

Changing the Oil

The Reason Why

This presentation was provided by Savvy Aviation, Inc out of Santa Rosa California by Mike Busch – **Changing the Oil** 2025 (<https://www.youtube.com/watch?v=EocWLwY4mxY>) webinar presented by Mike Busch in 2025.

This discussion is just a summary of the “**Changing the Oil**” webinar and will only focus on the three major manufacturers of aircraft reciprocating engines today; Continental, Lycoming and Rotax.

Federally Certificated and non-certificated aircraft engines

Both Continental and Lycoming are the primary manufacturers of Federally Certificated aircraft engines. All of their engines are 4-stroke, air-cooled, horizontally opposed cylinders (rather than in line) and usually a direct drive from the crankshaft to the propeller. The recommended over haul for these engines is usually between 1,200 hours and 2,000 hours of operation depending on the model.

Rotax engines, on the other hand, are normally not Federally Certificated because they are made for experimental aircraft (>50% of aircraft is built by non-FAA Certified manufacturers) and most of these engines are 2-stroke with no oil sump at all (oil mixed in the gas). The recommended over haul for these engines is around 300 hours of operation. In this discussion, the Rotax engine referenced is the 900 series which is a 4 stroke engine.

Note that all aircraft engine manufacturer goals = Weight being as light as possible per horse power, plus not turning the propeller faster than 2,500 – 3,000 rpm which is determined by the diameter of the propeller tip not to hit the speed of sound.

Oil Change specifications by manufacturer

Both Continental and Lycoming oil changes are from 25 – 50 hours of operation or 4 months (whichever comes first). Both engines are designed to operate with only 100LL (100 Low Lead) aviation fuel.

The Rotax 915, is a 4 stroke, water cooled, oil sump engine and is designed to run on automobile gasoline, its oil change is set at 100 hours of operation. Although, the manual specifies that you’re allowed to run on 50% 100LL, but your oil change must be at 50 hours.

Why Automobile Oil Changes are so different from aircraft

Automobile oil change specifications are normally in the thousands of miles (Jaguar can go up to 16,000 miles without an oil change). First, we must keep in mind the perspective. If an automobile averaged 60 mph, then 100 hours of operation would be 6,000 miles. Or, if it averaged 40 mph, then you're looking at 4,000 miles. Another thing to remember is that your automobile is only burning un-leaded 80ish octane automobile gasoline. The operative word here is "un-leaded" which puts virtually no carbon into the exhaust to fowl plugs, valves, rings and oil. Plus, automobile engines run with tighter piston ring protection to minimize the "blow by" that occurs during the compression and power strokes of the engine. It's the "blow by" that contaminates the oil.

The Aircraft Engine dilemma

How can an aircraft engine produce more horse power without increasing its weight? One answer is to provide higher octane fuel. This is accomplished by putting lead particulates into the fuel. There are companies working on fuel without lead that achieves 100 octane, but don't hold your breath. It's coming, but not here yet. Another issue with aircraft engines is that the rpm of the propeller is limited to 2,500 to 3,000 rpm. Adding a gear reduction to the crankshaft would mean more weight. So, most engines are direct drive (propeller bolted to the crankshaft). The third issue is engine efficiency or more correctly the most miles per gallon of gas. This third issue is why engines are operating on 4 strokes (2 full rotations of the crankshaft) rather than 2 strokes (1 rotation of the crankshaft). A 2-stroke engine can give us a lighter weight engine (a lot fewer moving parts), and a higher operating rpm, but at the sacrifice of burning more fuel per hour of operation. Companies are working on that dilemma, but again, don't hold your breath.



For now, we are stuck with the 4-stroke engine, slow rotation, high compression and a lot of "blow by" waste being pumped into the oil sump. So, we are not changing the oil because it has broken down, but because it is contaminated – downright filthy!

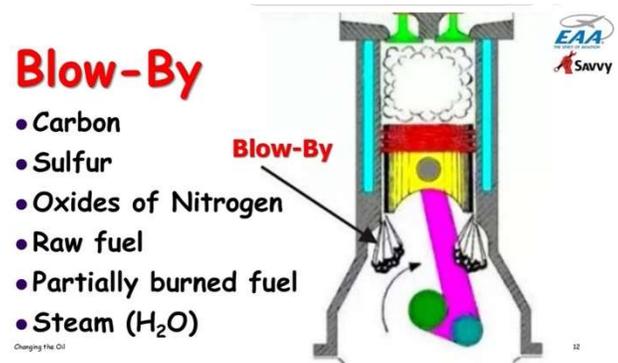
Blow-By characteristics

"Blow-by" is combustion gasses that make it past the piston rings and get into the crank case and contaminate the oil. Aircraft engines are slow turning and have huge displacements as compared to car engines. Aircraft engines have a lot bigger cylinders and pistons that accommodate huge amounts of combustion gasses that seep through the piston rings into the combustion chamber where the oil is busy lubricating the crankcase. To make matters worse,

aircraft engines are air-cooled which expand and contract with the different outside air temperatures. Air-cooled engine tolerances are very loose as compared to automobile engines where temperatures are closely controlled by the cooling water temperature.

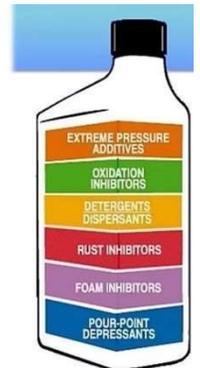
Acid Generator

Probably the biggest problem with this “blow-by” is the steam (H₂O) that gets into the crank case. If 100% of the gas is burned the result is pure steam (H₂O), but since only around 20% of the fuel is actually burned, then we get all of these other broken-down chemicals (i.e. carbon, sulfur and oxides of nitrogen) plus raw fuel, partially burned fuel and steam (H₂O). These partially broken-down chemicals, when mixed will create Sulfuric Acid (steam mixed with sulfur) and Nitric Acid (steam mixed with oxides of nitrogen) which are highly corrosive. Plus, if you use 100LL fuel, then there is a high level of lead salts included in the combustion not to mention that running a rich mixture means that a lot of the carbon has turned into Carbon Monoxide.



Motor Oil additive package

Another reason for accomplishing an oil change is to replenish the additive package. Motor oil contains a whole bunch of additives and they are quite important. Some of them get used up during engine operation and have to be replenished in order to continue doing their job.



- Acid neutralizers – Neutralizing the Sulfuric and Nitric Acids by using alkaline which gets used up during use.
- Dispersants (Ashless Dispersants) – Grabs onto carbon and lead salts holding them in suspension
- Friction modifiers (EP – Extreme Pressure) – Reduces friction where oil film might be lacking
- Rust inhibitors
- Foam Inhibitors – Helps keep the oil from foaming up due to all of the sloshing around that occurs in the crankcase.
- Pour-point depressants – Helps the oil maintain fluid during cold temperatures
- Viscosity index improvers (multi-viscosity oils)

Note: 100LL fuel equals 100 octane while jet fuel (kerosene which is very similar to diesel fuel) equals 0 octane (no octane). If you accidentally, put jet fuel into your gas tank, your engine will immediately shutdown as soon as the jet fuel reaches the engine.

Oil Analysis

BlackStone Laboratories is a very popular company that is very familiar with aircraft engines. In their comments they will let you know if you used auto-gas when you should have used 100LL and vice versa. The kind of metals that they found as well as how much moisture was in your oil. Plus, acid neutralizer ability:

- Insoluble particulates – Percentage imbedded in the oil.
- TBN (total base number) – Must be requested by the client.

Note that the provided “OIL REPORT” is from a Volvo 2.0 liter automobile with 3,800 miles, not an aircraft engine.



BLACKSTONE LABORATORIES

OIL REPORT

LAB NUMBER: [REDACTED]
 REPORT DATE: 7/6/2022
 CODE: 20598

UNIT ID: 21 XC00
 CLIENT ID: 171167
 PAYMENT: CC Visa

MAKE/MODEL: Volvo 2.0L (B6T6) Twin-Charged I-4
 FUEL TYPE: Gasoline (Unleaded)
 ADDITIONAL INFO:

OIL TYPE & GRADE: Castrol Professional 0W/20
 OIL USE INTERVAL: 3,800 Miles

CLIENT: [REDACTED]

PHONE: [REDACTED]
 FAX: [REDACTED]
 ALT. PHONE: [REDACTED]
 EMAIL: [REDACTED]

COMMENTS: This is another good report to add to your XC90's collection. Minor fuel dilution was once again the only detectable contamination, and it's not harmful or concerning. The TBN indicates additive additive in the oil to combat acidity, and the viscosity stayed firmly in the 0W/20 range so this Castrol oil held up well. It kept your engine properly lubricated based on the healthy wear readings. These are some of the lowest metal levels to date, and metals are well below averages. We see no reason not to try 7,000 miles next time -- go for it!

	3,800		5,500		4,800		5,500		4,133		1,738		UNIVERSAL AVERAGES
	MI/HR on Oil	MI/HR on Unit											
Sample Date	6/4/2022		2/21/2022		11/2/2021		8/15/2021		1/22/2021		10/15/2020		
Make Up Oil Added	0 cts		0 gals										
ELEMENTS IN PARTS PER MILLION													
ALUMINUM	1	3	2	2	4	8	15	5					
CHROMIUM	0	0	0	0	0	0	0	0					
IRON	4	7	5	6	8	10	19	13					
COPPER	1	2	2	1	2	7	25	2					
LEAD	1	0	0	0	0	0	0	0					
TIN	0	0	1	0	0	0	1	0					
MOLYBDENUM	9	56	53	9	53	37	1	77					
NICKEL	0	0	0	0	0	0	0	0					
MANGANESE	1	2	1	1	1	3	6	4					
SILVER	1	1	1	1	0	1	1	2					
TITANIUM	20	12	18	20	17	3	21	10					
POTASSIUM	0	1	0	1	0	0	0	3					
BORON	48	65	29	50	28	149	58	41					
SILICON	4	6	6	4	8	10	18	7					
SODIUM	4	12	4	4	5	62	5	6					
CALCIUM	1507	1262	925	1655	958	1097	1569	1248					
MAGNESIUM	17	355	578	95	544	191	15	538					
PHOSPHORUS	627	827	641	684	634	570	162	878					
ZINC	775	748	738	815	744	655	816	768					
BARIUM	0	0	0	0	0	0	0	0					

PROPERTY	Values		Should Be*	
	Actual	Unit	Min	Max
SUS Viscosity @ 210°F	53.2	cSt	46-57	
cSt Viscosity @ 130°C	8.23		6.0-9.7	
Flashpoint in °F	375		>385	
Fuel %	0.5		<2.0	
Antifreeze %	0.0		0.0	
Water %	0.0		<0.1	
Insolubles %	0.1		<0.6	
TBN	3.1		>1.0	
TAN				
ISO Code				

* THIS COLUMN APPLIES ONLY TO THE CURRENT SAMPLE

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Aircraft Motor Oils

The pure synthetic oils are no longer available. They really didn't help alleviate the accumulation of carbon on the metal surfaces in the engine.

Although, they will probably come back

when the FAA approves an Un-Leaded Fuel designed for aircraft engines. Till then the closest synthetic oil is the AeroShell W15W-50 oil and the AeroShell SPORT PLUS 4 which was designed to optimize the geared Rotax engines.



Oil Additives



STP oil additive is probably the most popular for automobiles, but is strictly prohibited for aircraft engines. The percent of additives in the MARVEL Mystery Oil and the AVBLEND is very minimal. The Lycoming Engine Oil Additive and the CamGuard Aviation additives are the best available for aircraft engines and may already be in the oil that you are presently using.