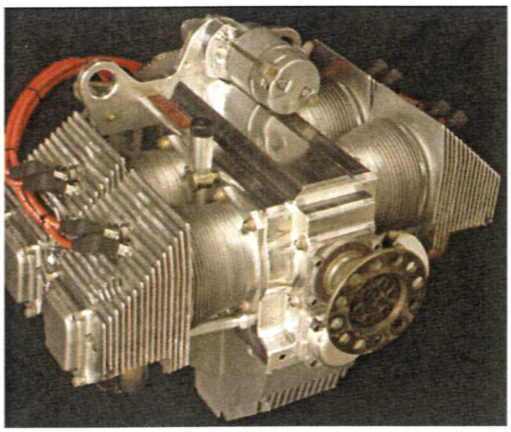
AeroShell TECH TALK

OILS FOR MICROLIGHT ENGINES

Engines used in Microlight, Ultralight and many homebuilt aircraft are generally light weight engines of small capacity with power outputs ranging from less than 20 Horse Power to just over 100 HP.

A high power to weight ratio is an important factor for the aircraft designer when specifying these engines and is the reason why two cycle/stroke and relatively high speed four cycle/stroke engines are popular in this market.

There are many different makes and types of engine used in this sector of aviation and the design of these engines is often somewhat different to that of aviation piston engines used in mainstream aviation such as those made by Textron Lycoming and Teledyne Continental Motors. The first, and most obvious, distinct class is the two stroke class.



TWO STROKE / TWO CYCLE ENGINES

Small capacity, spark ignition, two cycle engines have been available for many years for a variety of applications - motorcycles, outboard motorboat engines, lawn mowers and the like - but have also found a ready market in powering small light aircraft. All of these applications have the following in common:

- Relatively low initial cost
- Generally low use
- High power to weight ratio.

Added to this list for the aviation application must be good engine reliability.

In two cycle, spark ignition engines it is normal to mix lubricating oil with the fuel and the mixture is passed through the crankcase, prior to being burned. The oil content in the fuel (typically around 2% by volume) must lubricate all the engine internals before being transferred to the combustion space where it must burn leaving the minimum of deposits. Balancing these properties, lubrication and clean burn, can be a problem and leads to some juggling of properties to suit the application. For example, when full synthetic oils were developed for use in Grand Prix Motorcycle engines, the focus was inevitably on the lubricating properties. These engines develop in excess of 300 HP per litre, have very high acceleration loads with rapid speed changes and run in excess of 15,000 r.p.m. in some cases. Added to this is the consideration that the engines were often stripped after every race. It is easy to appreciate that in the development of these oils the load carrying and lubrication properties were more important than the cleanliness of combustion.

With aviation we have a slightly different set of operating conditions. The engines have fairly modest specific power outputs - around 70 HP per litre (although the normal cruise power percentage is high) - infrequent engine speed changes and the aim is to achieve good reliability with low combustion chamber deposits.

We at Shell recognised that there is a wide range of two stroke oils available to pilots, but little or no information about their suitability. Because of this, Shell conducted some comparative laboratory testing with aircraft applications in mind and we found that a semi synthetic product, Shell Advance VSX-2, displayed the right physical properties. This led onto a flight trial, overseen by Skydrive the UK Rotax Agent, to assess the characteristics in operation. Two identical flexwing microlights were chosen at a flight training school, both flying from the same field with similar flight profiles, the only difference being that one engine used Shell Advance VSX-2 and the other a premium quality competitor oil.

Engine wear was carefully measured during the trial and the engine using Shell Advance VSX-2 displayed less cylinder wear than the engine run on the competitor oil. The Shell engine also showed low levels of combustion deposit with the piston rings still free to move despite being inspected after over 220 hours of operation instead of the recommended 50.

Recently, Shell Aviation research has further pushed the boundaries of 2 cycle aviation engine lubrication, the results of which will be seen soon in the Australian market with the introduction of AeroShell Sport 2! More information will be available soon.

FOUR STROKE / FOUR CYCLE ENGINES

One of the major disadvantages of the two cycle engine is that the fuel economy is quite poor. This is one of the reasons why four cycle engines are more prevalent for larger power outputs. These engines tend to fall into two categories, those that should use automotive oils and those that should use aviation oils. One of the critical distinctions is the cylinder head temperatures that are encountered in the engine.

Air cooled four cycle engines which are designed for aviation use (engines such as Lycoming, Continental, etc.) will normally use aviation oils. This is because the mixture of air cooling and high average power settings typical in aircraft use results in the cylinder head temperature being relatively high and the additives used in automotive oils form ash when exposed to

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these temperatures. This can lead to combustion chamber deposits which can cause the onset of pre-ignition and ultimately catastrophic engine failure. Aviation oils do not use the same type of additive chemistry and this is why the oils are referred to as "Ashless Dispersant" oils.

Engines which are modified automotive engines, or aviation engines which have liquid cooled cylinder heads such as the Rotax 912 series, should use automotive oils or a specific Aviation 4 cycle engine oil, like the upcoming AeroShell Sport 4. The liquid cooling keeps the cylinder head temperature down and the engine internals in these engine types are designed to take advantage of the specific additives used in these types of oils.

PROBLEMS WITH FOUR CYCLE AUTOMOTIVE ENGINE LUBRICATION

The problem is that most of the automotive oils are now designed to be used with unleaded fuels. This means that if the aircraft is run on Avgas 100LL, which still contains Lead, then the oil must be able to dissolve the high levels of Lead compounds which get into the oil due to combustion gases and unburned fuel getting past the piston.

To be able to dissolve this lead the oil needs to have good solvent properties, something which is not a consideration for most automotive oils as they are developed for use with unleaded fuels. If the oil is unable to dissolve the Lead by-products, then a semi solid sludge will form in the oil which can restrict oil-ways and compromise lubrication. This can particularly be a problem with some of the most recent highly refined or synthetic base oils - many of which are excellent lubricants, but have relatively poor solvent properties.

Again we at Shell have looked at this issue and have identified the semi synthetic Shell Advance VSX 10W40 as having suitable lubricant and additive properties for use in engines such as the Rotax 912's, whilst also having sufficient Lead solvency to be able to run on either unleaded fuels or Avgas 100LL. AeroShell Sport 4 will display similar benefits when introduced.

Of course this solvency is not an issue with spark ignition two cycle engines or engines using aviation oils. In the two cycle engine there is no oil permanently in the sump of the engine. As I mentioned earlier, the two cycle engine has the oil mixed with fuel and air in the crankcase and the whole mixture - exhaust residues included - is then transferred to the combustion chamber to be burned and exhausted to atmosphere. Because of this any Lead by-products are constantly pumped out of the engine and there is no need to use the oil to dissolve them.

In four cycle aviation engines, Lead solvency is less of a consideration as the aviation oils are designed to have sufficient solvency to run with Leaded Avgas, so the only complication is with automotive four cycle oils using Avgas 100LL fuel.

CONCLUSION

So you can see that with the differences in engine designs used to power Microlight aircraft not only should the oil be matched to the engine type but also, in some cases, it should be matched with the type of fuel being used.

AeroShell Sport 2 will be available in Australia early 2006 – another first for AeroShell!

HAPPY FLYING

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