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Dear Aviators

Welcome to issue 23 of Tech Talk and the last issue for 2008. With the warmer months now in full swing, hopefully you are getting out and enjoying the good flying weather.

Over the past 12 months I have been asked on a number of occasions for advice on Engine Break-in. Many pilots and LAME's are still looking for good, sound comment on this. Therefore in conjunction with my Shell Aviation USA technical team and Murray Wilkes from Shell Aviation Australia, the following article should go a long way to answer some of these questions and impart further information you may not have known before.

Please feel free to drop me an email or a phone call if there is anything you wish to discuss or question from the article – I am more than happy to have your questions or points of discussion passed back to our Technical staff for engagement or answers.

With the end of year very near, many I take this opportunity to also wish you and your families a joyous Festive Season as well as a safe 2009.

Happy Flying

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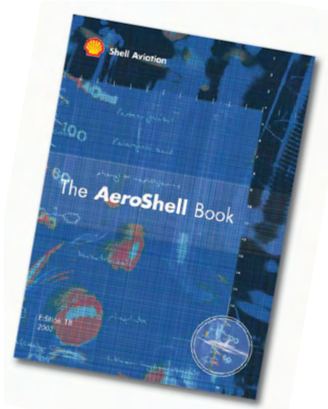

AeroShell TECH TALK

Engine Break In

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This information is applicable to both Lycoming and Continental horizontally opposed engines, however, pilots should also ensure that they refer to Lycoming Service Instruction 1014, and TCM Service Information Letter 99-2 for specific instruction about oil selection specific to your engine.

If your engine has recently been overhauled, is new, or has had one or more overhauled or new cylinders fitted, then you should "Break-In" your engine or cylinders using straight mineral oils unless otherwise specifically directed by the manufacturer.

When a cylinder is new the working surface is not as smooth as might be imagined. The objective of the break-in procedure is to rub off any high spots, both on the cylinder wall and the piston rings, so that the rings can create a good tight gas seal for proper long term operation. Incorrect actions by a pilot during the initial operation or new or overhauled cylinders can critically impair the correct break-in process, the most common are too low power settings, and the use of incorrect oils.

There are two main classifications of aviation piston engine oils on the market. These are generally referred to as Straight Oils, and Ashless Dispersant oils.

With the exception of some turbo-charged engines, break-in should be conducted using straight oils. The first risk with using Ashless Dispersant oils during break-in is that the higher film-strength will prevent the piston ring from rupturing the oil film and therefore the necessary abrasion on the cylinder wall will not occur. Secondly, the frictional process creates elevated surface temperatures on the cylinder wall and it is possible for this to cause the additives in the Ashless Dispersant oils to form a glaze in the honing grooves on this surface. When a cylinder is manufactured, a hone is used to score a diamond pattern into the surface of the cylinder wall, and this is necessary to allow an oil film to be held on the surface and lubricate the piston during normal operation. If glazing of the cylinder walls occurs before the break-in period is complete, then the piston ring will not seal properly, and the cylinder wall will no longer have the surface grooves necessary to carry lubricant, and the combination will result in a poor gas seal and high oil consumption. The only way to remove such a glaze is by re-honing the cylinder wall and replacement of the piston rings, - more expensive and avoidable additional maintenance. Successful break-in not only requires the use of correct grade and type of oil, but also the use of high power settings. High power settings result in high combustion pressures which, due to the piston ring design, help to force the piston ring out hard against the cylinder wall. This is another key to a successful break-in process.

So what does this mean for the pilot?

Use a good quality Straight Oil, such as AeroShell Oil 100 or Aeroshell Oil 120, and stay with it right through the break-in period (typically 50 hours but check your engine manual). Be sure to check the oil level frequently as oil consumption will be higher than during normal post break-in engine operation.

Ideally the oil and filter should be changed:

- Within 10 hours of operation
- Within 25 hours of operation
- Again when it has been determined that the break-in process is complete but no longer than 50 hours, or 4 months since the last oil change regardless of engine hours.

This is in line with the manufacturer's recommendations such as those found in Lycoming's Service Bulletin 480D

As for engine operation, it is all about generating high cylinder pressure and maximising the engine cooling. Use full rated power and RPM for every take off and maintain these settings until at least 500 feet above the departed runway; at this point you can reduce power to 75% and continue the climb to your cruising altitude.

Maintain 65% - 75% power for all cruise operations during the break-in period. Avoid high altitude operation with non turbocharged or supercharged engines, as altitudes in excess of around 8,000 feet will not permit sufficient cylinder pressures to be developed to ensure good piston ring force onto the cylinder walls. Interrupt cruise power every 30 minutes or so with a smooth advance to full power for 30 seconds and then return to the original cruise settings. The resulting variation in piston ring pressure and action against the cylinder walls will assist with the break-in process.

Avoid long, low power descents, as again, there will be insufficient cylinder pressure to force the piston rings out to form a good gas tight seal, and the engine will suffer from higher levels of combustion blow-by with much more oil being left on the cylinder walls. These conditions can lead to glaze formation and inhibited ring seating. When descending, carry enough power to keep the CHT's at least in the bottom of the green. For similar reasons, ground running should be kept to a minimum, particularly during hot weather. During break-in, it would be better to delay departure than to sit at the end of the runway for 15 minutes or so running in high ambient temperatures.

Be careful with engine cooling as the increased friction from the wear process will increase the cylinder wall and piston temperatures and so particular attention should be given to providing adequate engine cooling.
When climbing, keep the airspeed up, decreasing the angle of climb so that increased ram air is available for cooling. Be generous with the fuel mixture. Keeping a richer than usual mixture will provide a cooling of the combustion chamber. At altitudes in excess of 5,000 ft, the mixture should only be leaned sufficiently to restore power loss from an overly rich mixture.
These procedures will help to hasten the break-in and ensure a good match of rings and bore.

To summarise, don't handle your engine gently, remember to check your oil level frequently and top up with only the correct oil during the break-in period and observe the oil change periods. Particularly with group-owned or rental aircraft, be sure that all those that fly the aircraft during the break-in period are aware of these 2 points.

How do you know when you have broken the engine in?

There are several clues that the engine will give you, and one key one is oil consumption, so you should really start to take note what the consumption is from the start. You will notice that the consumption will probably be quite high initially, will reduce rapidly, and then plateau at a particular value. What this value is not really too important - it can be anywhere in the range of 1 litre approximately every 4 to 20 hours - an indication of stabilisation is more the key. Too high an oil consumption indicates that the engine has not broken in yet, or has possibly glazed the cylinders if it is in excess of 100 hours operation since new or overhaul.

Second indication to look out for is the exhaust stack. This will normally start being black and possibly even slightly wet due to the high level of oil burned during the initial stages of break-in. It will then turn to black soot and finally produce a tan / grey deposit, indicating that there is little oil being burned, and the mixture setting is correct.

Another indication is that of crankcase pressurisation. If you fill the engine up to the maximum oil level indication and it rapidly loses the first half litre down the breather pipe, then many people just fill the engine with less oil next time. This is fine if it is an old worn engine, but during break-in it is actually telling you something. Assuming that it is not an aerobatic engine, the reason that the oil is being pushed down the breather is that the crankcase is being over-pressurised by exhaust gases blowing by the rings. In other words, the engine is not effectively sealing itself and has not achieved a good gas seal between rings and bore indicating that the break-in process is not yet complete.

It is best to top oil up to the maximum and monitor whether it rapidly loses the first half litre or so.

Chrome Bores vs. Steel bores.

Most engines have nitrided steel cylinders and cast iron or chrome-faced piston rings. Whilst this combination will often break-in quite easily, it would be good advice to fly as often as you can in the initial break-in period if your engine is fitted with steel cylinders rather than Channel Chrome bores.

The steel cylinders are particularly susceptible to surface corrosion in the early life of the engine, with surface rust being quite common after only a few days of inactivity if the conditions are right. The break-in process tends to happen quite quickly with steel bores, but the potential for corrosion remains.

Channel Chrome cylinders obviously do not suffer with the same corrosion problem, but the hard chrome surface is much more difficult to break-in, sometimes taking over 100 hours of operation. It is therefore, very important to be patient to ensure proper ring matching with corrosion-resistant cylinders as the hard surface of chrome bore engines is much more prone to cylinder glazing following improper break-in.

Long Term Operation on Straight Mineral Oils.

It is perfectly possible to run engines permanently on straight mineral oils but, as straight mineral oils do not contain additives, they tend to allow deposits to form in the engine. The Aeroshell "W" Ashless Dispersant oils contain an additive that is designed to keep particles separated so that they do not congregate to form a large mass. If these particles are kept separated then they are less likely to block an oil passage and deposit inside the engine. If the filter is of the relatively efficient cartridge type then the small, dispersed debris will be removed by the filter element. It is these particles in suspension that makes an oil appear black.

If straight mineral oils are used, then the oil tends to appear relatively clean, but carbon and other particulate deposits will be found covering many parts of the inside of the engine. This is not a big problem unless you later encourage these deposits to loosen. Changing onto an Ashless Dispersant oil after a significant build up of these deposit has occurred, can result in loosening these deposits. This normally results in an abnormally high level of filter deposits after the period of change over, so care should be taken to monitor this. The critical time period for a significant deposit to occur inside an engine running on straight mineral oil depends on the individual engine type, operating temperature, flight profiles etc. but is normally around the 300 - 400 hour mark. If your engine has run for this length of time on straight oil and you convert onto or Ashless Dispersant oils, then take care to monitor your filter more frequently for signs of blockage.

I normally advise therefore, that there is less risk carrying on with a straight oil for more that 50 hours if you're unsure whether or not the break-in is complete, than there is from having the cylinders glaze from changing to an ashless dispersant oil too early.

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