

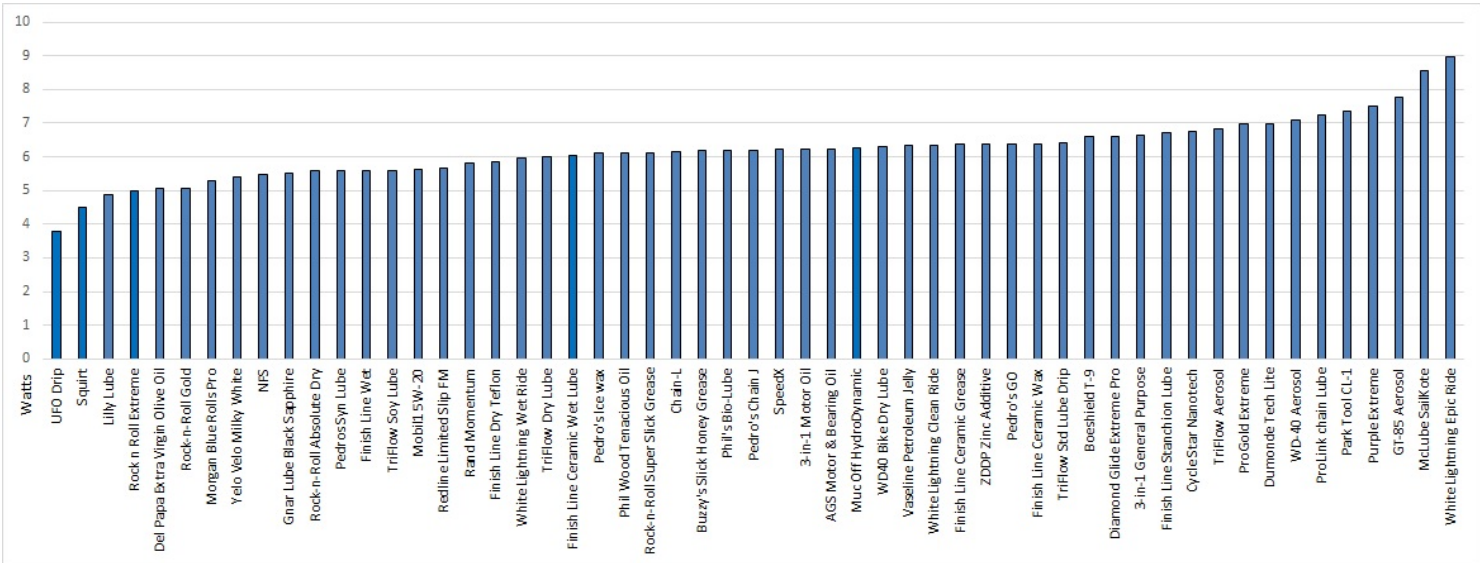


CHAIN LUBE EFFICIENCY TESTS

Friction Facts and Velo News collaborated on two chain lubricant efficiency tests. The first test was released in Velo News in March 2013. The follow up test was released in March 2014. This document contains both of the articles, respective test results, and commentary. In total, 55 different lubricants were tested. A summary graph of the combined results appears below for quick reference.

UFO Drip Chain Coating was added to the graph below based on Friction Facts test results. UFO Drip was not available at the time of the Velo News tests and therefore added recently.

Note- The data in the graph pertains only to user-applied lubricants. Factory-prepped racing chains are not included.



DRIPPING WITH SPEED

Inexpensive drivetrain efficiency is all about lube By Caley Fretz

Lube isn't all that sexy, at least not this kind. But it is unquestionably the cheapest way to make your bike measurably quicker.

Surprised? So were we. But the results of our third-party testing, commissioned by *Velo* and performed by independent lab Friction Facts, are extraordinary. The difference between the most- and least-efficient chain lubes is not just a marginal gain. There is no cheaper way to save watts.

Attaining maximum drivetrain efficiency has long been an endeavor of the detail-oriented mechanic, stopping at nothing to minimize drag on the day of a big event. Bearing seals are removed; grease is replaced with light oil; ceramics are used in place of steel. Frequent cleaning and replacement remove durability and longevity as concerns, opening up a world of potential efficiency gains.

That's why our test centers on efficiency. We didn't ask Friction Facts to pick the best lube across every weather condition or every rider — that, frankly, is impossible. Some of the best lubes in this test likely would disappear completely after a few hours in the rain; others would never make it through even a dry-weather training week. But durability was not our concern.

We asked Friction Facts only to determine what lube makes a drivetrain most efficient, to identify the concoction that most effectively slickens the hundreds of metallic contact and rotation points on

a chain. We had one primary question: Among 30 highly popular lubes, which will make you fastest on race day?

EFFICIENCY RESULTS

The fastest bike lube isn't designed for your bike at all. In every measure, the most efficient chain lubricant is simple paraffin wax, sold in solid blocks at any hardware store. In the efficiency test it was faster than the best bike lube by 0.24 watts and the worst by 3.05 watts under ideal conditions. Following an hour covered in dirt, sand, and water, the paraffin was nearly 6 watts faster than the worst-performing lube.

That's similar to changing from a low-quality training tire to a super-thin race tire, or from a cheap aero wheelset to the best available. Best of all, paraffin wax costs less than \$10 for a few blocks, which will last months, if not years.

Rock-n-Roll's Gold chain lube is far and away the most efficient bike-specific drip lube we tested. Minimal solvent and a healthy heap of PTFE (Teflon) are both visible in the bottle, helping to make Gold 0.51 watts faster than the next fastest drip lube.

Unsurprisingly, the lubes loaded with PTFE, the same material that keeps your eggs from sticking to the pan, tended to perform the best. Rock-n-Roll's Gold led the charge, followed by the company's Absolute Dry concoction. TriFlow's light Soy Lube, which uses Teflon, was in the mix as well. All of the top four drip lubes are based around the stuff.

The regular oils stacked up in the middle, and oil

weight didn't seem to play a large role. Heavy oils like Phil Wood's Tenacious Oil were quicker than some lighter ones, like Pedro's Chain J. But more on viscosity later.

The lubes containing a significant amount of "carrier," designed to evaporate quickly after application, were by far the worst of the bunch. The aerosols, which are mostly carrier, were all clumped in the last quarter, and the slowest by a large margin was White Lightning's Epic Ride Light Lube, which is also mostly carrier.

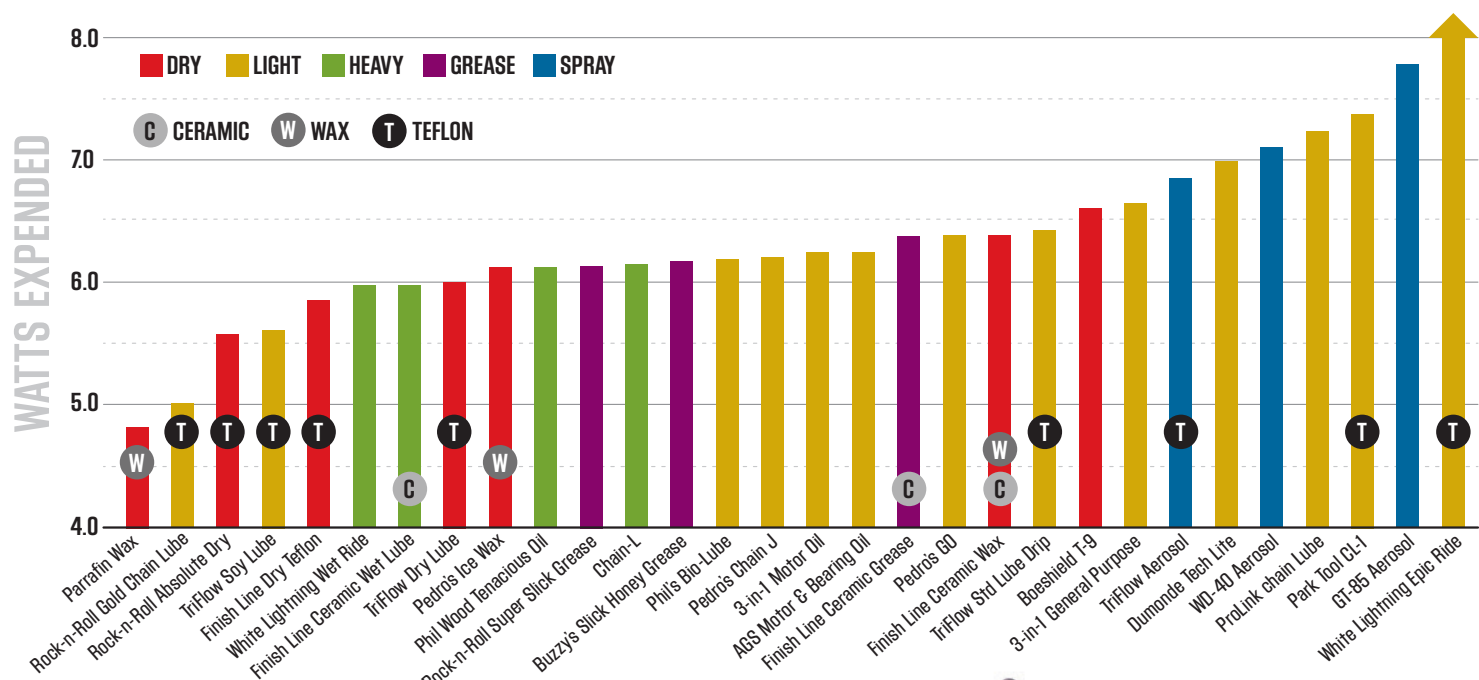
LONGEVITY RESULTS

We tested eight of the lubes for longevity, simulating a single dirty, wet ride and testing efficiency before and after. Each of the eight was chosen as a representative of a certain lube type. For the most part, four of the eight, representing greases, wax-based drip lubes, regular oils, and biodegradable oils, were all very similar, losing about 2 watts over the hour-long test.

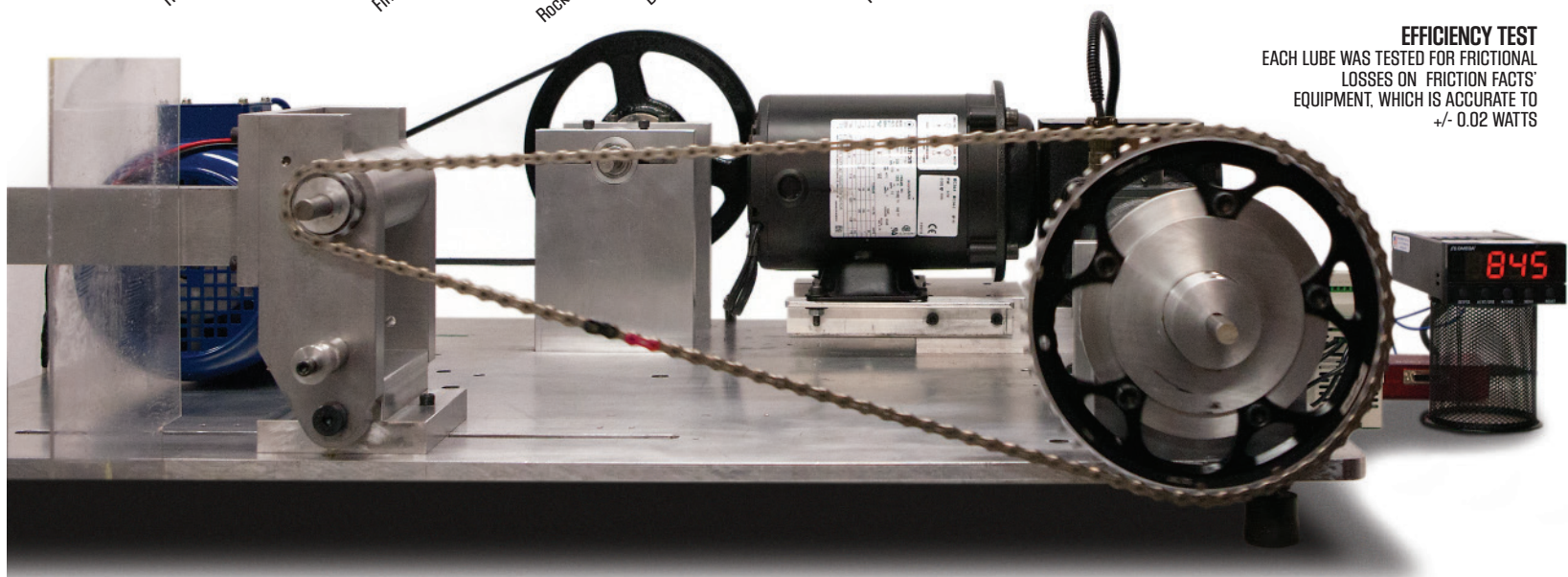
Once again, the old technology of paraffin wax vanquished all comers. In the longevity test, it was completely unperturbed by water, sand, and dirt; in fact, it was over 0.5 watts faster after being run for an hour in the grime. We believe that the wax needs to bed in a bit for maximum efficiency. And, since nothing really sticks to it, the goop was simply shed before it could slow anything down. The only other lube to increase efficiency after the dousing and dirtying was Park Tool's CL-1.

Pedro's Ice Wax performed the worst of our eight representative lubes, requiring more than





EFFICIENCY TEST
EACH LUBE WAS TESTED FOR FRICTIONAL LOSSES ON FRICTION FACTS' EQUIPMENT, WHICH IS ACCURATE TO +/- 0.02 WATTS



3.5 additional watts to turn around. By the end of the hour-long test, the chain with Ice Wax on it was completely dry. The super fast Rock-n-Roll Gold jumped nearly two watts after the grime run, as did the Buzzy's grease, TriFlow Soy, and Finish Line Ceramic. The Gold lube also began to dry out, and was running audibly louder.

This, of course, points to the obvious: The most efficient lubes in perfect conditions are likely not the fastest when the going gets rough, with the exception of paraffin. Park Tool's CL-1 is a good stand-in for a number of mid-weight, oil-and-Teflon based lubricants near the bottom of the efficiency ranking, and its excellent performance in the longevity test bodes well for that lube type in bad conditions. If your race day is also a rainy day, something with more carrier and a light oil might be the way to go.

VISCOSITY

The viscosity results, which were designed to measure how quickly a lube will work its way

into a chain, were largely inharmonious with the efficiency testing. It seems clear that the contents of a lube are far more important to its dry-weather performance than the viscosity, with both very thin (like the Rock-n-Roll Gold) and very thick (like White Lightning's Wet Ride) lubes doing quite well in the efficiency testing.

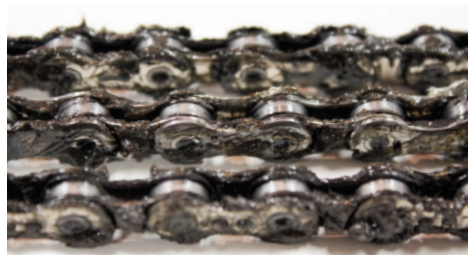
In fact, even the longevity test didn't correlate very well with viscosity. TriFlow's Superior Soy lube was highly viscous and was decidedly average in the longevity test, while the thinner Park Tool's CL-1 did very well. The only firm conclusion we can draw is that some light lubes, like the Pedro's Ice Wax, will wear off quickly, and efficiency then plummets — not that this should surprise anyone. The more viscous lubes, in general, seem to hold onto the chain better, making them more durable. This is why rainy days will see many pro mechanics use a heavy oil first then cover the chain with grease, in an attempt to lock in the lubricant.

THE TAKEAWAY

The only real argument against paraffin wax is its more intensive application process. It's obviously the fastest in ideal conditions, and even in nasty conditions it is still an exceptional single-day lube. On our test bikes, it has slogged through hours of snow-covered roads without a squeak or squeal, remaining clean enough to touch the whole time; it will live through just about anything you can throw at it in a single day.

In real-world testing, we've been getting upwards of 650 miles out of an application (shortened by about half if riding in wet weather) before the chain begins to dry out. When the wax hits the end of its life, it does so quickly and dramatically: your drivetrain will go from quiet to raucous in the space of a few minutes. So, it is best to re-apply relatively frequently. Whether it's simply too much effort to bust out the crock-pot every half dozen rides or so is, of course, up to you.

Among the normal drip lubes, a few themes



stand out, many of which are visible right in the bottles themselves.

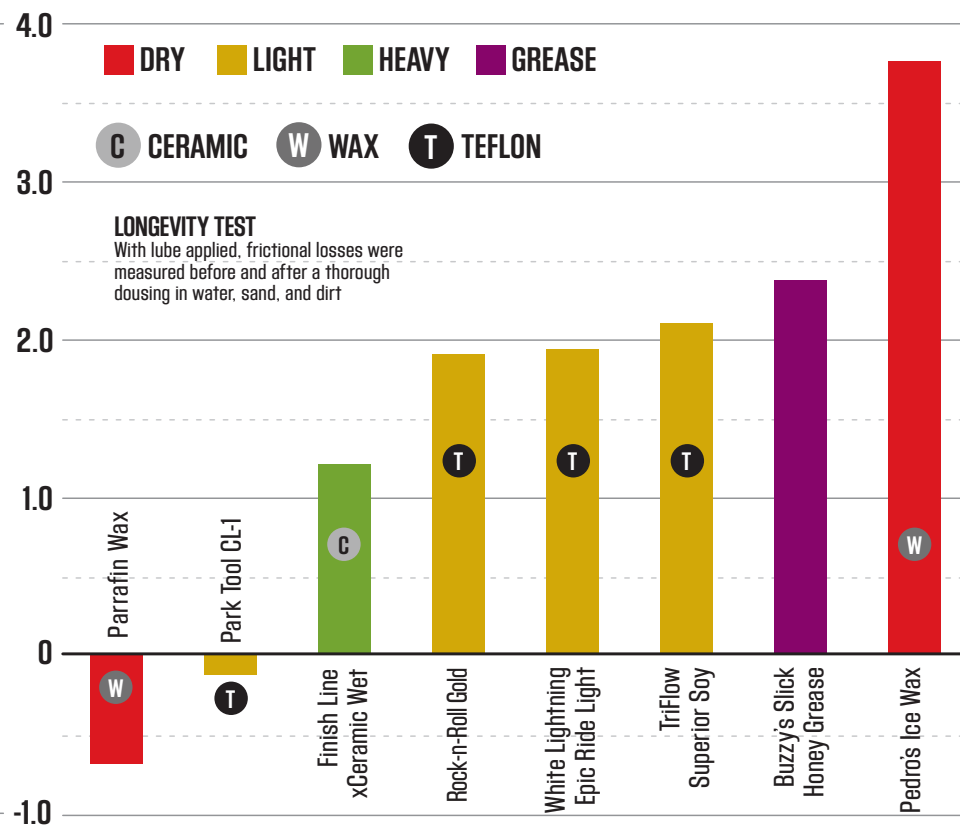
The oils all performed alike, so pick one based on the desired viscosity. Thicker will stay on the chain longer, in most conditions, but will also be dirtier. The fastest heavy oil, and therefore perhaps the best choice for consistently bad conditions, is White Lightning's Wet Ride.

The drip waxes don't last long, and are only effective if the quantity of wax is very high — as with Pedro's Ice Wax. Too much carrier, and the lube

will perform terribly. If the clean drivetrain that wax lubes offer is that appealing, one is better off buying some paraffin.

The lubes that contain large amounts of slick additive, like PTFE or wax, relative to their concentration of carrier, are almost always faster. The fantastic Rock-n-Roll Gold has huge amounts of PTFE, a bit of oil, and some carrier, all distinctly visible through the side of its clear bottle. Rock-n-Roll Absolute Dry drops the oil and ups the carrier, but also ups the PTFE even further, keeping it near the top of the list. The lubes with lower PTFE or wax-to-carrier ratios always performed worse — in fact, the bottom quarter of the efficiency test is chock full of them.

It's clear, then, that going for a lube with as much PTFE as possible is the best bet for pure efficiency. For consistently wet weather, go with heavy oil. And for the meticulous mechanic, happy to pull a chain off and re-wax it every few weeks, cheap hardware store paraffin is unbeatable. ✓



APPLYING PARRAFIN

Parrafin wax, our clear winner, is sold in solid chunks, and it therefore needs to be melted before application. This needs to be done somewhat carefully, because the gas form of paraffin is highly flammable (that's why candles stay lit). Boiling a pot of paraffin on the stove might blow apart your house.

The safest method is to use a low-temperature cooker, like a crock-pot, to melt the wax slowly and keep it well below boiling point. We brought our wax to 150°F. Once the wax is melted, simply thread a wire through a thoroughly cleaned chain, dip it for a few minutes, then pull it out and re-install. Wax will be flung all over during the first few pedal strokes, but the wax that stays inside the rollers is what really counts. Expect to get hundreds of dry miles out of an application.

Friction Facts also sells pre-waxed chains, into which the company has melted ingredients like PTFE to make the chain even faster, available at friction-facts.com.

HOW IT WAS DONE

Friction Facts owner Jason Smith performed three tests, examining for pure efficiency in ideal conditions, longevity, and lube viscosity. All thirty lubes were put through the initial efficiency test and the viscosity test, while eight lubes representing various categories went through the longevity test.

EFFICIENCY TEST

Each lube was tested on three top-of-the-line chains, one each from Campagnolo, SRAM, and Shimano, and the final results are an average of all three. The chains were cleaned with an ultrasonic cleaner in odorless mineral spirits prior to testing, and then all three chains were immersed in a 100°F bath of each respective lube and run in the ultrasonic machine for five minutes. The greases were worked in manually.

The chains were then hung to dry for thirty minutes, wiped clean, then mounted on the test equipment, always facing the same direction. Chain tension simulating 250 watts of rider output was applied, and each chain was run for five minutes, with data captured at the end of each five-minute run. The system is accurate within +/- 0.02 watts, and system losses from the four ceramic bearings in the equipment were subtracted from the final results.

LONGEVITY TEST

The same three chains were used for this portion of the test, and each chain was thoroughly cleaned between each round of testing using the ultrasonic machine.

Each chain was tested as in the initial efficiency test to acquire a baseline for each lube. The chains were then moved to another tester, which applied the 250-watt load but did not measure efficiency, so that water and grime could be applied. With the chain spinning under load, gravel and dirt were sifted onto each chain for 30 seconds, then the chains were sprayed with 30 full pumps of an industrial spray bottle, then another 30 seconds of dirt was applied. The equipment was allowed to run for 60 minutes while covered in dirt and water.

Each chain was then placed back on the efficiency tester for another reading and results were gathered relative to the baseline.

VISCOSITY TEST

This simple test was intended to determine how well each lube could work its way into a chain. All 30 lubes were dripped on a steel plate placed at a 30-degree angle. Each lube was dripped 10 times; the time was started when the first drop hit the steel, and the lube was allowed to flow 10 inches. When the lube hit the 10-inch mark, the timer was stopped.

HUNTING FOR SPEED

Searching for the fastest lubes on the planet

By Caley Fretz

The first rule of chain lube is simple: there are no rules.

Given the endless variables of weather, road conditions, riding styles, equipment choices, and maintenance habits spread across the cycling world, there is simply no way to stamp a foot down and shout to the world that this, right here, is the best chain lube money can buy for every rider, every day, in every part of the world. It's an impossible distinction to make.

However, determining the best lube based on the solitary, though very important, attribute of efficiency is possible. Using a collection of pricey lab equipment and a good deal of elbow grease,

it is feasible to find the fastest lube available — the best lube for your most important days, the one that most effectively slickens the hundreds of metallic contact and rotation points on a chain so that it steals as little power from your pedal stroke as possible. Efficiency is speed, after all.

Could we find the world's fastest lube? That was our challenge.

ON THE HUNT

We began by returning to the Friction Facts lab owned by Jason Smith; we used the same setup in a nearly identical test last year. Utilizing his independent facility, we found out precisely how much power a chain saps as it articulates through a drivetrain with various lubes applied, measuring power loss in watts.

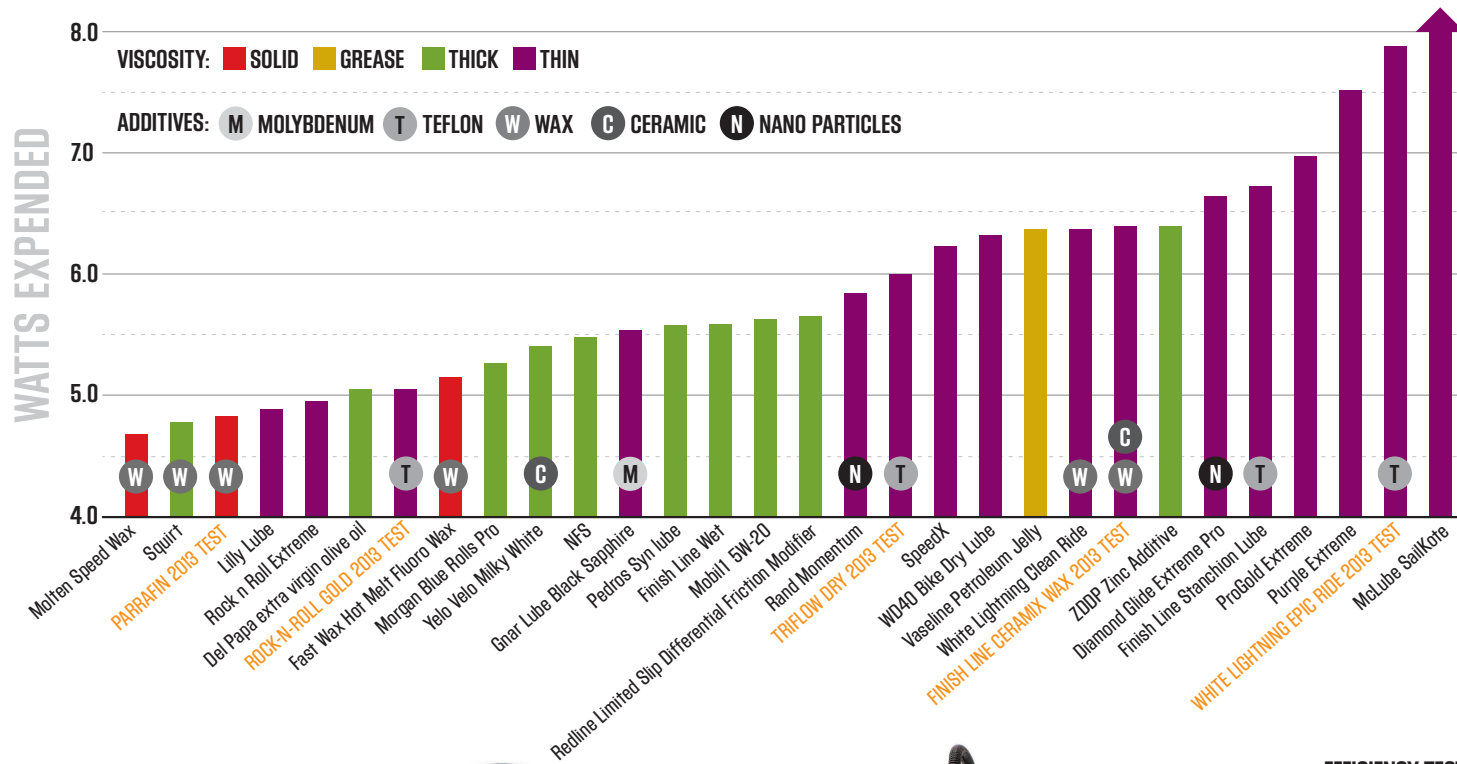
Because Smith calibrated the test equipment

to a reference oil from the original round of lube tests, published in the March 2013 issue of *Velo*, all of the data from both tests is directly comparable. We've included key results from that original test, along with the new data, on the opposite page.

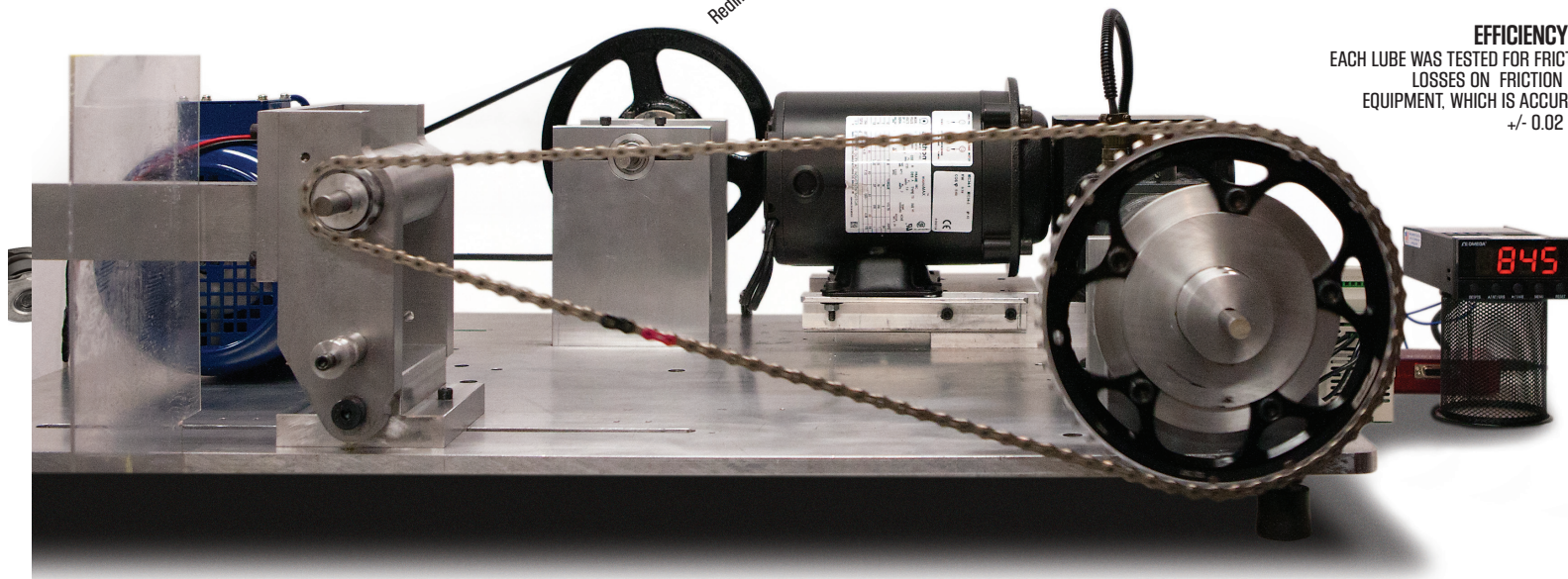
Last year was a first run; we picked 30 popular lubes and ran them through the process with no real notion of what would work well and what would not. The data from that test shaped our selection of 25 new lubes for this analysis. After last year's test, for example, we knew that Teflon-infused lubes did well, as did wax-based lubes, so we sought more. We also looked into a few lubes making impressive claims based on their use of nanotechnology. And, of course, we grabbed a few popular lubes that were left out the first time around, like Pedro's legendary Syn Lube.

No stone was left unturned. Smith, who bought all the lubes on the open market to prevent manufacturers from tampering with their usual formula, tested everything from

ISTOCKPHOTO: BRAD KAMINSKI



EFFICIENCY TEST
EACH LUBE WAS TESTED FOR FRICTIONAL LOSSES ON FRICTION FACTS' EQUIPMENT, WHICH IS ACCURATE TO +/- 0.02 WATTS



traditional drip lubes to melted paraffin wax to car oil to olive oil — yes, the sort that would normally end up on a salad, not on a chain.

Were we successful? Did we find the world's fastest lube? It's impossible to say for sure, but given the trends in the data — the main ingredients in the fastest lubes tend to be consistent and predictable — we have certainly come close. If there's something faster out there, it likely isn't commercially available. Or, it may not be a bike lube at all.

THE RESULTS

For the second year running, the fastest lube wasn't a traditional lube at all. Molten Speed Wax is, as the name suggests, a wax. It has to be melted before it can be applied to the chain.

It is based loosely on a formula developed by Friction Facts itself, which Smith has published

for public use. (We must stress that Smith has no association with Molten Speed Wax — the company is simply using part of his publicly available formula.)

Last year, hard paraffin wax, the sort that's easily sourced from any local hardware store, was the fastest lube by a good margin. Molten Speed Wax adds Teflon, or PTFE, and molybdenum to standard paraffin. Both additives are frequently used to make liquid lubes more efficient. The results were predictable: Molten Speed Wax improved upon the results of normal paraffin by 0.14 watts — not much, but in this game of tiny margins, enough to consider going with Molten over generic paraffin.

The true hero of this test, though, was Squirt Lube. It is the fastest drip lube we've ever tested, and is actually faster than simple paraffin. It was only 0.10 watt slower than the Molten Speed Wax.

Squirt is another wax-based lube; in fact, it

is based on a substance called slack wax, which is the precursor to paraffin wax. "Slack wax is close to what comes out of drill rigs," explained Smith. "It contains wax and oil in its natural state. Paraffin is slack wax refined to remove the oil. Squirt might be on to something by using the raw, unrefined slack wax, as it is a mix of wax and the natural oil."

Squirt ran even faster when it was tested without the recommended overnight dry time, an experiment we performed out of simple curiosity. This goes against the manufacturer's recommendation, so the lube's official result remains based on an overnight drying period. But it is something to keep in mind: to make Squirt even faster, apply it just before a short event.

Because Squirt is essentially wax based, it runs exceptionally clean, preventing too much gunk from building up in a drivetrain. In our testing, longevity was slightly below average

— 300-400 miles in good conditions. But it is much easier to apply than paraffin, a fact that may tip the scales in its favor for many riders.

The difference between the best and worst lubes in this test was 3.68 watts. The lubes in this round of testing were, on average, quicker than those we tested last year; it's an unsurprising result as we honed our search for the fastest lube available. Rock-n-Roll Extreme did well, even better than the quickest drip lube in last year's test, Rock-n-Roll Gold. Lilly Lube, which contains proprietary additives intended to decrease friction at high pressures, was faster than Rock-n-Roll Gold as well.

Amazingly, our grocery store tin of Del Papa Extra Virgin Olive Oil was the fourth fastest lube. We can't speak to its longevity on a bike chain, but it's hard to argue with that level of versatility.

The lubes making nanotechnology claims did not excel; however, we have found that they are incredibly long lasting in the real world and seem to improve drivetrain durability. SpeedX, which claims to utilize polar binding, was 1.53 watts slower than the Speed Wax. Rand Momentum, which claims to use rare vegetable oils and nanoparticles, had an average result, 1.15 watts slower than Speed Wax.

All waxes are not created equal, of course. Fast Wax Hot Melt Fluoro, designed for cross country skiing, did well, but was still half a watt slower than Speed Wax. Something about paraffin seems to work particularly well on chains.

As before, certain additives seemed to be consistently effective. Look for lubes with molybdenum and PTFE — Gnar Lube Black Sapphire and Molten Speed Wax, for example — or wax in an oil base, like Squirt. Wax lubes in a solvent base tend to perform poorly.

THE TAKEAWAY

We've long been proponents of the waxing method. With the right equipment, it's not particularly onerous, and it leaves one's drivetrain so wonderfully clean that any time lost in waxing is gained back ten fold in cleaning. Longevity of a wax treatment is better than most expect — we've ridden many hundreds of dry miles on a single application. That paraffin is also the fastest solution, producing the most efficient drivetrain, and is made even quicker with Molten Speed Wax's concoction, is icing on the cake.

Squirt is a phenomenal alternative, though. It, too, is very clean, though not quite as clean as paraffin. Once the water in the solution dries it picks up very little dirt. The kicker, though, is that it can be applied like any other drip lube. No more crock pots, no more potential for flammable paraffin fumes. Ease of use and incredible efficiency: Squirt really is the whole package. It's not great in wet weather, but on dry days only Speed Wax will be faster.

METHODS

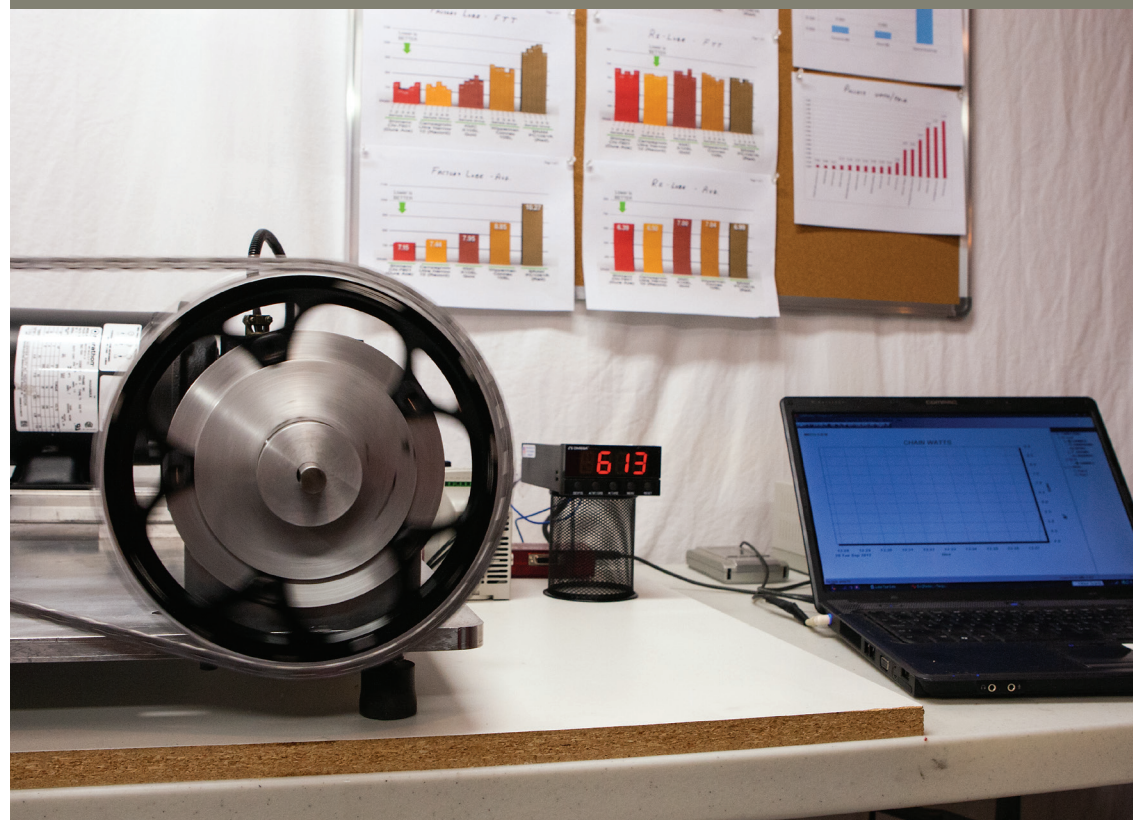
Friction Facts owner Jason Smith performed all testing in his third-party lab. All 25 lubes were put through the same efficiency test, with a protocol in place that ensured accuracy and repeatability. The equipment was calibrated using a reference lube from our last lube test, so all data is directly comparable.

Each lube was tested on three top-of-the-line chains, one each from Campagnolo, SRAM, and Shimano, and the final results are an average of all three. The chains were cleaned prior to each test in a six-step process, in three sequential solvent baths, consisting of an odorless mineral spirit, in an ultrasonic machine. All three chains were then immersed in a 100-degree Fahrenheit bath of each respective lube and run in the ultrasonic machine for five minutes. The chains were then flipped and run for another five minutes in the ultrasonic machine. The greases were worked in manually.

The chains were then hung to dry for 30 minutes, wiped clean, then mounted on the test equipment, always facing the same direction. Then, 60 pounds of chain tension was used, simulating 250 watts of rider output. Each chain was run for a minute, re-dipped in the lube, and then run for the load test.

If manufacturers' instructions referred to a dry time, those directions were followed after the second dip in lube.

During the load test, each chain was run for 10 minutes or until the friction level stabilized, with data captured at the end of each run. The system is accurate within +/- 0.02 watts, and system losses of 0.24 watts from the four ceramic bearings in the equipment were subtracted from the final results.



APPLYING PARRAFIN

Paraffin wax is sold in solid chunks; therefore, it needs to be melted before application. This must be done somewhat carefully because the gas form is highly flammable (that's why candles stay lit). Boiling a pot of paraffin on the stove might blow up part of your house.

The safest method is to use a low-temperature cooker, like a crockpot, to melt the wax slowly and keep it well below boiling point. We brought our wax to 150 degrees Fahrenheit. Once the wax is melted, simply thread a wire through a thoroughly cleaned chain, dip it for a few minutes, then pull it out and re-install. The first few pedal strokes will result in wax being flung about, but the wax that stays inside the rollers is what really matters. Expect to get a few hundred dry miles out of an application.

BRAD KAMINSKI