



MIKE BUSCH
HANDS ON / SAVVY AVIATOR



*Some popular
aircraft engine oils.*

All About Oil

Part 1: What you should know

BY MIKE BUSCH

IF I ASKED YOU to explain the purpose of engine oil, you'd probably say something like "to lubricate moving parts and reduce friction and wear." That's correct, but lubrication is only one of six key functions that oil must perform in your piston aircraft engine. In fact, the lubrication needs of big displacement, slow-turning piston aircraft engines are really quite modest, compared to the high-revving engines in our automobiles. Lubrication demands tend to vary with the square of rpm, so a car engine has far more demanding lubrication requirements than an airplane's engine has.

Oil also serves as a vital coolant for engine components that can't be air-cooled. Pistons, for example, are exposed to just as much heat of combustion as cylinders, but they don't have cooling fins or exposure to airflow. The only thing that keeps them from melting is the large quantity of oil that is splashed and squirted onto the bottom of the pistons to carry away the heat.

Another key function of oil is to keep the engine clean. Compared to car engines, piston aircraft engines are positively filthy creatures. They burn heavily leaded fuel and allow large quantities of lead salts, carbon, sulfur, water, raw fuel, and other nasty combustion byproducts to blow by the rings and pollute the bottom end of the engine. The oil has to be able to keep these contaminants dispersed and hold them in suspension so they don't accumulate on internal engine parts in the form of sludge.

Oil also acts as a sealant to prevent the leakage of gases and liquids (including the oil itself) past piston rings, O-rings, gaskets, and various other kinds of seals.

If your airplane has a constant-speed propeller, oil serves as the hydraulic fluid used to adjust the blade pitch. If it is turbocharged, the wastegate is probably hydraulically actuated by oil as well.

Last, but certainly not least, oil is required to protect expensive components like crankshafts, camshafts, lifters, and cylinder barrels from rusting during periods when the airplane is not flown. Because we tend to fly our airplanes less often and more irregularly than we drive our cars, the preservative requirements of our aircraft engines are far more demanding than for automotive engines.

SIX KEY FUNCTIONS OF OIL

- Lubricate
- Clean
- Actuate
- Cool
- Seal
- Preserve

LUBRICATION

The purpose of lubrication is to reduce friction and wear on the engine's moving parts. Friction occurs because even the smoothest surfaces have microscopic peaks and valleys. Whenever surfaces come in contact, these

tiny peaks adhere to one another via tiny “micro-welds.” If those surfaces are in relative motion, the micro-welds constantly fracture and re-form, resulting in friction and wear.

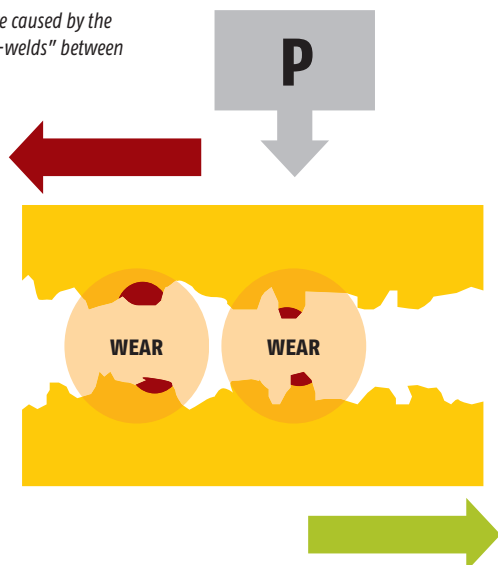
There are several different kinds of lubrication. The most effective kind is hydrodynamic lubrication. It occurs when a fluid—most commonly a liquid like oil—is interposed between the moving parts. The relative motion of the parts creates sufficient pressure in the lubricant to keep the parts from touching. Think of a water-skier being supported by the skier’s relative motion to the lake and the resulting pressure of the interposing water. The water pressure prevents the skier from sinking and contacting the lake bottom. Or consider a car hydroplaning on a rain-slicked road; its locked tires are separated from the pavement by water pressure—that’s hydrodynamic lubrication.

This kind of lubrication works well if the relative speed of the parts is high enough to overcome the load pushing them together. If the relative speed is not high enough, then there will not be enough lubricant pressure to keep the parts separated. (Think of the towboat slowing down until the skier sinks.)

If hydrodynamic action cannot keep the parts separated, we must rely on boundary lubrication. Boundary lubrication relies on a thin, soft, solid film deposited on the moving parts—typically by chemicals called “extreme pressure additives.” That thin film reduces friction and wear by chemically interfering with micro-weld formation.

Rub your hands together vigorously and you’ll feel the friction between your palms in the form of heat and resistance to movement. You just created and then fractured a few zillion micro-welds on the surface of your palms! You can reduce the friction in several ways—for instance, by coating your palms with Vaseline or by dusting them with talcum powder. Think of the Vaseline as hydrodynamic lubrication and the talc as boundary lubrication.

Friction and wear are caused by the fracturing of “micro-welds” between moving surfaces.



Power to the Sport Pilot...



Aerovee Engine Kit
80hp \$6,995

AeroInjector
Throttle-Body
For 30-160hp
4-Stroke
Engines
\$395
Included in AeroVee Price!

www.AeroConversions.com
or call: 920.231.8297

TrickAir
Snow Skis



S.T.C.'s Now Available For Many Models of Aircraft
www.TrickAir.com 800-374-4237

www.spidertracks.com

~~SEARCH & RESCUE~~

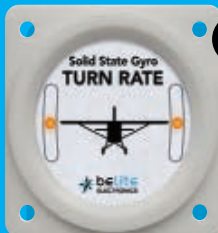
Crashing a plane is bad enough. Not being found in time can turn a survivable accident into a tragedy.

It's now time to save lives. Spidertracks has been invented to find you faster. Unlike traditional emergency location systems, spidertracks works before you crash, transmitting your position via satellite from take-off to landing. The search is over; 'found technology' is here.

To find out more, visit our website or call 800-491-2895

TIME TO SAVE LIVES | spidertracks

Simple, Affordable, Featherweight Avionic Instruments



New!

Turn Rate Indicator with automatic battery switchover, perfect for IFR backup.

Patent Pending



New!

Air Speed Indicator measuring 35-135 KNOTS!

Available at Aircraft Spruce

Introducing PCAS™ Portable Collision Avoidance System, the only portable collision avoidance system to deliver quadrant bearing, using relative altitude and range of the top 3 most threatening aircrafts. Displayed in a portable, self-contained module with integration capabilities to most moving map systems.

XRX Only portable system with direction.



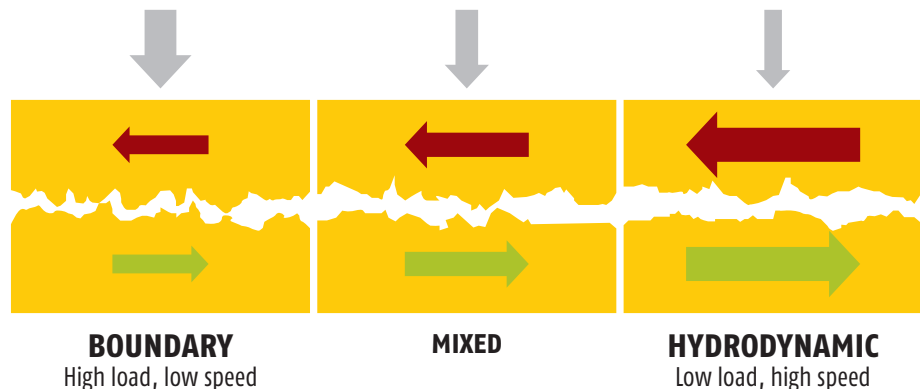
MRX Digital range and altitude.



ZAON
FLIGHT SYSTEMS

www.zaon.aero
(800) 496-9430

MIKE BUSCH



Hydrodynamic versus boundary lubrication.

TYPES OF LUBRICATION

Most of the lubrication in our engines is hydrodynamic. It's accomplished in two different ways. Some moving parts—such as the main and rod bearings—are pressure lubricated by oil that is distributed directly to those parts by means of a series of drilled passages in the crankcase and crankshaft known as oil galleries.

Many other moving parts—pistons, rings, cylinder barrels, cam lobes, lifter faces, gears—receive no direct lubrication from oil pressure. These critical components rely entirely on splash lubrication. When the engine is running, lots of oil extrudes from the crankshaft's pressure-lubricated main and rod bearings and is flung in all directions by the rapidly turning crankshaft, splashing oil on everything in the vicinity.

Other critical parts are too slow moving and too heavily loaded to be separated hydrodynamically and rely mostly on boundary lubrication. One interesting example is the interface between the piston rings and cylinder barrels. Most of the time the piston is moving rapidly inside the cylinder and the ring-to-barrel interface is lubricated hydrodynamically so there's no metal-to-metal contact. At top-dead-center, however, the piston slows to a complete stop, then reverses direction. The slowing of the piston defeats any effective hydrodynamic lubrication in the critical ring-reversal area at the top of the stroke. For a brief but critical period during each

crankshaft rotation, the rings stop moving, sink through the oil film—like a water-skier whose towboat stopped—and come in contact with the cylinder walls. The only thing that protects this “ring reversal area” from accelerated wear is boundary lubrication.

Boundary lubrication is also crucial during the first few seconds after the engine is started. That's especially true if the aircraft hasn't flown for a while and most of the oil has stripped off the parts. Until oil pressure stabilizes and the crankcase fills with splash oil, dry engine parts have to rely on boundary lubrication alone.

TYPES OF ENGINE OIL

Now let's talk about the different types of oil, and the pros and cons of each. Here are the six most widely used piston aircraft engine oils in the United States:

- Multigrade Oils:
 - » AeroShell 15W-50 (50 percent synthetic)
 - » Exxon Elite 20W-50 (25 percent synthetic)
 - » Phillips X/C 20W-50 (0 percent synthetic)
- Monograde Oils:
 - » AeroShell 100/80 (non-ash dispersant break-in oil)
 - » AeroShell W100/W80 (0 percent synthetic)
 - » AeroShell W100 Plus/W80 Plus (0 percent synthetic)

Many other moving parts—pistons, rings, cylinder barrels, cam lobes, lifter faces, gears—receive no direct lubrication from oil pressure.

AeroShell 15W-50 is by far the most popular multigrade oil. It is referred to as a semi-synthetic oil because it is a 50-50 hybrid of petroleum-based mineral oil and a synthetic oil called polyalphaolefin or PAO. To this half-and-half mixture of mineral and synthetic base stock, Shell adds chemicals called “viscosity index improvers” to give the oil its multigrade properties. It also adds a complex additive package including ashless dispersants to help prevent sludge, corrosion inhibitors to help prevent rust, and an extreme-pressure boundary lubricant called butylated triphenyl phosphate (bTPP).

Exxon Elite 20W-50 is a very similar formulation to AeroShell 15W-50, except that its base stock is only 25 percent synthetic and 75 percent petroleum-based. Its additive package is nearly identical to the one used in AeroShell 15W-50.

Phillips X/C 20W-50 is an inexpensive, no-frills, all-petroleum multigrade. It's made strictly from dead dinosaurs with no synthetics. Phillips adds viscosity index improvers to obtain multigrade properties, and ashless dispersants to prevent sludge.

Moving on to the monograde oils, AeroShell straight 100 is an SAE 50 mineral oil with minimal additives. It's used primarily as a break-in oil, and occasionally as an operating oil for radial engines.

AeroShell W100 is by far the most popular monograde oil. The “100” means that its viscosity rating is SAE 50, and the “W” prefix means that it contains an ashless dispersant additive package to help keep particulates in suspension and minimize sludge formation. (This “W” prefix that denotes ash dispersant additives should not be confused with the “W” suffix in “15W-50,” which denotes that SAE 15 is the oil's winter rating.)

AeroShell W80 is a less-viscous version of AeroShell W100, and it's used as a wintertime oil by operators who prefer monogrades.

AeroShell W100 Plus is simply AeroShell W100 to which Shell has added the same package of



EVERYTHING A HOMEBUILDER NEEDS AND MORE!!!



AN-MS HARDWARE



AIRCRAFT SITKA SPRUCE



4130 /ALUMINUM TUBE



GPS UNITS



HEADSETS



OXIMETERS

800-221-9425 WWW.WICKSAIRCRAFT.COM 618-654-7447

Your One-Stop Prop Shop

**Only Sensenich Offers You the Choice:
Wood, Metal, or Composite Adjustable**

**Fixed-pitch
Wood and Metal
Propellers**

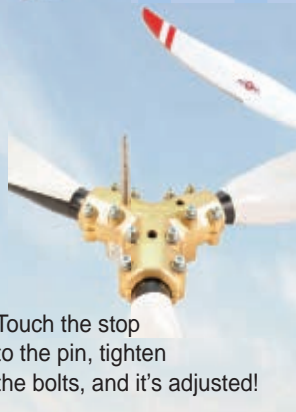


**Auto-indexing
Composite
Propellers**



for Rotax 912,
Jabiru,
O-200, O-320

Our composite propellers feature lightweight metal-edge hollow blades and easy, accurate, foolproof pitch indexing.



Touch the stop
to the pin, tighten
the bolts, and it's adjusted!



www.sensenich.com

813-752-3711

Lancaster, PA Plant City, FL

uma
Aircraft Instruments

Silkscreened
Range Markings
Mechanical
Replacement
Gauges

Custom dual &
3 in 1 gauges
E.L. Lighting
Available

Made in the USA
1-800-842-5578
www.umainstruments.com

Call Toll Free: 1-800-237-6902

aerox
Built In & Portable Oxygen Solutions

Emergency Portable Systems
Oxysaver Cannula Retrofit Kits
Filling Stations & Adapters
Masks & Cannulas
Parts & Accessories
Remote Regulators
Flow Meters & Flow Regulators

Everything Oxygen

www.aerox.com

MIKE BUSCH

The advantages of synthetic oils—which are quite compelling for automotive and turbine use—are much less significant for piston aircraft engines.

anticorrosion and antiscuff additives that it uses in 15W-50.

MONOGRADE OIL VERSUS MULTIGRADE OIL
Monograde oil is simply mineral oil plus an additive package. It has viscosity, or thickness, that varies rather dramatically with temperature. At operating temperature—around 200°F—it's quite thin and flows very freely. But at room temperature, it's thick and goeey. Get it cold enough and it won't pour at all.

Multigrade oils are much less thick and goeey at cool temperatures. They still get thicker as temperature decreases, just not nearly as much. To make a multigrade oil, you start with a really thin monograde oil (something like SAE 10 or 15) and then add an artificial thickening agent called a "viscosity index improver" (VII). This is a man-made polymer that has the unusual property of getting thicker and more viscous when heated—precisely the opposite of what mineral oil does. By combining oil with VIIs, the manufacturer can obtain pretty much any viscosity-to-temperature curve it likes. Multigrade aircraft oils are roughly 90 percent base stock, with the remaining 10 percent composed of VIIs and other additives.

At operating temperature, AeroShell W100 and 15W-50 have essentially the same viscosity. At room temperature or colder, the difference in viscosity is obvious and dramatic. The W100 pours like black-strap molasses, while the 15W-50 pours like Aunt Jemima Lite.

The advantage of multigrade oil is that it doesn't thicken nearly as much at cold temperatures. This offers a significant benefit during cold weather if you have to start without a preheat. With multigrade oil, the oil flows more quickly to the main and rod bearings, and splashes more quickly onto the cam, lifters, pistons, and cylinders.

On the other hand, the fact that multigrade oil remains thin and pourable

at cool temperatures also can mean that it drains off engine parts more quickly after shutdown. You can see this for yourself by checking how much longer it takes for the oil level on the dipstick to stabilize after shutdown. It takes many, many hours with a thick monograde oil like AeroShell W100, but less with a multigrade like 15W-50. Consequently, multigrade doesn't provide as long-lasting a physical barrier against corrosive attack during extended periods of disuse. This is not important for "working airplanes" that fly every day or two, but it can be important for airplanes that fly irregularly and sometimes sit for weeks at a time.

MINERAL OIL VERSUS SYNTHETIC OIL
Oil is made up of giant molecules called polymers. Some are natural like mineral oil, others man-made like PAO. Different polymers have different shapes. The molecules of mineral oil have a lot of side branches, while the molecules of synthetic oil are smoother and less "branchy."

Mineral oil gradually degrades the longer it remains in service. The little branches gradually shear off the molecules—known as polymer shearing—which causes viscosity to decrease. Because synthetic oil is less branchy, it suffers far less from polymer shearing and retains its viscosity longer. This means that synthetic oil can go a lot longer between oil changes, at least in automotive applications.

The smooth, less branchy molecules of synthetic oils like PAO do offer some significant advantages over mineral oil. They provide improved lubricity, simply because they are smoother and more slippery. They also last longer, because they suffer less from polymer shearing and thermal breakdown.

But mineral oil also has its advantages. Its branchy molecules do a much better job of holding particulate contaminants in suspension so that they can be drained out at the next oil change instead of settling out

as sludge. In fact, the full-synthetic Mobil AV 1 was withdrawn from the market more than a decade ago because so many engines were ruined by lead sludge deposits. To put it bluntly, synthetic oil simply can't deal with filth.

Mineral oil is also a better sealant, because its branchy molecules are less likely to sneak by O-rings and gaskets in the form of oil leaks.

The advantages of synthetic oils—which are quite compelling for automotive and turbine use—are much less significant for piston aircraft engines. The improved lubricity is less important simply because piston aircraft engines have such modest lubrication requirements. The extended oil-change intervals that synthetics offer in automotive applications are of little use in piston aircraft engines because the oil gets so filthy with blowby that it's a bad idea to go more than 50 hours without draining the dirty oil.

Corrosion is the No. 1 reason that piston aircraft engines fail to make TBO (time between overhauls). We almost never wear these engines out; we rust them out. This is a big problem in the owner-flown fleet, because owner-flown airplanes tend to fly irregularly. Working airplanes that fly every day or two almost always make TBO without breaking a sweat.

I personally prefer mineral oils over semi-synthetics for piston aircraft engines. The advantages of synthetics simply don't benefit these engines the way they do automotive and turbine engines. I also prefer monogrades over multigrades, except when multigrade is necessitated by exposure to unpreheated cold-starts in sub-freezing temperatures. For aircraft operating in cold climates, I recommend using a mineral-based multigrade like Phillips X/C 20W-50 during the four coldest months of the year, and switching to a monograde like AeroShell W100 for the remaining eight months for maximum corrosion protection. Of course, if the airplane flies frequently and regularly so that corrosion risk is low, then there's nothing wrong with using a multigrade year-round.

Next month we'll cover additives, oil consumption, oil level, oil-change interval, oil filter inspection, and laboratory oil analysis. *EAM*



Mike Busch, 2008 National Aviation Maintenance Technician of the Year, has been a pilot for 44 years, logging more than 7,000 hours. He's a certificated flight instructor and an airframe and power-plant mechanic with inspection authorization. E-mail questions to Mike at mike.busch@savvyaviator.com. Mike also hosts free maintenance webinars on the first Wednesday of each month at 8 p.m. (Central). To sign up or access the archives, visit www.SavvyMX.com/Webinar.

BIG SCREEN

AVIONICS



GARMIN

The choice is as clear as glass...

AEROTRONICS

INC.

The G900X AVIONICS SUITE, an all-glass panel designed for kitplane builders of the popular Lancair and Van's RV-Series aircraft, is available from Aerotronics, Inc., a Garmin G900 certified dealer. This fully integrated "glass package" puts a wealth of safety-enhancing data at your fingertips.

Dedicated to setting the standard of innovation, craftsmanship and customer service by creating a world-class example of excellence.

406-259-5006 • 1651 AVIATION PLACE • BILLINGS, MT 59105 • www.aerotronics.com

The Boeing 777's Great Great Great Great Granddaddy



The Boeing 40C delivered much more than mail and is considered the first US airliner. This Randolph-finished beauty restored by Addison Pemberton is the only 40C in the world still flying.

★Lustrous foot-deep finish
★Lasts and lasts and lasts
★Easy worry-free repairs
800-362-3490
info@RandolphAircraft.com

Randolph

Aircraft Products

RandolphAircraft.com



Slippery Stuff

About Oil Part II: Additives, consumption, levels, intervals, filters, and analysis

BY MIKE BUSCH



LAST MONTH, I WROTE about the types and properties of the various kinds of engine oil available. This month, the discussion continues with oil additives, oil consumption, oil levels, oil-change intervals, oil filter inspections, and oil analysis.

AFTERMARKET ADDITIVES

Pitchmen have long been promoting oil additives that eliminate friction and wear, increase fuel economy, improve your landings, raise your IQ, and rescue your marriage.

The granddaddy of these is Marvel Mystery Oil (MMO). Folks have been pouring this stuff into aircraft engines for more than 80 years. It was developed in 1923 by Burt Pierce, the inventor of the Marvel carburetor, and was intended as a fuel additive to clean carburetor jets. The name “mystery oil” came from the fact that Burt Pierce refused to divulge its formula.

As far as I can tell, MMO doesn’t do any harm if used in moderation, but it doesn’t seem to do much good, either. Its formula is no longer a mystery since regulations require the current manufacturer, Turtle Wax Inc., to publish the ingredients on a material safety data sheet. Turns out MMO has some interesting ingredients, including pig fat, perfume, and red food coloring in a base of petroleum distillate solvent. I don’t use MMO.

Some aftermarket oil additives—notably Microlon and Slick 50—contain a slippery resin called PTFE, which is made and marketed by DuPont under the trade name Teflon. The Microlon and Slick 50 folks claim that the stuff bonds with metal surfaces in your engine and virtually eliminates friction. This is bunk. Manufacturers of nonstick cookware will tell you just how difficult it is to get Teflon to bond to anything. Users of nonstick cookware will tell you just how easy it is to ruin Teflon coating because it’s so fragile. NASA did a study of Teflon oil additives a while back and concluded that they are ineffective as a friction reducer, and they can actually damage an engine by clogging oil filters and tiny oil passages in hydraulic lifters. DuPont specifically warns against using Teflon in internal combustion engines. Nevertheless, the promoters of Microlon somehow convinced the FAA to approve its use in aircraft engines. My advice: Just say no.



Aftermarket oil additives.

AvBlend has been around for two decades and is a repackaged automobile oil additive called Lenckite that has been around for even longer. Back in the ’90s, my friend Howard Fenton of Engine Oil Analysis in Tulsa ran a test of AvBlend involving several piston twins that used AvBlend in one engine and not in the other. When we looked at the oil analysis results, we could not tell which engine had the AvBlend and which didn’t. Like MMO, AvBlend appears to do no harm, but we didn’t find any evidence of benefit either.

Given this dismal history of miracles-in-a-can, when ASL CamGuard hit the market about five years ago, I was understandably skeptical. But in July 2007, I ran into CamGuard developer Ed Kollin at AirVenture and discovered that Ed is a sharp and experienced lubrication chemist who ran Exxon’s engine lab for many years, was heavily involved in the development of Exxon Elite, and seems to know more about aircraft oil and additives than anyone I’ve ever met.

I decided to run a test of CamGuard in my own airplane. I used it quietly for 18 months. My oil analysis results showed that

the big spikes in iron (caused by rust) that I had always seen when the aircraft was idle for a month or more were eliminated. That got my attention. I also found a modest across-the-board reduction in other wear metals (about 10 to 20 percent). I examined the oil analysis history of several other airplanes using CamGuard and saw much the same thing. I've been using CamGuard in my engines for more than three years now, and I'm convinced the stuff works.

For most of the airplanes we manage, we recommend AeroShell W100 with a pint of CamGuard added at each oil change. That's what I use in my airplane, and my two engines are at nearly 200 percent of time between overhauls (TBO) and still going strong. For wintertime operations in cold climates, I recommend Phillips X/C 20W-50 multigrade with a pint of CamGuard.

OIL CONSUMPTION

Take any group of aircraft owners and it's not long before they're comparing notes on

whose airspeed is the highest and whose oil consumption is the lowest. I'm here to tell you that low oil consumption is highly overrated.

Lots of factors affect oil consumption. Six-cylinder engines use more oil than four-cylinder engines. Big-displacement engines use more oil than smaller-displacement engines. Chrome-plated cylinders use more oil than steel cylinders. Nickel-carbide cylinders use less oil than steel. And so on.

Anything from a quart in 20 hours to a quart in four hours is normal. I've seen engines that burned a quart in four hours throughout their entire life and made it past TBO without any problem. I've also seen engines that used hardly any oil and then wound up needing a top overhaul after 500 hours.

TCM doesn't consider oil consumption to be a cause for concern until it exceeds a quart in three hours, and says that it isn't an airworthiness issue until it exceeds about a

quart per hour. I don't think any of us would allow our horizontally opposed engines to get to the point of burning a quart per hour, simply because it's embarrassing to run out of oil before you run out of fuel.

I get concerned about any sudden increase in oil consumption. If an engine has been using a quart in 12 hours for most of its life and suddenly starts using a quart in six hours, something has changed and that's a red flag. Until we figure out *what* changed, we can't be sure whether it's serious or benign.

I also get concerned if the oil starts to turn black and opaque quickly after an oil change—say, within 10 hours or so. That indicates excessive blowby, and some testing and troubleshooting is needed to determine why this is happening and which cylinder is the culprit.

Many owners install aftermarket air-oil separators to reduce oil consumption and keep the belly clean. I don't like air-oil separators because they return all sorts of ugly,

OIL ANALYSIS REPORT

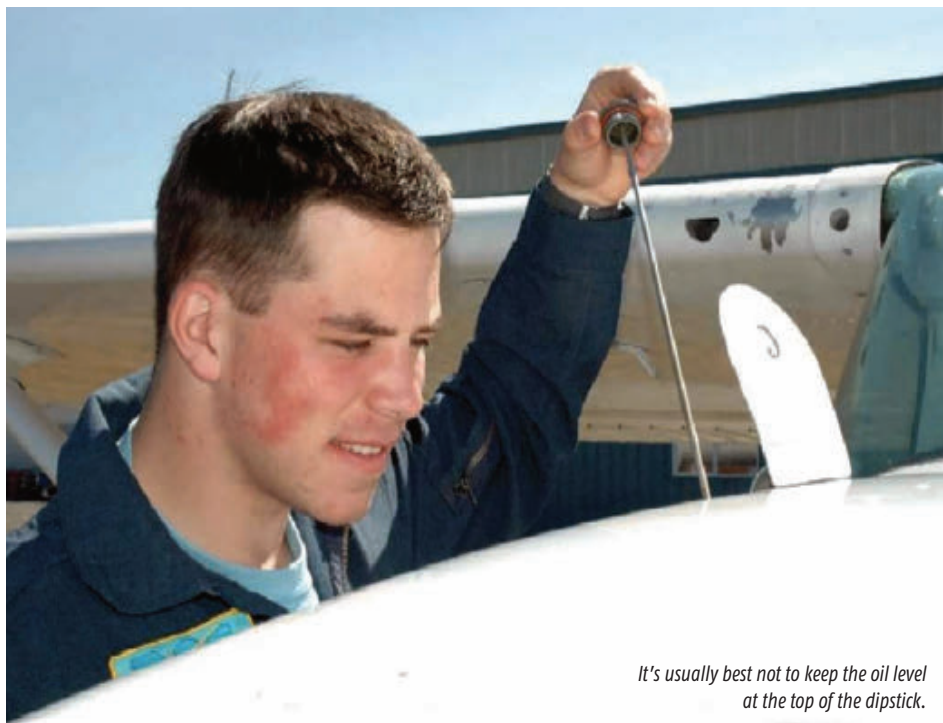
ELEMENTS IN PARTS PER MILLION	MI/HR on Oil	44	UNIT / LOCATION AVERAGES	33	44	50	50	55	UNIVERSAL AVERAGES
	MI/HR on Unit	2,608		2,564	2,531	2,485	2,435	2,385	
	Sample Date	08/02/10		05/02/10	12/28/09	06/28/09	04/05/09	08/25/08	
	Make Up Oil Added	4 qts.		3 qts.	4 qts.	6 qts.	4 qts.	4 qts.	
	ALUMINUM	5	7	5	7	8	7	7	8
	CHROMIUM	10	8	11	13	12	12	8	8
	IRON	46	38	44	52	58	47	45	40
	COPPER	4	3	5	5	7	4	4	4
	LEAD	6113	5840	4778	5238	5049	6515	6122	5511
	TIN	2	1	0	0	2	2	3	1
	MOLYBDENUM	3	3	3	3	4	4	4	3
	NICKEL	27	16	35	27	25	34	21	14
	MANGANESE	1	1	1	1	1	1	1	1
	SILVER	0	0	0	0	0	0	0	0
	TITANIUM	1	0	1	1	1	1	1	0
	POTASSIUM	0	0	0	1	1	2	0	0
	BORON	0	0	0	1	1	0	1	0
	SILICON	5	5	5	6	7	5	6	6
	SODIUM	1	1	0	0	5	1	0	1
	CALCIUM	75	20	59	11	48	67	63	15
	MAGNESIUM	2	1	1	1	2	2	1	1
	PHOSPHORUS	58	46	65	6	36	68	46	214
	ZINC	1	2	0	1	3	3	2	3
	BARIUM	0	0	0	0	0	0	0	0

Here is an excerpt of an oil analysis report from Blackstone Laboratories in Fort Wayne, Indiana, on the right engine of my Cessna 310. (I fly a twin, so I get two reports at each oil change.) The report for my left engine was unremarkable.

The column on the left is the most recent sample, taken on August 2, 2010. The engine was then at 2,608 hours since major overhaul (more than 1,200 hours beyond TCM's recommended TBO of 1,400 hours). Aluminum, chromium, and iron all look great—those would be from pistons, rings, and cylinder barrels, respectively. Copper is fine as well—that would be from bearings or thrust washers. Lead is low, indicating that the engine does not have excessive blowby. Silicon is also low, so the air filter is doing its job nicely.

The one red flag on this report is nickel, which is more than twice what it has been historically. The only source of nickel in my engines is exhaust valve guides, so there must be a valve guide that is experiencing accelerated wear. The elevated nickel has been present for at least two years, but is gradually increasing. Sooner or later, there will be a burned exhaust valve in my future.

I did a compression test and borescoped all the cylinders, so I know that none of the exhaust valves are leaking or showing any abnormal heat signatures...yet. But the oil analysis is telling me that an exhaust valve problem is inevitable, so I'll be watching closely. Of course, the oil analysis can't tell me which cylinder is having the problem, but that's something I'll know in time by means of continued borescope inspections and keeping a close eye on my digital engine monitor. Eventually, a distressed exhaust valve will become evident, and the corresponding cylinder will need to come off for repair.



It's usually best not to keep the oil level at the top of the dipstick.

nasty stuff to the crankcase that would otherwise be expelled out the breather.

DIPSTICK LEVEL

Oil consumption can be exacerbated by filling the sump to the top mark on the dipstick. Many engines don't like that and will promptly toss a quart or two overboard until the level decreases to one the engine likes better.

There's no reason to fill the oil to the brim. Before an engine can be certified, the FAA requires the manufacturer to demonstrate that it runs just fine in all normal flight attitudes with the oil sump filled to just one-half capacity. Most engines can function with even less oil than that. If you're curious how much less, consult the engine's type certificate data sheet, available on the FAA website.

As a rule of thumb, I recommend operating most engines at about two-thirds of the maximum sump capacity. That means running 8-quart engines at about 5 or 6 quarts and 12-quart engines at about 8 quarts. If

VP-X

The electronic circuit breaker system that integrates with your EFIS

- Electronic circuit breakers replace mechanical breakers
- See and reset faults on your EFIS
- Solid-state trim control
- Solid-state flap control
- Landing light wig-wag
- Detects burned out lights



Systems starting at \$1200

Get the most from your glass panel with the VP-X.
Learn more at VerticalPower.com or call (505) 715-6172.



Vertical Power

Copyright © 2011 Vertical Power Inc. All rights reserved. Multiple patents pending.

Stewart Aircraft Finishing Products STC'd for Certified Aircraft

Safe for You, Safe for the World, Safe for Your Airplane



*With low odor and ease of use, Stewart Systems is a perfect choice for the homebuilder, building in a garage or basement.
Non-Flammable, Water clean up!*

Super Shine

User Friendly

Lighter Weight

Stewart Aircraft Finishing Systems

5500 Sullivan St., Cashmere, WA 98815

1-888-356-7659 • (1-888-EKO-POLY)

www.stewartsystems.aero

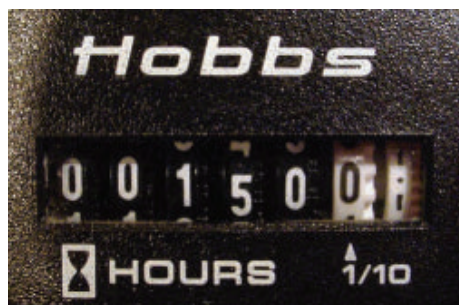
your engine uses a lot of oil, you might want to add one more quart to those figures for a little extra cushion.

OIL-CHANGE INTERVAL

Because piston aircraft engines get oil so filthy, regular oil and filter changes are an absolute must. Never go more than 50 hours or four months between changes, whichever comes first. Some experts recommend changing the oil every 25-30 hours or three months. If you have an older plane that has only an oil screen rather than a full-flow filter, you should not exceed 25 hours between oil changes.

If appreciable metal is found in the oil filter, or if the oil analysis report comes back with any red flags, we normally put the engine on a reduced oil-change interval until the source of the metal is identified or the problem resolves itself.

If you're approaching an oil change and you know the airplane will go unflown for several weeks, it's best to change the oil



Never go more than 50 hours or four months between oil changes. (Some experts recommend 25-30 hours or three months.)

before the downtime. Dirty oil tends to be corrosive, and you don't want your expensive crankshaft and camshaft bathed in that stuff for any longer than necessary.

OIL FILTER INSPECTION

Every time you change the oil, also replace the oil filter. Cut the old one open and carefully inspect the filter media for the presence of metal. Don't get too excited

about a few flecks of metal, particularly if it's non-ferrous metal such as aluminum, copper, or bronze.

If there's a significant amount of metal, investigate to determine what kind it is and where in the engine it's coming from. For example, metal whiskers (as opposed to flakes or particles) that are ferrous (attracted by a magnet) are typically associated with a failing lifter or cam lobe.

Of course, the source of the metal isn't always so obvious. If you're still not sure where the metal is coming from after examining it with a magnifying glass and checking it with a magnet, the next step is to send it out to a lab for analysis under a scanning electron microscope. This isn't nearly as scary as it sounds. It typically costs less than \$100, and the results come back within a few days. The report will identify the exact quantity, shape, and type of metal and usually the exact alloy. This is often sufficient to determine where in the engine the metal is coming from.

LEADING EDGE AIR FOILS LLC


The Central USA Independent Service Centre

ENGINES,
PARTS & REPAIR SERVICES
FOR YOUR ROTAX
POWERED AIRCRAFT

independent SERVICE CENTRE

ROTAX

 AIRCRAFT ENGINES



CHECK OUT OUR ON-LINE CATALOG YOU'LL FIND LOTS OF GREAT DEALS!
www.leadingedgeairfoils.com

CALL
TODAY FOR A FREE
CATALOG!

A&P TECHNICIAN ON STAFF

**MAINTENANCE
OVERHAUL • REPAIR**

1-800-532 3462

CALL
TODAY FOR A FREE
CATALOG!

LARGE INVENTORY OF ROTAX PARTS

SA/10

The Velocity TXL

253ktas @ 65%

1100lb useful load

+1300nm Range

VELOCITY

It's Time to Fly. Fast.



Dual side-stick and
new cockpit options
for 2010!



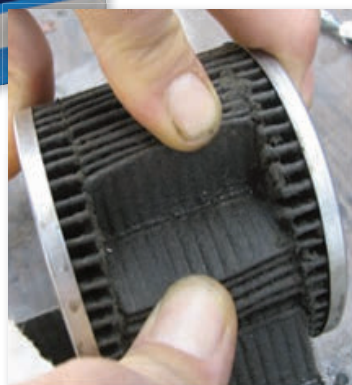


Sebastian, FL 772.589.1860 www.velocityaircraft.com

MIKE BUSCH



At every oil change, the oil filter should be cut open and inspected for metal.



OIL ANALYSIS

In addition to filter inspection, take an oil sample at every oil change and send it out for spectrographic oil analysis. This is not a substitute for filter inspection but a complement. Inspecting the filter allows us to detect metal that is big enough to be caught and visible to the naked eye. Oil analysis detects microscopic metal particles that are small enough to pass through the filter and would be too small to see anyway.

Oil analysis is superb at detecting slow wear events that never throw off metal particles big enough to see. It's also good at providing early warning of accelerating wear events that would eventually show up in the filter or some other way, but not until significant damage is done. **EAA**



Mike Busch, EAA 740170, 2008 National Aviation Maintenance Technician of the Year, has been a pilot for 44 years, logging more than 7,000 hours. He's a certificated flight instructor and an airframe and powerplant mechanic with inspection authorization. E-mail questions to Mike at mike.busch@savvyaviator.com. Mike also hosts free maintenance webinars on the first Wednesday of each month at 8 p.m. (Central). To sign up or access the archives, visit www.SavvyMX.com.

Memorial Wall

Dedicated to those who have loved and supported aviation

EAA's Memorial Wall is dedicated to those special individuals whose spirit, dedication, and passion for aviation positively impacted the lives of those around them.

Located at the foot of Compass Hill and adjacent to Fergus Chapel, EAA's Memorial Wall honors EAA members and aviation enthusiasts who have gone west. Bronze plaques with honoree names are installed annually on each side of the Wall. Each honoree has their biographical information and photo placed in the annual Memorial Wall registry album located in the Fergus Chapel.

EAA holds an annual dedication service on the last Sunday of EAA AirVenture Oshkosh. This service is followed by the reading of the names and a breathtaking missing man formation flight overhead.

A contribution of \$350 is required and includes a two-line plaque inscription, admission to the AirVenture ceremony, and a keepsake DVD of the event. Honorees submitted by April 12 will be included in the annual dedication. The Memorial Wall albums from all past years are now available online.

Visit www.eaa.org/memorial, call 920-426-6507 or 1-800-236-1025, or email Pat Heyer at pheyer@eaa.org for more information.

