Slippery Concepts

Engine Lubricants

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PHOTOGRAPHY: KIP WOODRING

In a bind, it looks like it would be just fine to use this national brand of multi-viscosity oil in your Harley's engine. H-D begs to differ. They'd rather you use certain diesel motor oils than this. Why?

The fine print on this side of the bottle reveals most of the reasons. Not only does H-D not particularly give a damn about API service ratings, such as SJ & SH, proclaimed here, they flatly balk at endorsing an energy-conserving lubricant like this. If there wasn't much difference between car oil and motorcycle oil before, there is now!

At 6,000 rpm, a Harley motor is enduring 50 explosions every second in each cylinder! The crank turns 100 times a second and the pistons and rods are screaming up and down, slamming to a complete halt and reversing direction almost instantaneously at the same rate. On 4-1/4-inch-stroke big twins, piston speed approaches 4,600 feet per minute! Valves are opening and closing, springs are bouncing like mad, and bearings along with everything else in there is moving, moving, moving! Your reciprocating mass is reciprocating fast. Not that it isn't all terrifically well organized, but the unsung hero in all this boogying, the thing that makes it all possible — let alone commonplace — is oil!

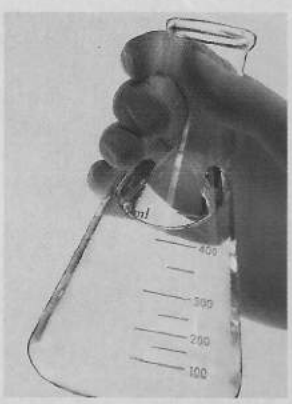
Motor oil is a very complicated substance, but all you need to know is engine lubricant (which we commonly call oil) is made up of three components.

Base Stock Oil

There are a few basic types of oil. For reciprocating engines they are: castor, conventionally refined petroleum, hydrocracked petroleum, and synthetic oil.

Castor-based oils are first of all, natural. It's not unusual to hear it called bean oil because is comes from the castor bean, not out of the ground. It's the stuff that smells so good at the dirt track races and has basically only one advantage — it's slippery! It wasn't unusual years ago, to see the stuff leaking out of the seam between the metal bottom of the can and the cardboard sides. Plastic bottles solved that problem, but there are so many other problems associated with castor oils that today they are only used for racing.

One of the better ideas to come along lately is so-called *pure base oil*. This is true for both marketing reasons, such as hide-bound traditions and prejudices against synthetics...



...and, because, the stuff really is 90-percent more pure than conventional base oils. Although not clear like you'd think from this picture, clearly, clear and pure are two different things: especially after you add lots of good, protective additives.

Synthetics, on the other hand, seem to have suffered greatly from bad marketing. That was then; this is now. Over 50 years after they were first developed, they have been perfected.

Synthetic Oil

Synthetic oil is a superior lubricating product in every way that is measurable. Here are the basics:

1) Resists heat better. It takes more than 600 degrees Fahrenheit to vaporize the stuff! Regular motor oil begins to torch at about 350 degrees Fahrenheit. Since air-cooled Harley engines run at 180 to 210 degrees Fahrenheit and have been known to get as hot as 240 to 260 degrees, that adds up to a much better safety margin. That extra high-temperature stability has lesser benefits, too. Your motor won't burn up as much oil and that also means less sludge and built-up varnish in the engine.

2) Slipperier. The molecules in synthetic oil are more uniform in length, weight, size, and shape than those found in nature. That makes it much easier for them to slide over things. The resultant loss of friction can actually be measured, but — one last point — the stuff is not so slippery that it will keep bearings from rolling.

3) Film Strength. This is the real payoff! Film strength is what keeps those little molecules from being pushed or torn apart under extreme pressure. Regular oil is about done at 500 psi; synthetics go about 3,000 psi. Think about that for second. In an area where two metals are trying their absolute best to destroy each other, where pressures and friction can go ballistic at almost any moment, synthetics cover your bet six times over!

4) Cold start protection. Regular oil will not remain as a boundary layer on metal surfaces. When you shut the motor off, the stuff heads for the bottom of the crankcase, leaving pistons and rings, valves and guides, cams and pushrods, in the lubrication lurch. we'd be willing to bet that many of the inexplicable tappet roller failures in Harley motors are a testament to this nasty little habit. Leave a bike parked long enough for the lubricant to drain off the rollers and needles in the tappet, and little rust pits appear. Cold-start the bike a month later and tah-dah. You've just knocked the rust off that dry roller and successfully jeopardized the surface hardening at the same time. Hold that thought whenever you light up your engine. Picture some mighty important metal surfaces crying out for lubrication in the time it takes for your oil pump to pressurize all of those bearings, lifters, passageways, and so on, all the way to the rockers — 18 inches straight uphill. Then, count slowly to thirty. That's how long it can take for the whole motor to get lubricated.

5) Extended change intervals. The expense of the stuff is offset by the need to change it about half as often. There's also an environmental dividend, in that you don't generate as much toxic waste, either.

So, if this stuff is so great, why doesn't everybody use it? A few reasons come to mind. New engines actually shouldn't use it until they are broken in. The added friction and surface abrasion of mineral-based oils help to seat the valves and rings and create even mating surfaces. Big oil companies have been slow to come around to synthetics because building the stuff is a different technology and an expensive process. Now that they are getting into it, (Pennzoil has just introduced an affordable synthetic, for instance) they will push it like mad. But, the biggest reason by far is that the would-be consumer is ignorant of the benefits and distrustful of the technology; even if they've known about it for years. They rationalize, "Yeah, my Grandaddy used 'ol Maximillion 105-weight Reclaim in his '26 JD, so I won't use nothin' he didn't; family tradition, y'know." or, "Besides, I can get the stuff right down the street for 39 cents a quart." And my favorites: "The stuff is too slippery; it'll make my bike leak." Usually coupled with, "I've been usin' brand X for years. If I change now, or mix 'em, it'll blow my motor. Besides, oil's oil! I ain't payin' five bucks a quart, no sirree Bob, I ain't that stupid."

Petroleum oil stocks should need no real introduction. They are the backbone of nearly all engine lubricants, at about 99.5 percent of the total market, and are basically refined crude oil. Harley-Davidson 20W50, the factory-recommended engine lubricant for Buells and Harleys (including the water-cooled V-Rod), is about 85-percent conventionally refined petroleum oil base stocks.

Hydrocracked oil stocks start with regular crude oil; there are at present only three or so hydrocracking facilities in the United States. Unlike conventional refining, this process involves pumping crude oil into a furnace heated about 600 to 700 degrees Fahrenheit then, once the

oil is up to temperature, pumping it into a still (Yes, you read right!). The light gases and liquids rise to high trays in the still, while heavier oils settle on the lower trays. The heavy stuff is sent back to the cracker furnace and reheated to 800 degrees Fahrenheit under nearly a ton of pressure! Add a few catalytic chemicals and bang! The heavy oil molecules split into lighter molecules. The lighter molecules go back to the still. But still, you say, why bother? It's because the net result, the oil itself, resists oxidation as much as three times longer, generates 90-percent less acid, and — because it's so pure — has 50-percent less sludge in it. So, what we have is a better base stock. And if the base oil does more of the work, the additives can do their job, namely protect the engine. Case in point: The only pure base-stock motorcycle oil on the market has roughly the same amount of additive protection as factory H-D oil. However, under lab test conditions, all things being equal, it takes over twice as long to break down.

Synthetic oils (Poly-Alpha-Olyphic or P.A.O) have been around since World War II. The stuff was not exactly perfected at that stage; then in the last half of the twentieth century, synthetic oils came into their own. They have so many advantages, they simply cannot be ignored. We'll spare you the technical jargon and just say that synthetic oil molecules are superior to mineral-based — period.

Blending

They say: Kissin' don't last — but cookin' do! And that's just as true in the process of blending lubricants. Without getting too complex, let's just say it can be the difference between bathtub gin and 12-year-old single-malt Scotch. Every manufac-

turer seems to have its own recipe for blending the different types of base stock oils as well. Sometimes subtle, sometimes completely different from each other, these techniques for building complex lubricants can involve everything from the specific compounds involved, to the temperature at which they are cooked into the end product.

Additives

We truly take a lot for granted when we assume the oil doesn't need any help to do its job. The modern oil additives package includes more than just base elements like zinc and phosphorous. There's *stuff* in there that acts as detergents and acid neutralizers. Things like co-polymers, which in the petroleum industry, can be the chemical equivalent of anything from styrofoam cups to nylon stockings. These co-polymers and dozens of other chemicals and compounds are there to help the basic oil from shearing down its viscosity (wearing out). They also do other things too. Grouped into rough categories, we have...

Viscosity-Index Improvers — to keep oil from thinning too much under heat.

Dispersants — keeping contaminants in suspension, to keep them off vital engine parts.

Detergents — (soap, if you will) to prevent varnish build-up and sludge, especially on the piston rings.

Anti-wear agents — Motorcycle oil should be full of them.

Antioxidants — to keep oil, which loves oxygen, from turning into tar. This becomes a big issue at high rpm, or pulling a heavy load in the heat.

Rust and corrosion Inhibitors — The problems here, are worst at cold-

Quality filters are the unsung heroes of engine longevity. Without them, oil, no matter how good, would have a tough time doing the job.

Oil Filters

OK, given that oil is the magic elixir, what's the secret trick in keeping it that way?

Oil filters! In days gone by, most motorcycle engines had at least three strikes against them in terms of longevity: They were air-cooled (wear out three times faster than water-cooled); filled with thick, straight-grade oil (A subject in itself...no H-D motor, built since about the time hydraulic lifters were perfected, should run on 60wt oil!); and our forefather's engines had no oil filter worthy of the name. Considering all those bearings and shafts, rings and cylinders, valves and guides, and all that relative motion combined with close tolerances, you wonder how something as indispensable as a filter could be overlooked?

Well, decades ago, even if you were to examine a sample of oil, you wouldn't be very likely to notice the dirt because, hey, the stuff is too small to see most of the time. The few chunks you might see, ironically, are not usually the ones to worry about (as far as wear is concerned anyway) because they are too big to enter the tight clearance areas. To see why this is so, consider a plain rod bearing with a typical diametrical clearance that averages 0.002 inches. The oil film layer (the separation between shaft and bearing, or *thickness* between perfect running and a blown motor) is slightly less than 10 percent of this, or about 0.00015 inches.

Dramatic improvements in engine life are apparent when full-flow filters are used, with typical reductions in wear; relative to non-filter equipped engines. Granted, no oil filter will remove all the particles in an engine: filtration that fine would be extremely restrictive and cause high-pressure drops across the element, not to mention excessively frequent filter changes. The happy medium, agreed to by most reciprocating engine manufacturers, seems to be filtration between approximately 10 to 25 microns. Studies have shown this is an effective value for maximum filtration with minimum hassles. Harley changed from 20 microns to 10 microns with the filters on the Twin Cam and V-Rod motors. It's worth noting that a filter is proven most efficient after it has operated a while and developed a so-called *cake*, or coating on the element. Clean oil needs a dirty filter — Go figure!

start, and ironically, hot shut-off in moist, cool climates. Water loves the insides of an engine, and a hot motor on a cold night is just like fogging up the windows at the drive-in movie.

Friction modifiers — the new kids on the block, mostly an energy-saving car thing.

Pour-point depressants — prevent wax crystals from forming in the base stocks in cold weather and conveniently lowers the temperature at which oil remains a pourable fluid.

Foam Inhibitors — similar to the stuff they put in fork oil to keep it from mixing with air. You would not want your oil to suddenly become compressible, just when your motor needs a strong boundary layer of non-shear slipperiness would you?

When it comes to oil, the point to remember is that it's literally a package deal. All three components interact to protect and cool engine parts — hopefully, for a long time under unpredictable conditions. Above all, you want the stuff to work consistently, at least until the next change. How do you know it is? One of the best indicators is viscosity retention; call it an endurance test for engine lubricants.

Relative Viscosity Retention

(As a percentage of initial viscosity retained after normal use in the same motorcycle.)

	0 miles	800 miles	1,500 miles
Mobil 1	100%	86.6%	83.0%
Castor Synaptic	100%	78.1%	74.5%
Castor GTX	100%	72.2%	68.0%
Spectro 4	100%	68.0%	63.9%

Revealing isn't it? Yet all you need to know is a few basics, which are pretty much agreed on by all parties.

1) The worst thing you can do to an engine...is starting it! That 70 to 90 percent of all the wear and tear in an engine occurs on start-up is a fact, so there's not much to argue there.

2) Short hops, which don't warm oil to operating temperature, are as hard on engines as over-heating.

3) There are few basic types of oil. For reciprocating engines they are: castor, conventionally refined petroleum, hydrocracked petroleum, and synthetic.

4) Additives are what make oil work. Multi-viscosity oils are rated as such because of them.

5) Additives are what wear out in oils. And they are what keep things from wearing out in the engine.

6) The ideal temperature for oil is considered to be 212 degrees Fahrenheit, since it will boil off moisture.

7) At a constant 240 degrees Fahrenheit, you cut oil's service life in half.

8) Every 12 degrees above 240 degrees Fahrenheit, cuts life in half again.

9) Air-cooled engines operate at temperatures as high as 350 degrees.

10) Straight-weight viscosity or single-grade motor oils went out with high-button shoes and flathead engines. Use them at your own risk.

11) Most modern multi-grade SAE-rated oils have an EPA-imposed cap on the amounts of certain additives, preventing clogged catalytic converters. The 20W50 oils aren't subject to these limitations.

12) The frequent changing of both oil and filter are still the best insurance for engine longevity.

P.S. — As for the ongoing argument about whether there's any difference between car oil and motorcycle oil: Harley-Davidson service bulletin #1065, states flat-out, that energy-conserving car oil is no longer suitable for use in H-D motors. Basically, the newest API service rating for automotive oils is designed to protect catalytic converters — not engines. To comply with this rating, the major oil companies have removed most of the basic elements (zinc, potassium, magnesium, etc.) in the additive packages — which save engines but plug-up and burn-out cats. Harley says that as a result of this, these oils will no longer work as a substitute for motorcycle oil. In the unlikely event that you have to use a substitute for H-D oil in the field, the factory now condones using either oil designed for diesel engines or a good synthetic oil like Mobil One, or Castrol Syntec.