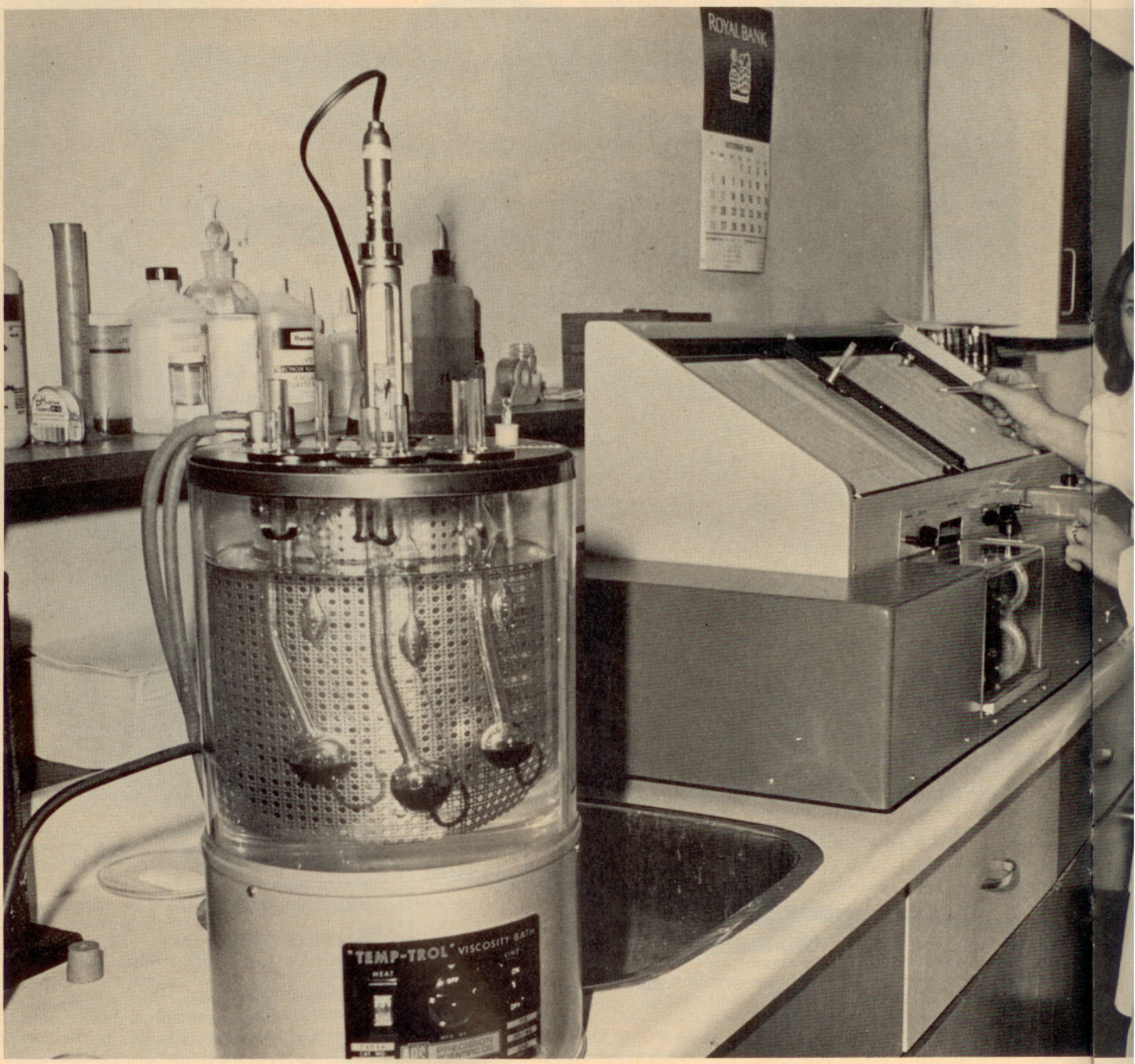
Used Oil Analysis

by GORDON GROENE



■■ Spectrographic analysis of used engine oil first paid off for me 15 years ago when I sent in a routine sample during a 100-hour inspection on my Continental IO-470.

The report came back that traces of aluminum were higher than normal, and the lab suggested we check cylinder walls with a borescope. On one cylinder we found a light scuff mark where a wrist pin keeper was smearing, took off the cylinder, found a badly worn keeper, and replaced it.

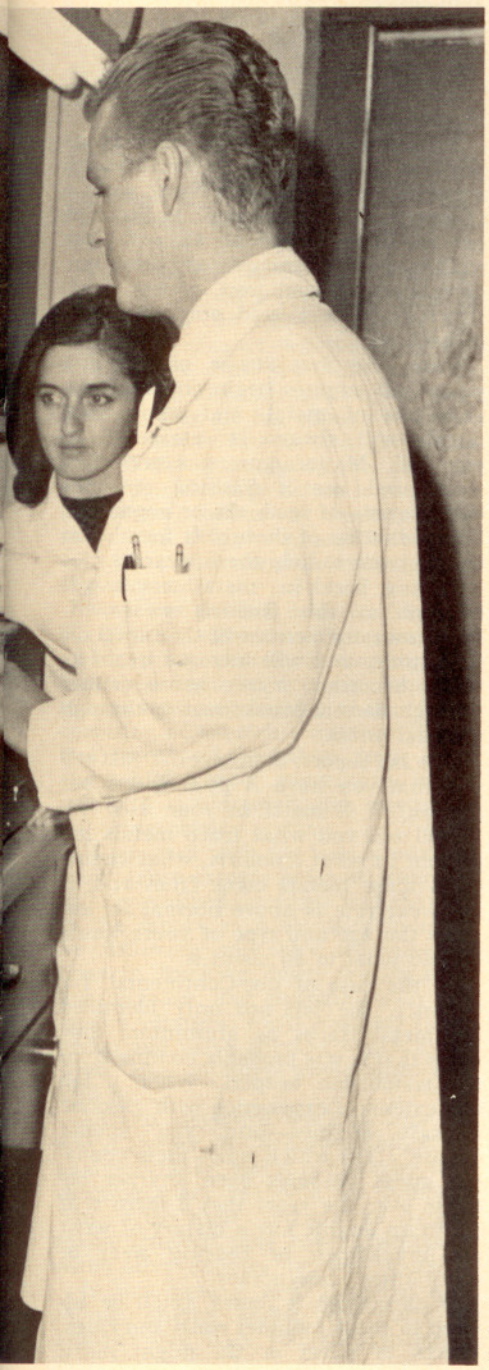
For the price of one oil analysis and one wrist pin keeper we headed off cylinder damage, the stepped-up wear rate that circulating metal particles were causing throughout the engine, and lengthy downtime for the more extensive repairs that surely would have been needed if we'd waited until the trouble showed itself in more dramatic ways.

Today, as oil analysis becomes more common not just in aviation but in trucking and tractors, more labs are available in more places. Technology has improved, volume has increased, and prices have come down to the $10 to $15 range for routine tests. The price is almost too good to be true for what is, in effect, a survey that can tell you what engine parts are wearing, at what rate they are wearing, and how this wear rate compares to other engines just like yours. If you use analysis to extend drain times, you'll save on new oil and filters too.

Getting more time out of each oil change is, in fact, the primary reason why oil analysis is used by operators of heavy machinery, stationary engines, and large ship engines which use many gallons of oil per change. For them, the cost of analysis is a bargain compared to the price of new oil and filters, and downtime for the oil change. Through analysis, they are assured that oil maintains its proper viscosity, is not thickened by sludge or thinned by coolant or fuel, and is not contaminated by metal particles.

For the private pilot whose airplane uses only six or eight quarts of oil per change, it's cheaper just to put in new oil. That assures not just that the oil maintains its lubricity but that additives are present in correct amounts. Since oil experts continue to debate this point, we won't go into it here.

There are three chief reasons why used oil analysis pays off for the pilot. First, it can warn you long before other symptoms reveal themselves



Technicians study an infrared spectrogram that shows organic contaminate in an oil sample. In the foreground is a viscometer that determines the flow properties of oil at various temperatures. (Spectro Metrics photos)

Prophesy, prevention, prescription

All used oil analysis data is typed into a master computer that diagnoses the engine's condition based on established wear patterns, previous history, and current test data.

that trouble is brewing in your engine. Second, it can disclose that your flying habits, especially in regard to mixture control, need revamping. Third, analysis records can protect your engine warranty. Too, if you are buying a used airplane, and can get analysis on an oil sample that has been circulated and drained properly, you'll have added insurance against getting stuck.

It used to take hours to conduct the physical tests needed to identify and measure trace metals. Now with a spectrograph, laboratory technicians get an instant readout, in parts per million, on the amounts of chromium, aluminum, silicon, iron, copper, lead, silver, tin, boron, and other elements in used oil.

From the first stroke of the first piston, all engines begin shedding minute bits of metal, and some trace metals will always be measured in your oil. Manufacturers expect this wear, and use a flashing—or thin outer layer—of lead, tin or copper, or a combination of these soft metals, on engine parts to help them wear in.

During break-in, metal traces will be high as this flashing wears off. Metal measurements will then level off for a time, and will increase again as wear becomes more acute either through normal breakdown or through unusual stress.

The lab report, then, doesn't just tell you that you have X ppm (parts per million) of X metal in your used oil. It will tell you what trace metals are present in what amounts, what engine parts these metals come from and, if the wear rate is above normal for engines the age and type of yours, you'll be told what to do about it.

In the case of my Continental, for instance, the lab not only identified the metal traces as aluminum, they knew that it was probably coming from the piston pin keepers. When a lab has extensive experience with gasoline aircraft engines—and you should choose a lab which has—their educated guess becomes even sharper because over the years they'll learn that a certain engine has a history of wrist pin breakdown or bearing wear or some other idiosyncracy.

If chromium is found, you'll be advised to check cylinder walls and rings. Traces of silver or tin might mean bearing wear. If lead is found in your oil, the lab will look further to see if you're leaking fuel (leaded gas) into the crankcase. If you're getting lead or copper or tin, it could be flashing.

But if you're showing a big increase in all three, which constitute babbit from which bearings are made, the lab will point to bearings as a possible problem area. Add a big nickel increase to this combination and it could mean you're into wear in the bearings plus a scored crankshaft.

If high percentages of silicon are found, you'll be told to check that your air filter is in good condition and is seating properly. Dirt that gets into your oil circulates and adds abrasive wear, however slight.

You probably watch for metal particles in your oil screen with each oil change, and can tell for yourself, just by using a magnet, whether these bits are ferrous. But you still have the problem of identifying them—and by the time they are big enough to see it's already rather late in the game anyway. With oil analysis, you can find and repair damage before it results in breakdown, before a small problem turns into a big one, and before circulating metal shavings cause greater engine wear.

Now, say the lab finds fuel in your oil. This means either that your start and warm-up procedures are improper (get the engine to operating temperature as soon as possible) or that you're operating at too rich a mixture. If they find traces of chromium from rings, and a high carbon percentage, it also points to an extremely rich mixture or a leaking primer system.

If you run with too lean a mixture, you'll cause engine hotspots where oil will be oxidized, and this will show up in the report as a viscosity increase. By following the lab's recommendations in tracking down the cause of this increase, and enriching your customary mixture, you'll head off future piston and valve burning which excessively lean mixtures could ultimately lead to.

All this detective work is done for you, however, by a knowledgeable oil analysis center, and it is based on their spectrographic readouts in combination with their records of engine manufacturers plus case histories of many other engines just like yours.

If you have a new airplane, or a rebuilt engine under warranty, oil analysis can help you substantiate a

claim that unusual wear is building up in your engine even though the actual failure might not occur until after a guarantee has expired. Keep a record of regular oil analyses and, if wear is reported to be greater or of a different type from normal, try to get a warranty extension in writing. It's here that oil analysis can be at its most effective, because you're up against that expiration date and would otherwise have no inkling that an engine will not have a normal life span.

In buying a used airplane, oil analysis is a diagnostic tool that can pay dividends, and the prudent buyer will insist on it. It's important, though, that oil be thoroughly circulated—that is, used in the engine for at least 10 hours—and drawn when well warmed up with all contaminants in suspension. You'll also need to know how many hours are on both the oil and the engine to get the most complete lab results.

To get oil analysis, contact a couple of labs and get their literature. You'll want one that knows aircraft engines, one that deals by mail, and the best buy. Most labs now give quantity discounts, so you're better off to buy prepaid mailer kits by the dozen.

If you do a lot of flying, and want to use oil analysis on other engines you own (car, trucks, industrial engines, transmissions, industrial hydraulics), you'll quickly go through the dozen samplings at a total cost of about $120. If you'll use only an occasional sample, buy in quantity through your flying club, or invest in samplers at about $15 each bought one at a time.

To obtain the sample, just drain well-warmed oil into the bottle provided by the lab, fill out the forms giving all the data they need to give you a complete condition report, and drop it in the mail. Your report will come back by mail, preceded by a telephone call if something needs immediate attention. Individual reports are revealing, and a record of repeated reports tells you even more because it shows wear patterns and gives you an idea of future wear directions.

Remember the old story about the battle that was lost because of a horse that was lost because of a shoe that was lost because of a nail? Use oil analysis as the horseshoe nail at the foot of a sound preventive-maintenance program for your airplane. □