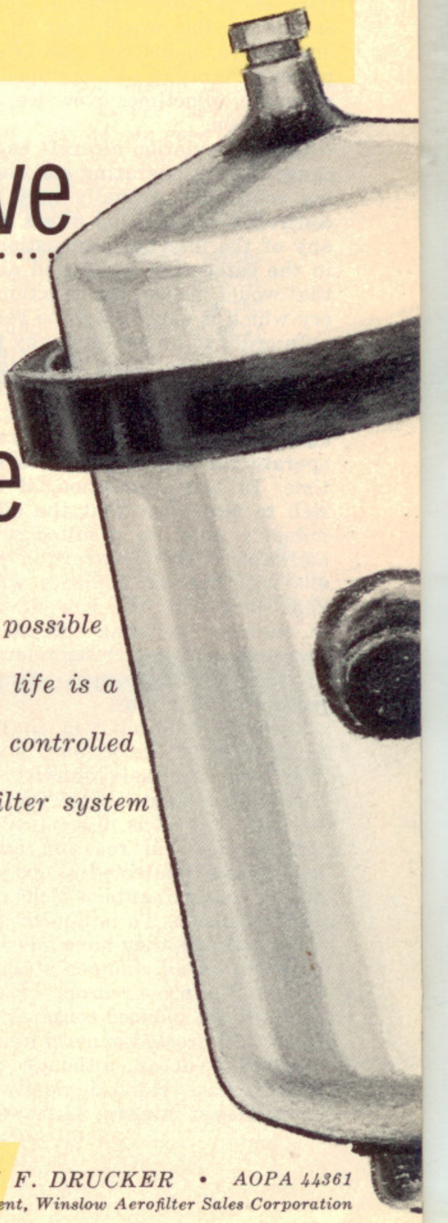
Preventive Engine Maintenance

One of the best possible safeguards of long engine life is a full-flow, controlled pressure oil filter system



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It is about time for general aviation—owners, operators and pilots—to take a long, hard look into their aircraft engine operation, maintenance, and overhaul costs. For the weight of evidence at hand clearly indicates that the greater majority is paying through the nose for excessive operating costs because of ignorance, misinformation, and sheer neglect of the factors involved in the operation of internal combustion engines.

This sorry circumstance is the fault of no one but the general aviation owner, operator, or pilot. It cannot possibly be ascribed to aircraft engine or airframe manufacturers, to engine overhaul or maintenance stations, or to the refiners of oils used for lubrication in aircraft engines.

The premise here is that the staggering amount of premature aircraft engine life, matched, incidentally, in no other internal-combustion engine field, is an appalling waste which is the rule, rather than the exception, and for which general aviation numbly and humbly pays and pays. By contrast, you can be sure that the scheduled airline operators or other informed professionals could never survive economically with the same short engine life which general aviation accepts as one of "those things."

The concern here is not with pilot abuse or misuse of engines, acts of commission such as running above rated capacity, using gasoline of the wrong octane rating, failure to use mixture controls (at altitude to provide sufficient gasoline for cooling), or improper climb procedures or speeds which do not give the rear cylinders sufficient air flow, etc., but with acts of omission: a downright lack of the simple fundamentals necessary to insure safe and sustained performance during the normal course of the life which has been so painstakingly engineered and built into aircraft engines by the manufacturers. And these same manufacturers will tell you that perhaps three, possibly four out of ten general aviation aircraft engine users realize the full life and reliability which is inherent in their world-renowned products. This would indicate that this waste can approximate 60%, a monstrous figure. It's money tossed down the drain for no sensible reason. Exaggerated? Let's see!

Refer to any aviation trade paper or periodical in which used aircraft are listed for sale. Here are samplings, at random and reflecting no whit of derogation to any one name of aircraft or aircraft engine:

"*Bonanza,* TTAE, 570 hours; 60 since MOH. . . ."

"*Comanche,* TTAE, 680 hours; 95 STOH. . . ."

"*Cessna,* TTAE, 490 hours; 45 since re-manufactured engine. . . ."

Analyze the numerical repetition of advertisements such as these and you can arrive only at the conclusion that something is drastically wrong, particularly so since there are also aircraft listed, in the minority, to be sure, with much higher operating times than those cited above. By contrast, engines in professional use, largely airline, are performing perfectly with 2000 hours between overhauls; not only on brand new engines but on those which already have had several major overhauls. And as an interesting sidelight, it may be noted that our same American-made aircraft engines enjoy a much longer life in the hands of foreign users. Why? The professionals and foreign users make it a point to know everything possible about the operation and maintenance of these engines, from an economic as well as a mechanical necessity, and apply simple and proven safeguards to take care of their engines when in use and *when not in use.* Mark that last phrase; it holds much significance for general aviation.

Your answer to this, of course, must be that these professionals and foreign users have devised an intricately detailed program of lavish engine care and maintenance which keeps their engines running longer than those in general aviation and which we couldn't possibly embrace because of the time and costs involved. This is not necessarily so.

The airline operator is faced constantly with the inexorable facts of his economic life: cost per passenger mile, and he uses every resource at his command to keep this figure to a minimum in order that he may operate at a profit. Every phase of his operation of aircraft is accounted for in "cents per passenger mile." He is acutely aware then that engine life and overhaul costs can make the difference between profit and loss and he makes it his business to see to it that he gets maximum life and the lowest in maintenance and overhaul costs. Accordingly, scheduled airline pilots are rigorously drilled into precise operation of engine and propeller controls in every stage of airplane movement from taxiing to takeoff, to initial climb, to climb to altitude, to cruise, to descent, to approach, to landing, to engine braking, and to taxi. In the same fashion, the foreign user of American-made aircraft engines approaches his own operating techniques with a strict adherence to those precepts recommended by the engine manufacturer and to the use of the proper fuel and lubricants. In addition, these two categories of aircraft engine users, foreign and professional, practice the best possible preventive maintenance by providing

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their engines with the best possible safeguard that man has yet devised: full-flow, controlled-pressure (Winslow patents) oil filters. It's that simple. Yet the average aircraft owner drags his feet about investing in an oil filter for a variety of peculiar reasons that range from the superstitious to the hilarious.

The owner or user, in the majority we speak of, will talk out of one side of his mouth about why an oil filter should not be installed, "my engine's got an oil screen and that's enough", "I change the oil pretty often", "too much weight", "costs too much", etc.; from the other side of his mouth he complains about how "lousy" and expensive the engine is. Right next to him on the same airport, another owner with the same make and model of engine, the latter properly protected with an adequate oil filtration system, is enjoying double the life, one-third the cost, and added safety. This does not penetrate our hero's stream of consciousness. Nor does it ever occur to him to ask himself why it is that, except in general aviation, every other internal combustion engine in the world, gas or diesel—automotive, industrial, construction, or power-generating—is equipped with an adequate, sometimes over-size, oil filtration system.

General aviation aircraft engines, because of their operating and non-operating conditions, actually need full-flow, controlled pressure oil filters more than any of the internal combustion engines in the categories mentioned above, and that would include construction machinery which is supposed to be very rough.

In order to understand why this is so, we may use the cliche that engine oil is the "life blood" of any internal combustion engine and that without this circulatory system no engine anywhere can operate for any appreciable length of time. In this connection, it might be well to remember that the oil refining industry must be credited with a remarkable collective effort in producing oils with specific qualities which have kept pace with the new developments in engines, including the uses of new and lighter alloys, closer tolerances and higher operating ranges: compressions, loads and durations.

Oil men will tell you that good oil actually never wears out; it seldom if ever loses that basic lubricity which has been refined into it. But they will also tell you that oil is a chemical and subject to chemical reaction and change and seriously affected by externally induced contaminants which can cause costly damage. To minimize these deleterious effects they have advocated, and properly so, oil changes at specified intervals. For some reason, these chemical changes and induced contaminants seem to have impressed general aviation only slightly, if at all, although these phenomena are watched closely in other categories of internal combustion engine

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users. They insist on maximum life and economy in their operations; they get it.

Without getting involved in technical terms, we may describe the function of oil as a shield, composed of multi-millions of molecular-sized hydrocarbons which form a tough, thin film between moving parts and thus eliminate friction. Wear of moving parts and load bearing areas, then, is eliminated or reduced; but only as long as this oil film is unadulterated or its efficiency unimpaired by external elements. If operating conditions are ideal, these oils could last indefinitely, as they do, for example, in large electricity-producing generators where the turbine bearings are fed from a reservoir which is constantly filtered and reused, without change, almost indefinitely.

However, in internal combustion engines, and particularly aircraft engines, there are so many varying conditions: heat, pressure, cold, chemical reactions and solid contaminants that unless we do something to help oil stave off these enemies, we are going to continue to be faced with excessive wear, excessively premature engine life and increased operating costs. Once the engine is in your aircraft and the oil is in your engine, there is nothing that the engine manufacturer or the oil refiner can do to help you out, other than to lay down the rules for proper engine operation and fuel and lubrication guidance. This they gladly do. But from here on out, it's your baby and it is up to you to know and to understand what is taking place inside that engine and to take the proper steps to guard against those factors which are robbing you of better engine life and longer oil life.

These factors are:

1. Condensation. The formation of water inside the engine which is caused by temperature changes. The greater the temperature range change and the greater the frequency of temperature cycles, the greater is the amount of water produced. This holds true whether you hangar or not, and the only way to avoid condensation would be to store your aircraft permanently in a temperature and humidity controlled insulated room. As long as your engine is not running, this chemical phenomenon continues and the inside of your engine is, in effect, a highly efficient water-producing machine, a cousin to the small portable water distillers now offered on the market. The condensate forms and re-forms during all of the time that your aircraft engine is idle and leads to the paradoxical truism that you can actually damage your engine more by not using it than by using it. For those aircraft in general aviation which are flown only a few hours per month this is a most significant fact to take note of, for it indicates that the "enemies" are constantly at work within with the engine at rest.

Mixed with oil, this condensate forms an emulsion which, under heat and pressure of an operating engine, produces sludge, an all inclusive term of the gums, acids, varnishes and lead residue which are generated within the engine. Sludge has no lubricating properties whatever; it impairs or destroys lubricity and in direct ratio to the amount formed in any particular quantity of oil. As lubrication efficiency diminishes, the friction factors increase, and with them the wear rate of finely machined parts and bearings areas in your engine. In addition, as the operating temperatures in your engine climb higher, they harden the carbon present in this sludge into flinty particles which "bake" or bond onto these vital moving parts. An engine teardown is required to remove this carbon. And that carbon which does not adhere flows with the circulation of the oil, acting as one of the most efficient abrasives known to man.

Your engine oil screen affords some partial relief by catching and retaining some of this sludge and some of the other contaminants in your oil. However, the "straining" abilities of this screen must, of necessity, be limited. Too small and the screen is plugged and collapses; too large and almost everything goes through, including raw sludge. For instance, a 100 mesh screen is equal to about 149 microns or about .0059 inch while a full-flow element will filter down to five microns, about 30-40 times smaller than the average engine oil screen can catch and retain. Similarly, the cubic capacity of the screen is also necessarily limited by reason of physical dimensions so that, depending on how much the engine is idle, unless cleaned and serviced fairly often, it can become an additional problem. On the other hand, a full-flow controlled pressure filter is roughly 20 to 60 times greater in capacity than the engine screen (depending on engine size) and is warranted for 100 hours of use with a 100% fail-safe factor regardless of what type of operation the fixed-wing aircraft is involved in. If, by reason of sheer neglect, an element is allowed to remain, without change, in the filter for an abnormal length of time and becomes overloaded, the engine will continue to function although the oil supply is now not guarded. When a screen becomes overloaded it may collapse and your engine soon ceases to function.

2. Acidity. The chemical reactions in engine oil, produced first by condensation and then sludge, continue to build and expand in scope to produce an acid which attacks metal causing the familiar "pitting" and "flaking" off of tiny metallic particles from any part within the engine. Aside from the ultimate destruction of these jeweled machined surfaces, these metallic solids, borne by the oil, circulate throughout the entire interior of the engine, causing spalling of load-bearing surfaces, roughening them, and produces abnormal friction and wear. So vicious is this acid attack that no area within the engine is immune to it and there are documented cases where this acid has eaten completely through crankcases.

An owner in Virginia along the seaboard related to me that he flew but five or six hours per month, and his valves and valve guides were eroded in an engine having less than 200 hours. Replacement, of course, was expensive, but it did point out to him that acid attack, magnified and abetted by salt air corrosion (salt crystal deposits within the engine), had robbed him of the inherent life built into these parts by the engine manufacturer. Salt crystals, incidentally, are a threat wherever aircraft are operated on or near a sea-coastal area but they can be filtered out. An engine screen cannot take these out.

In this connection, and here we seem to tread into the field of pure naivete, unless the general aviation pilot or owner has had the experience himself, he is totally unaware that carbon and metallic solids can harm controllable pitch propellers which depend on the oil reserve for operation. The current term is "coking" of the propeller hubs. There are some interesting cases where props have locked in pitch because of solid contaminants in the oil supply. Similarly, in the larger radials which are equipped with clutches, the effect of sludge and carbons present in the oil supply can be a continuing source of maintenance headaches. With turbosuperchargers moving into the smaller horsepower field, engineers will tell you that an oil filter is an absolute necessity unless you want to overhaul turbine bearings (operating at speeds up to 70,000 rpm) every 300 hours or less. It doesn't take much imagination to visualize what even the smallest amount of carbon or contaminants can do at these high speeds.

3. Dirt. Aircraft engines eat dirt in surprisingly large amounts through the air intake systems, depending on their environment. We speak here of general aviation, not crop-dusting or helicopters where dirt ingestion is so magnified that oil filtration systems are virtually standard operating equipment. At any airport, hard-surfaced or not, the air is heavily dirt laden in those broad, open areas which any aircraft engine will gulp in unbelievable quantities. Our entire atmospheric envelope is dirt-laden and it might be startling to learn of the quantities present at 30,000 feet. Ingested into the engine, carried in suspension by the oil, pumped under pressure to every bearings area—crankshaft and rod bearings, wrist pins, piston rings and ring lands, valves, guides, etc. This dirt, combined with hard carbon and metallic solids, grinds with the merciless efficiency of a rock drill against these polished and plated surfaces. The result: excessive wear, short engine life, and the woes of the repair bills.

We have an aircraft engine made with jewel-like precision and the use of the finest lubricating oils the world can produce. But we also have those insidious and incessant enemies: water, sludge, acid, carbon, and dirt working constantly against the most important unit in the aircraft—the engine. We can also compound our problems (as if we didn't have enough to cope with) by misuse or abuse of the engine in operation and by failing to use the proper fuel or lubricants recommended.

To foil these "enemies" requires only a sensible program of preventive maintenance, beginning with an adequate oil filtration system made specifically for aircraft engines, to eliminate or minimize excessive wear and premature engine life, and to prevent the possibility of engine failure in flight. END

THE AUTHOR

William F. Drucker, author of "Preventive Engine Maintenance," has been associated professionally with internal-combustion engines—both gasoline and diesel—for 30 years. A mechanical engineer by profession, Drucker has engaged in engineering sales and sales management in the heavy-duty automotive industry — trucks for commercial transportation and construction. Vice president of Winslow Aerofilter Sales Corporation, Mount Carmel, Conn., Drucker has been flying since 1930 (he learned to fly in a Waco 9). During his early flying days he engaged in barnstorming in practically all of the available planes of the day, including tri-motor Fords. He presently flies 30-40 hours per month in a Mooney Mark 21 for his company.