AeroShell TECH TALK

OIL ANALYSIS - HEALTH CHECK FOR YOUR ENGINE

How many of you have recently had a full medical heath check? I'm sure that you will agree that it comforting to know that by simply monitoring things like blood pressure and taking blood samples for analysis that doctors can confidently assess the state of your health. It is remarkably similar with your aircraft. You, the pilot, monitor parameters like oil pressure, oil temperature, magneto rpm drop as you fly the aircraft, but did you realise that the oil can also contain vital information about the condition of your engine internals in much the same way as blood can?

As your engine is used, small amounts of wear occur all the time. This wear metal appears as minuscule amounts of metal held in suspension in the oil. These particles are much too small to be removed by your oil filter - and will do no abrasive damage to your engine - but by analysing the level of these particles in used oil the operator has a means of assessing the condition of the engine. But if these particles are so small, how are they detected? The answer is that the used oil sample can be analysed by a laboratory using a very sensitive technique known as spectrographic analysis, and particles can be detected down to levels of less than one part in every million of oil.

It is not just wear metals that can be detected; water content, fuel dilution, acid content of the oil and other characteristics can be measured. But what use can all this data be you might ask?

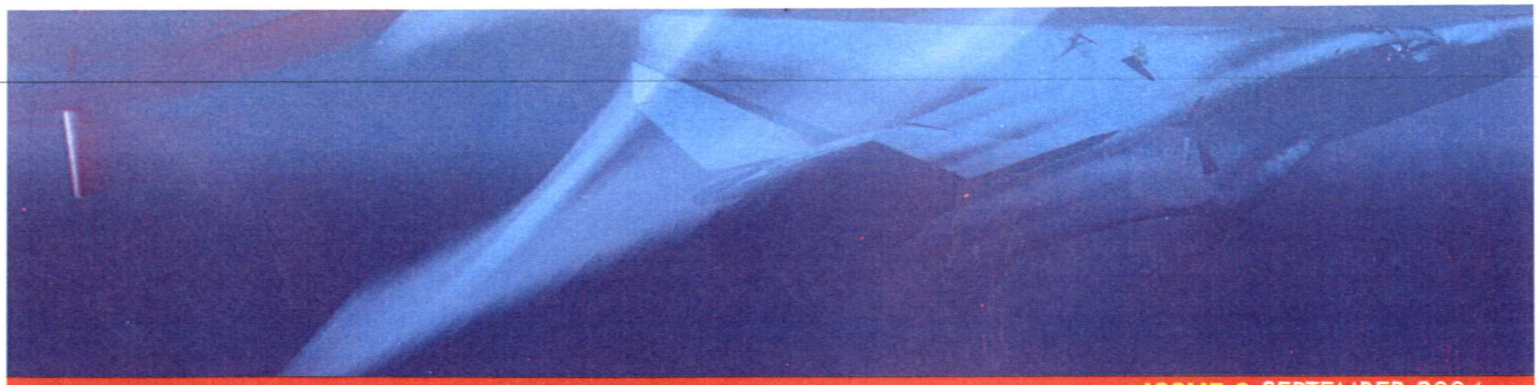
All engines produce a certain amount of wear metal - this is normal. The significant point about oil analysis is that the level of microscopic wear metal present in used oil will normally increase if a component starts to wear excessively. This will normally occur prior to any particles being present in the filter and is a good way of predicting a failure. Not only this but the data can also be an indication that the engine is not set up correctly or a clue that the engine is being operated incorrectly. Let me give you a few examples:

- High Aluminium content is usually from Gudgeon Pin end caps and is often an indication that the engine is not being properly warmed up prior to take off.
- High Silicon content is normally from the ingestion of dirt and dust, so the inlet filters should be checked.
- High Chrome content can be an indication of excessive piston ring or cylinder bore wear. This can be due to overloading the rings due to incorrect magneto timing.
- High Fuel dilution combined with high water content shows that the engine is being operated for too long on the ground at low idle speeds and the idling speed should be increased.
- Fuel dilution with high Lead content can be due to either worn piston rings which should be checked with a compression check, or poor fuel mixture adjustment (which should be checked and adjusted).

It is not only the engine that we can analyse by sampling used oil, we can also look at the condition of the oil.

As oil is used in an engine several things happen to it to cause it to degrade. The best measure of the condition of the oil is what is known as the Total Acid Number, or TAN. When an oil is in contact with the air, especially at high temperature, it will degrade and a by-product of that process is the formation of organic acids. This is prevented to a certain extent by having anti-oxidant additives in the oil, but these additives are depleted over time and is one reason why oil changes are necessary. Once the anti-oxidants have been consumed, the oil itself will start to oxidise resulting in poorer lubricating properties. If the Total Acid Number of the oil is measured then an assessment can be made as to whether the anti-oxidant has been used up and if the oil has started to degrade significantly in use. These are good clues as to whether the correct oil choice has been made, whether the oil has been thermally stressed in use, and may even be a sign that the oil change period needs to be reduced.

The viscosity characteristics of an oil can also give some indication of how effective it is in an engine. The viscosity of an oil is related to the size of the oil molecules - the bigger the molecules, the higher the viscosity and vice versa. If the oil has undergone severe shear stress, as can happen in gearboxes for example, then the molecules can be broken into smaller pieces with the result that the viscosity of the oil can reduce over time. However, exposure to high heat can also make the molecules join together, or polymerise, to make large structures which can increase the viscosity. You will no doubt see that if both these processes happen at the same time then the overall result may be no change in the viscosity, so measurement of viscosity alone does not give a complete picture - it must be considered in conjunction with TAN which should also increase with polymerisation.



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You will start to realise that there is a lot of practical information that can come out of oil analysis and it is an excellent way of limiting wear and preventing failures which increases aircraft safety and reduces the amount of expensive repair bills.

FILTERS

Many people also throw a lot of useful information into the bin when they dispose of oil filters. These filters normally contain a lot of carbon deposits, but they will also hold any larger pieces of metallic debris that has come from the engine internals.

Your engine may produce a small amount of metal which will be seen in the filter element and this can be classed as normal. There is no defined level which is normal for an engine - each engine is different - but there will be a quantity which is usual for your engine. This will vary not just from engine to engine, but also it will depend on whether the engine has recently been overhauled. Engines which are still being broken in after overhaul will produce more wear metal than at other times. This is nothing to worry about as wear metals are inevitably produced as part of the abrasive break in process and is one of the reasons why the oil drain period is shorter during these times.

These filter deposits can be sent off to a qualified laboratory for analysis where the filter deposit weight and composition can be accurately assessed. Any metal deposits, even very small ones, can be analysed to see not only what the deposit is made of, but also what the exact alloy composition is. This means that not only can the laboratory tell that a particle is steel, for example, but also which steel alloy it is. This is significant as different alloys are chosen by the engine manufacturers to perform different functions in the engine - so the steel alloy used in the cam shaft is different to that used in the valves and so on. This means that a small particle found in a filter can often be identified as coming from a particular component - so both you and your aircraft's engineer could know which component is wearing and you have the opportunity to work out why or have the chance to replace it before complete failure occurs.

Again this is a very powerful tool in preventing an in flight engine failure and also for reducing maintenance costs. Imagine that you know that a valve is worn and needs replacing. Your engineer knows which part he needs to replace before he dismantles the engine, so the labour costs are reduced, and he is also needs to replace just one part rather than the whole engine as might be the case if it failed. You also have the satisfaction of knowing that you have a reliable engine which is less likely to stop working when you need it most.

Even if you do not go to the extent of sending your filter off to a laboratory for analysis, there is some basic analysis that you can do yourself. Rather than throwing the old oil filter away (or just cleaning it if you have a screen filter) then why not look at the deposits yourself? This will not be as accurate a technique as sending it off for analysis but if you know what is the normal level of deposition is for your engine, and what types of particles are normally there when the oil is changed, then you may notice a change when things start to go wrong.

If you are going to analyse your own filters, then a word of advice; use the proper tool to open the filter. Do not cut it open using a saw as the metal produced by sawing will contaminate the filter and give a false indication of deposits. There are tools available from aviation suppliers that work rather like a can opener and do not produce any metal swarf. Remember when looking at the results of either oil or filter analysis, the absolute values or quantity of deposit is less important than how the values have changed from previous samples - every engine will have a different level of what is normal and how this changes over time is the important factor. For this reason the analysis of individual samples is of limited use, a long term program of sampling is much more valuable.

So, to conclude, why not use these techniques to let you "look" inside your engine, and next time you change your oil don't look at it as just old oil, look at it as a valuable source of information to give your engine a health check!

HAPPY FLYING

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