Keep Your Engine Active

You can shorten the life of your aircraft engine by not using it enough

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■■ When I was a lad, working for a new automobile agency, there existed among used car buyers a belief that the best possible buy was a car owned by a little old lady and driven only occasionally.

Such a vehicle would nearly always have been garaged and was seldom driven more than a few thousand miles a year and, of course, never over 35 mph. To acquire a five- or six-year-old vehicle operated under such conditions would be almost akin to having a new machine at a fraction of the price. There actually were situations like that and such cars usually did look new in many cases.

How could one go wrong on such a deal? You could and many did. When such a vehicle was taken from a near-retirement type of service and operated on a much more active and higher-speed basis troubles nearly always developed shortly thereafter. The running gear soon became loose and noisy. Lubrication and coolant leaks developed in the engine. Oil consumption increased, strange engine noises suddenly appeared and all too soon that smooth, quiet machine aged.

Even though the vehicle may have had proper and adequate *service* care,

The airplane above is doing what yours should once a week for at least a half hour of cruising flight. Leave it like the airplane at the right for extended periods of time and the engine will literally rust and rot.

it did not have good *operating* care. Despite the low mileage, the machine's working mechanisms were worn out. In such situations, it is not the normal wear and tear of mileage and age that deteriorates the vehicle. Instead, it is the silent, unobstrusive erosion of inactivity. Given the proper circumstances this culprit can reduce a machine to overhaul status well in advance of a normal service life. Why? Let's take a closer look at what normally goes on inside your aircraft engine when it is operating—and some things that go on when it is not operating.

To begin with, the reciprocating internal combustion engine will produce one pound of water through its combustion process for every pound of gasoline that it burns. It is often possible to see this phenomenon with an automobile when ambient conditions are right. Almost immediately after start-up one can observe water spitting from the exhaust pipe. Hot exhaust gases expelled into the cold muffler and tail pipe quickly cool, causing the water in the spent gases to condense, where it will be blown out of the tail pipe in a quite visible form. In cold weather this condition is obvious in the form of white steam from the exhaust for quite some time after the engine has been started.

Lighter-than-air craft such as Zepplins utilized this water in combustion gases to a practical advantage. Their exhaust systems were designed to promote condensation of water in the spent gases and return this water to ballast tanks. In so doing the loss of weight occurring from consumed fuel could be compensated for by the captured water. This practice eliminated the expensive and wasteful need to valve off hydrogen or helium in order to maintain proper lifting stability. However, this water serves no such practical advantage for the fixed-wing aircraft and can be a detriment to engine life.

An aircraft engine cylinder assembly usually consists of a steel barrel with an aluminum cylinder head. The pistons are aluminum in nearly all cases. Aluminum expands and contracts more than three times as much as steel for a given temperature change. The piston must have sufficient operating clearance when the engine is operating at maximum allowable cylinder head temperature (CHT), otherwise it would seize to the cylinder wall.

Now consider that same piston-to-cylinder wall fit when the engine is cold. The piston will have contracted more than three times as much as the steel cylinder in which it operates. Consequently, the clearance is going to be considerably greater than it was at maximum operating temperatures. Now let's start a cold engine and see what happens as a result of the excessive clearance.

The piston having shrunk to a smaller diameter, the lands (grooves for the rings) will not provide as much support under the piston rings as they will with normal operating temperatures. Also, low-speed operating conditions normal to start-up and ground operation will not provide sufficient cylinder gas pressures essential to good piston ring-to-cylinder wall sealing. Thus, some of the combustion gases will escape past the piston rings and into the interior, or crankcase, of the engine.

This leakage of combustion gases into the crankcase of the engine is called "blowby." Of course this undesirable blowby will abate with increasing engine temperatures, but until it does it will definitely result in the introduction of water vapor into the crankcase area of the engine.

Upon entry into the cold crankcase, the hot gases will quickly cool, causing the water present in them to condense back to a liquid which contaminates the lubricating oil. The air inside the crankcase at start-up is also cold but will become heated more quickly than the surrounding crankcase walls. Upon contact with the cold walls, moisture present in this air will condense much in the same manner as moisture forms on the glass of a cold drink. The combined process will produce several ounces of water each time the engine is started.

Actual amounts of water produced vary with respect to ambient conditions. The greatest amounts occur during cool, high-humidity conditions as are common to spring and fall. In addition to possible rust damage, this water is also responsible for the formation of sludge. Various parts of the engine, such as hydraulic lifters, have no provisions for purging themselves of sludge deposits. Such accumulations can eventually result in expensive troubles.

Unfortunately, water is not the only troublemaker. During normal combustion, the gasoline fuel chemically changes into various other compounds. Among these by-products are destructive acids such as sulphuric, nitric, formic and others. During the actual combustion process and subsequent exhaust

event, these acids are anti-hydrous (complete absence of water in liquid form) and therefore relatively nondestructive.

A substantial amount of these acids are introduced into the crankcase by means of "blowby" and contaminate the lubricating oil. If water is present in the lubricating oil these acids become active, whereby they are capable of inflicting corrosive damage to any and all metal parts of the engine.

Another combustion compound is lead salts, a by-product of the antiknock additives. This compound is also quite corrosive when it becomes activated by moisture. Lead salts are present in the combustion chamber and exhaust valve port at all times and when activated by moisture can cause corrosive damage to upper cylinder parts, exhaust valves, guides, etc. These lead salts also find their way into the interior of the engine by way of combustion blowby. Contamination of the lubricating oil by lead salts adds one more destructive factor in terms of engine damage.

Another source of premature wear is lack of initial lubrication during engine start-up after a prolonged period of inactivity. This condition is caused by oil drain-off while the engine is at rest. The cylinder wall area above and below the piston is the most susceptible to this problem. On the other hand, oil trapped between two close fitting surfaces, such as bearings and their mating journals, tends to remain for indefinite periods. This fortunate behavior is due largely to a phenomenon known as surface tenacity, whose subsequent resistance to movement tends to hold the oil film in place. However, the exposed area of the cylinder wall above and below where the piston has stopped has no such protection. Consequently, such areas are subject to oil drain-off.

The film of oil on an engine's cylinder wall during normal operation is approximately two mils in thickness. That's not much when you consider that 10 mils equals only .001 inch. Nevertheless, that thin film of oil will remain on the cylinder walls after shutdown for a period of approximately seven days. Needless to say, starting an engine with dry cylinder walls causes metal-to-metal contact between piston, rings and cylinder walls. The resulting wear under such circumstances can reduce engine life between overhauls.

> ***"...periodic ground operation is not a satisfactory solution to inactivity problems..."***

After standing approximately 14 days, the exposed portions of the cylinder walls become dry enough to lose their protection from rust. At this point they can and do rust.

Gaskets and rubber seals employed in many areas of the engine also suffer from excessive periods of inactivity. Gaskets, especially cork, dry out during inactivity and tend to shrink. This causes oil leaks when operation is resumed. Perhaps you remember the early, nylon-belted automobile tires and how they would develop temporary flat spots from overnight inactivity.

Such flat spots resulted from a tendency of rubber to "cold flow" under pressure. However, just a mile or two of normal driving would exercise the tire sufficiently to relieve this "hysteretic" condition. Rubber gaskets and "O" rings can behave in a similar manner. The normal vibration and temperature changes of regular engine operation tend to aid such rubber items in maintaining their natural viability, but long and repeated periods of inactivity tend to produce a permanent hysteresis with such items resulting in early replacement.

The damage caused by excessive inactivity results from rust and corrosion caused by water, acids and corrosive combustion products generated by the engine itself. Such inactivity can also cause permanent deformation hysteresis to gaskets and seals. This kind of damage is not isolated to the engine either. The rubber seals and gaskets employed through the airframe's various systems are also subject to permanent deformation from excessive inactivity.

The problem isn't limited to rubber parts either. Premature wheel bearing failure is often due to inactivity. How could that possibly happen? By constant, but very slight, movement. Take an airplane tied down outside and introduce long periods of inactivity coupled with frequent winds sufficient to rock it. As the airplane rocks gently on its wheels, the rollers in the wheel bearings move slightly. In due time the rollers, under pressure, will displace the lubricant in the immediate area of contact causing metal-to-metal contact between the rollers and their races.

> ***"...the reciprocating engine will produce one pound of water ... for every pound of gasoline that it burns..."***

Under normal operation, the lubricant is heated in the immediate area of contact and will flow back onto the race in the path of the next roller approaching. This does not occur under the gentle motion just described and damage to the race will eventually result in the bearing having to be replaced. Of course if the airplane is always hangared such a condition is not likely. There are still more examples, but there should be little doubt left by now that long periods of inactivity can be detrimental to your airplane and its engine. Now, what can you do to prevent this unprofitable wear and tear.

One time-honored practice is to go out to the airport every week or so and run the engine for 10 minutes or until the oil temperature approaches the normal range. Indeed, running the engine will distribute oil to all the parts, but what about the wear resulting from such "dry" starts wherein the engine has been inactive long enough for the oil to have drained off the cylinder walls and other places. If you operated the engine every three days you could be reasonably certain of keeping ahead of lubrication drain off, but what about the water condensation problem described earlier?

You are adding more water and corrosion contaminants with each such runup. Remember that blowby contamination is at its worst during initial start and warm-up. During normal operation in flight, blowby contamination is at a minimum. Engine parts such as the underside of the pistons reach normal temperatures well above the boiling point of water. Oil sprayed continuously on such hot parts causes the water present in the oil to boil into steam. The ensuing expansion causes the steam to pass from the crankcase and overboard through the crankcase breather tube. The same will be true for most blowby gases entering the crankcase. It would never be in the best interest of the engine to attempt duplication of such internal operating temperatures on the ground. Thus, periodic ground operation is not a satisfactory solution to inactivity problems.

You could pull the propeller through a series of revolutions every few days and one engine manufacturer actually has a bulletin to that effect. However, unless you can prop your engine fast enough to maintain 600 rpm or better what good will this practice accomplish?

To put oil back on the cylinder walls you need to get the engine turning fast enough to achieve minimum system oil pressure and you need to keep that up long enough to insure complete relubrication of all cylinder walls.

There is only one advantage that I can see in pulling the propeller through. The oil between the piston and cylinder wall will not drain off as rapidly as with the exposed areas of the cylinder walls. Perhaps one then might be led to believe that if the propeller were pulled through regularly, oil remaining between the piston and cylinder wall would be redistributed about the cylinder and subsequently prolong a measure of protection. The only advantage that I can see in this practice is uniform rusting of the cylinder walls.

Abolition of those two time-honored practices leaves us with only two more. One certain solution remaining is to pickle (long term storage preservation process) the engine, but that would take it out of flight status. Of course there is another solution and this one is quite certain in terms of preventing inactivity damage. It is also the simplest—all you need do is fly the aircraft on a regular basis. If you flew the aircraft at least once a week with no less than 30 minutes at cruise power you could provide a reasonable degree of protection against inactivity damage.

Another certain measure of protection for aircraft flown infrequently is more frequent oil changes. An oil change every 90 days rather than by so many hours of operation is good practice for aircraft flown less than 10 hours per month.

Keeping the aircraft hangared will further reduce inactivity damage. A heated hangar is still better since such an environment tends to reduce moisture-condensing temperature changes.

In the final analysis, the cheapest and easiest protection against inactivity damage is simply flying the aircraft. □