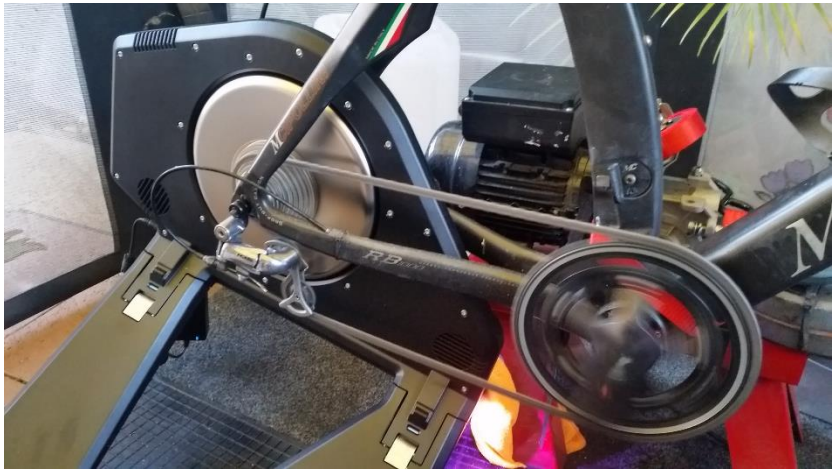
Zero Friction Cycling



Lubricant On Test : Smoove

Cost: $25.00 Aud from Lead Out Sports (+ delivery).

Size – 120ml

Photo :

Manufacturers Description on package;

Smoove™ is a long lasting bicycle chain lube for use in any terrain. Smoove™ works in dry, wet, muddy or perfect sunshine conditions. Smoove™ reduces chain wear and increases the lifespan of drivetrain components. Smoove™ lasts longer between applications than most other chain lubricants, runs cleaner and is extremely durable. Love your chain – use Smoove™.

Directions on package

Smoove is a long lasting lubricant formulated to withstand even the most demanding conditions. Whether in wet or dry conditions, smoove is extremely durable and one application lasts a whole ride, effectively protecting your mechanical drivetrain components from wear and tear. Smoove also reduces friction, enabling you to unlock optimal performance. Smoove is self cleaning, 100% biodegradable and solvent free.

Apply Smoove to a dry chain. Apply on the inside of the chain whilst turning the pedals to ensure that the lube gets worked into the chain. Let the lube dry for at least an hour. Best results are achieved if the lube is applied the night before. Do not wipe chain after application too much lube will cause lube residue to accumulate around. To much lube will cause lube residue to accumulate around derailleur pulley wheels an cassette.

Extra information from Manufacturer website

There is a Q&A section that is worth a read, also from the Bike Radar review they obtained the following extra information from the manufacturer such as they have seen…….

Gravel riders get up to 700km from single application

Road riders get 1000km

MTB riders get 400km.

Smoove's secret is in its water-based formula, which contains wax and "special additives". Deyzel explained that when he was developing Smoove, he wanted to make a lube that had the best qualities of wax and oil, but didn’t attract dust or disappear quickly – a big endeavour.

“Although Smoove has some similarities to other wax-based lubes when it's still in liquid form, after it’s completely dried out it leaves behind a material that's in what we refer to as a 'plastic state'; it's not a solid and not a liquid. This gives it the ability to move with the chain, repel dust and heal itself so that it doesn’t shear mechanically and flake off,” Deyzel told *BikeRadar*.

Any extra detailed information re application and usage from website;

No – just to ensure leave at least an hour before using – best results are from applying the night before.

Clean Chain Efficiency rating: Not yet tested by FF – on first look it seems like squirt from a different bottle, albeit you can notice it is slightly lighter viscosity. However as per claims it is made of different stuff and dries to a different state. So whether it tests similarly very high efficiency like squirt being that it is also a wax emulsion lube it is difficult to predict – but if I was a gambling man I would wager it would FF test similar to Squirt.

Viscosity: Thick – 1ml moved 7.5cm in 10secs on 30dg angle (*note slightly thinner than Squirt which moved 5.5cm)

Test stops when net chain wear reaches 0.5mm+

Smoove Main Test Results

Block (each 1000km)	Wear measure (mm)	Inc. On previous measure	% Wear for block (0.5mm=100%)	% Wear rate per 100km	Comments / Observations
0 – Initial check measure	**0.111**	**n/a**	**n/a**	**n/a**	**Shimano chains usually measure 0.1 to 0.15mm from new.**
1 – No contamination	**0.207**	**0.096**	**19.1%**	**1.91%**	As per squirt review – the initial clean block 1 wear rate a bit of a shock – however result and fix explained in main review.
2 – Dry contamination	**0.294**	**0.183**	**17.4%**	**1.74%**	The first lube tested to date that showed a decreased wear rate vs clean block 1. Explained in main review.
3 – No added contamination	**0.304**	**0.010**	**2.0%**	**0.2%**	So a very interesting overall trend. That is an extremely low wear rate after contamination block 2, and shows what Smoove would have been capable of from the beginning if block 1 result rectified, as well as how resistant it is to dust contamination.
4 – Wet contamination	**0.530**	**0.226**	**45.1%**	**4.51%**	A big jump here so smoove is susceptible to water contamination. It has well outperformed RnR Gold , and outperformed Squirt by a little, however still well behind Molten Speed Wax at only 8% wear for this block.
5 – No added contamination	**0.633**	**0.193**	**20.6%**	**104.3%**	Readings checked at end of interval 2 @ 600km- test stopped there. Extrapolated results would equal 34.3% wear for block 5, and 118% total if run to end of block. Smoove being "plastic – non shedding" simply has no mechanism to move contamination back out after water has provided a medium for contamination to enter.

Extrapolated wear based on first 5000km = 4423km ****Note this could be well improved upon by rectifying initial wear rate.***

Extreme Contamination Block (chain cleaned again prior to test)

Start wear measure	500km measure	1000km or end of test measure & km	% Wear for block (0.5mm=100%)	% wear rate per 100km	Comments / Observations
n/a	**n/a**	**n/a**	**n/a**	**n/a**	Not tested as past wear allowance – however as an approximation we are using 5 x wet contamination wear rate as result for extreme contamination block (based on increase seen during msw test which was tested in both). This would equate to 100% wear from new in around 443km.

Single Application Longevity test (Chain Cleaned Prior to test – no added contamination – Cumulative wear checked every 250km) – allowed extra 0.25mm on top of end of block 1-6 wear measure

***Note: For Smoove – I already knew that without adjusting manufacturer application instructions it would record a poor result due to lack of initial penetration to pin. So its initial longevity test was done after applying lubricant ultrasonically. This delivered a much improved result vs its block 1 avg wear rate, however it deteriorated faster than expected.**

Working on theory that Smoove is capable of building layers, and trialling a method that users can perform at home (albeit at quite a time and effort cost), a lengthy process was undertaken to ensure proper penetration and multiple layers of lubricant built up. This method delivered outstanding longevity test results.

Start wear measure	% wear 250km	% wear 500km	% wear 750km	% wear 1000km	% Wear 1250km	% wear 1500km	Comments / Observations
Test 1 0.632	Test 1 0.641 (1.9% for 250k block)	Test 1 0.687 (9.2% for 250k block)	Test 1 0.751 (12.6% for 250k block)	Test 1 0.836 (16.9% for 250k block)	Test 1 0.926 (17.9% for 250k block)		After both Smoove and Squirt demonstrated very high wear rates for clean block one which subsequently improved by block 3 – demonstrating a lack of initial penetration through the lubrication gap to the pin – And Squirt demonstrated an initial wear during single

Test 2 Different chain start at 0.480 wear	Test 2 0.470 -2.0% for block. Layers built up well!	Test 2 0.496 5.14% for block, 3.14% since start	Test 2 0.577 16.29% for block, 19.4% since start – still has a sharp drop once worn.				application longevity test very similar to clean block one rate but then held on impressively, I decided to see if could properly assess smoove better by negating the initial penetration issues so lube was applied ultrasonically at 38g c. For the first 250km block Smoove delivered a much lower wear rate than its clean block 1 wear rate and also squirt (applied normally). However by 500km the wear rate had increased a lot, and by 750km and 1000km it was well behind Squirt which had not been applied ultrasonically. I then trialled a different method of layering with Smoove which delivered outstanding results.

Test observations and review.

I believe Smoove was designed to take aim fairly and squarely at Squirt – to be the top wax emulsion lube, and therefor top drip lube – especially for outright longevity and harsh conditions. Coming out of the bottle it looks exactly like squirt, has a viscosity very similar to (but slightly lighter than) Squirt – and one could be forgiven for initially thinking Smoove was perhaps re bottled Squirt.

Due to similarities with these two wax emulsion lubes there will be much cross referencing to between them in each of their reviews.

Smoove recorded the exact same initial very high wear rate of 19.1% for block 1 - showing the exact same issue as Squirt re initial penetration to pin as explained a little further down in this review. So applying either Squirt or Smoove as instructed on a clean chain and following their application instructions is simply not adequate to initially get lubrication to a crucial point it needs to be – on the pin and inside the bore of inner plate shoulders.

Applying Smoove and Squirt initially in a much more detailed process does resolve this – however it really is quite a process. First let me explain what is happening in case you missed FB posts / Squirt review.

What is normal for most drip lubes is they will record their best wear rate (lowest) in clean block 1 – where chain is clean, lube is initially not contaminated and it doesn't get very contaminated running on stationary trainer, and the chains protective coatings are intact. They tend to show a notable increase in wear during block 2 when contamination is added at 7 points throughout the test block. Wear rates remains high from that point onwards however block 3 should show a drop in wear rate vs block 2 – how much of a drop is a good indication of how well a lube is able to 'clean as it lubes" and clear some of the contamination out. The increase in wear in block 2 vs block 1 can be an indication regarding how much or how little contamination the lubricant absorbed or resisted.

Smoove is the first lube tested so far that showed a **decreased** wear rate in block 2 vs clean block 1. This tells us two things – one Smoove is exceptional at resisting dust contamination and, two - finally now the lube is penetrating through the very small lubrication gap to the pin. But unfortunately 17.4% - whilst an improvement on block 1, is still not really able to be classed as a low wear rate – it is just a very interesting result to record lower wear during a block with a lot of added contamination vs its first clean block 1, `and what it tells us regarding dry contamination resistance and penetration rate. If one were to ensure their chain was fully lubricated to the pin and hit the dirt Smoove would perform exceptionally well. The "Plastic" state of the lube does not really provide a vector for dry contamination to enter inside the chain, most dry contamination should either bounce off or stick to outside only. So the trick is getting the chain to be properly lubricated to the pin to avoid the initial high wear rate and the high friction that would accompany that which the rider would not be able to "feel" – but I can assure you will be there unless the rider has undertaken some fairly concerted initial effort to get the lube through to the pin.

This is backed up further by a very surprising block 3 result. Block 3 – which reverts back to a clean block - giving lubes a chance to demonstrate their "clean as they lube" ability. Smoove showed only a 2% wear rate for block 3 which is quite amazing – and as will be

explained later – is not due to any exceptional cleaning ability of the lube. What this is telling us now is that a) Basically no dry contamination penetrated during block 2, and b) That once the lubricant has finally properly penetrated to the pin the level of performance Smoove can deliver is impressive indeed.

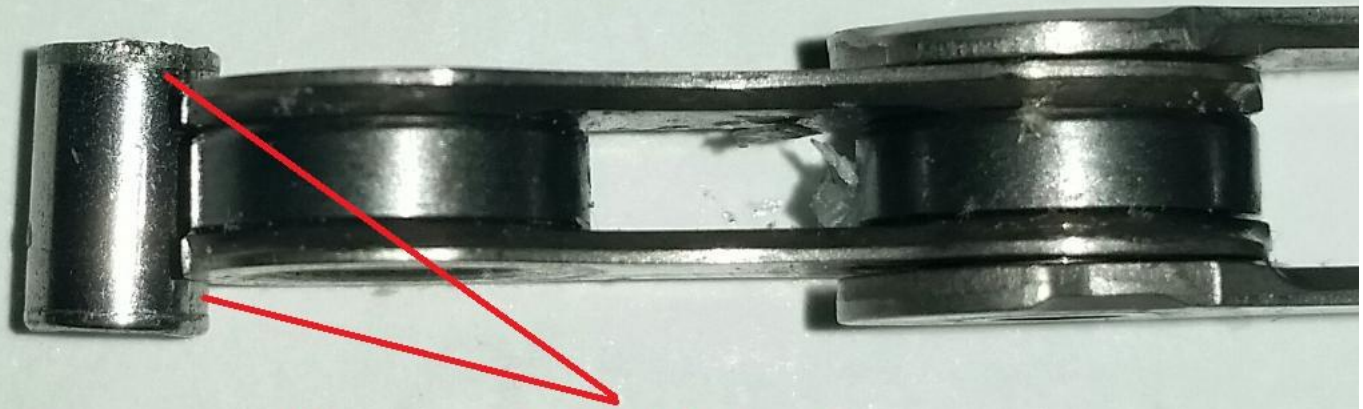
So what is this lubricant penetration issue I keep eluding too?

10, 11 and 12 speed chains have a VERY, VERY, VERY small single access point for lubes to penetrate through to the pin and then disseminate across its length. The friction interface between the pin and the inside of the inner plate shoulders is a key high pressure friction and wear point. It is the point right inside the chain at which the chains metal parts articulate against each other under full rider load. If lubrication here is poor then this will result in a high rate of elongation wear, and there is no getting around it – a 19.1% wear of hardened steel parts in clean block 1 is very high. Unfortunately a fast wear rate of hardened steel parts just flat out takes friction, and that eats watts just like it is eating the metal parts.

Thin low viscosity lubricants penetrate this gap easily enough, however higher viscosity lubricants such as wax emulsion drip lubes have a much tougher time getting in AND disseminating across the length of the pin. Wax emulsion lubes can also rely on building up lubrication layers over time, and this becomes of importance later as we look at the single application longevity result.

So - wax emulsion lubes will penetrate past roller without too much issue, however from there things get a lot tougher. The images below will help explain the challenge;

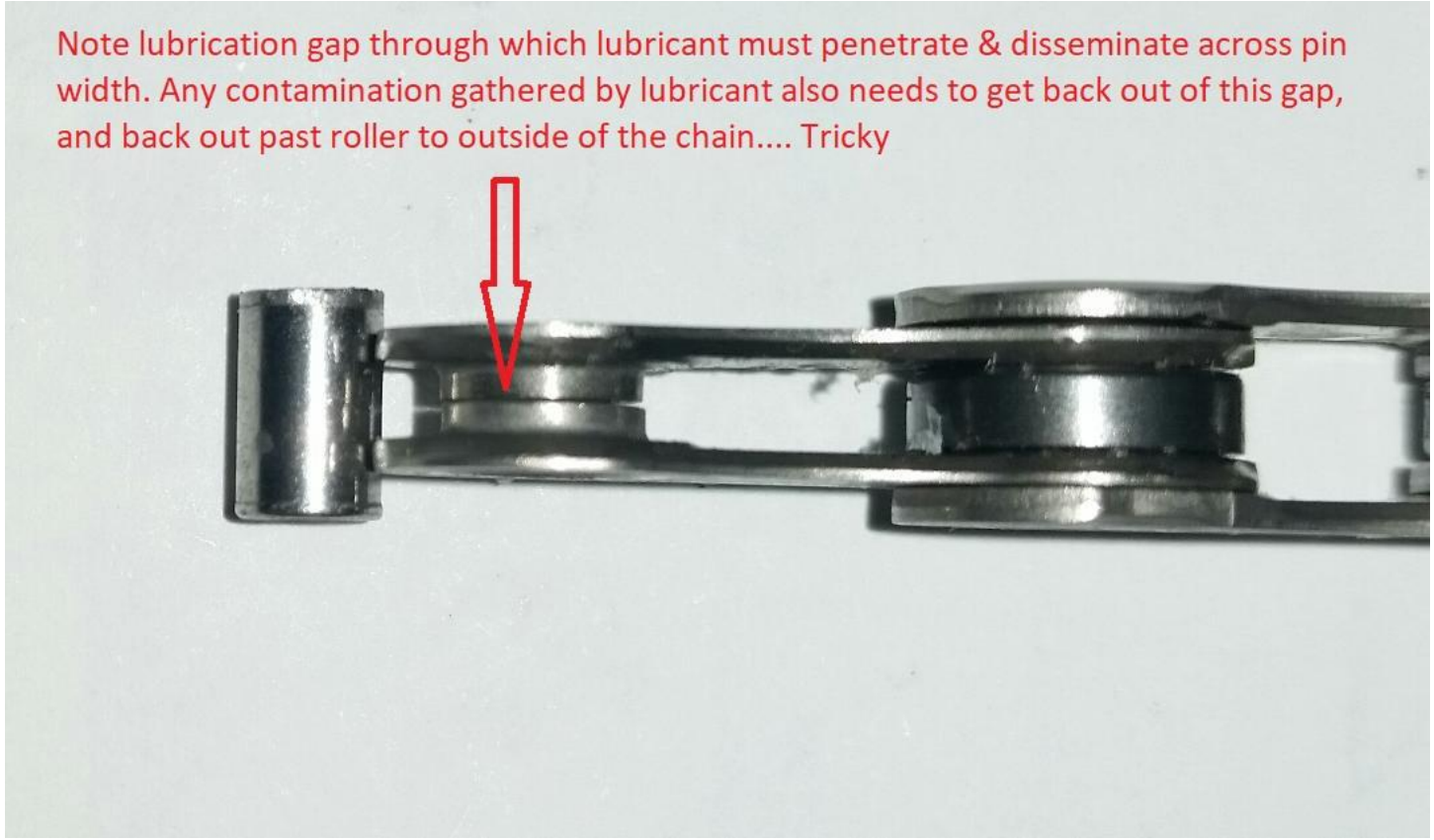
Pin is riveted to outer plates & does not move. Inner plate articulates around pin. When roller contacts teeth roller stops, and so inner plate also articulates inside roller.

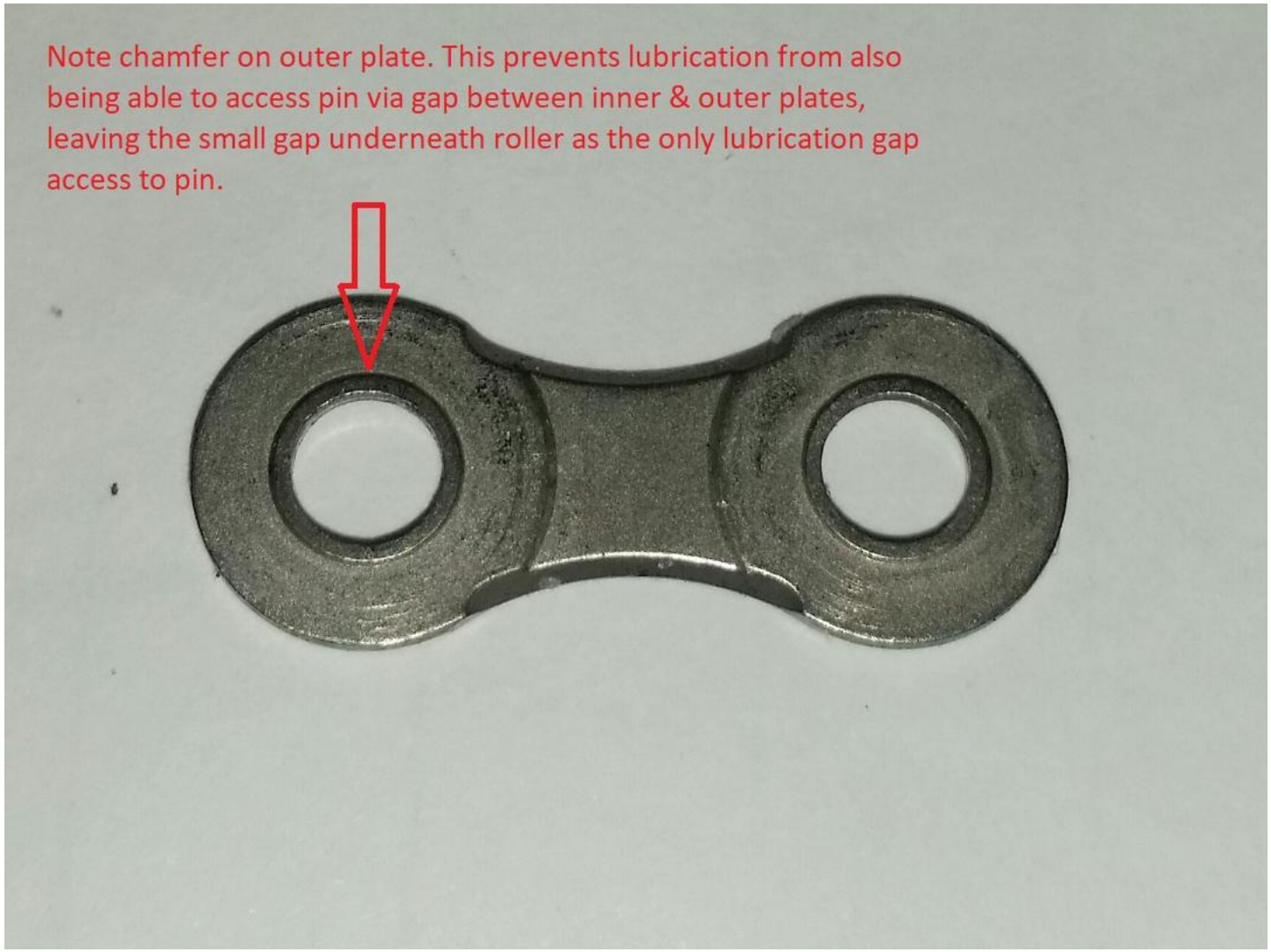


Note amount of pin width that requires lubrication - inner plate shoulders articulate around this area under full rider load.

Now with Roller removed

(Note width of inner plate shoulders – inside bore articulates around pin, outside of plate shoulders articulates inside roller.




Note chamfer on outer plate. This prevents lubrication from also being able to access pin via gap between inner & outer plates, leaving the small gap underneath roller as the only lubrication gap access to pin.

With wax emulsion lubes such as Squirt / Smoove – instructions are to properly clean chain of factory grease as the two do not play well together (this is common for most drip lubes - factory grease is for packing and storage protection). Wax will not really be able to adhere to the surface of chain metal that is covered in factory grease – which tend to be mineral oil based. Factory greases are also pretty high on the contamination gathering scale so they will grab and hold a lot of contamination to ruin a low friction lubrication party. It is rare that a lubricant does not recommend cleaning factory grease off chain first.

(Also a common issue I see is the myriad of ways riders have arrived at to clean their chain from diesel to gum removers to secret methods they discovered talking to a world tour mechanic etc. Some are fine, but many cleaning agents leave a heavy film of themselves behind which can affect some lubricants ability to do what they were designed to do. A lot of lubes need to bind / bond to chain metal and form their own lubricating layer and its ability to do this can be severely compromised if it first has to penetrate a film left behind from a degreaser or diesel / petrol etc. Often prepping a chain is two distinct parts – part 1 is dissolving off what is currently on there with a solvent or degreaser & part 2 is finishing with methylated spirits / acetone / isopropyl alcohol etc to ensure no film is left behind from cleaning agent).

So after properly cleaning off factory grease – you have a clean dry chain with no lubricant – all metal on metal. You now add highly viscous Smoove. It will get past roller ok and lubricate between roller and outer surface of inner plate shoulders – but it is clear from the testing that it takes time**, a long time**, to properly penetrate the lubrication gap to pin, disseminate sufficiently across pin and inside of the inner plate shoulders – and finally to be able to build up a sufficient layer of lubrication that will last a proper length ride interval. To start with it is clear the pin and inside bore of inner plate shoulders are running with very little lubrication or the very high initial elongation wear rates would not present, nor would wear rates continue to improve even after contamination has been added.

And here we can also explain the discrepancy in the high wear initial wear rates we saw with Squirt vs the very high efficiency test result for Squirt from Friction Facts efficiency testing – as this is the same issue for Smoove.

Firstly for the FF efficiency testing, after the chains have been cleaned the lubricants are applied ultrasonically – fully immersed – and at 38 degrees Celsius for 5 minutes. The FF testing needed to ensure 100% penetration of the lubricant on test to all parts of the link as the test is all about outright efficiency of the lubricant – hence the meticulous chain cleaning and lubrication process. Whereas normal user application for

Smoove / Squirt one is dripping a pretty thick lubricant onto the outside of the chain and then trying to work it inside before allowing it to dry. Penetration past the roller seems fine, but these viscous lubes are clearly not penetrating very well at all through the lubrication gap to the pin. Even following Squirt / Smoove's application instructions to the letter – it is obvious from this is insufficient and will result in initial high friction and wear of pin and inside of inner plate shoulders.

Secondly - the Friction Facts efficiency testing runs are typically 5 minutes long. Any lack of depth of the lubrication layer on pin is unlikely to arise in 5 minutes. With ZFC testing – after chain has been cleaned and lubed as per manufacturer instructions, it then goes on a 400km / 12hr 15min interval, re lubed and then onto another run of just over 11 hours, re lubed and onto next run again for just over 11 hours. Road interval simulations of 400km and 11 to 12hrs ride time is probably in line with minimum expectations most riders would have for most lubes – and especially so for lubes claiming great longevity. However the very high wear rates for block one for Smoove and Squirt, which improve over thousands of km and in the face of added contamination - clearly demonstrate there is initially insufficient penetration of the viscous lube through the lubrication gap to the pin. And it takes a surprisingly long time for this to properly occur.

Backing this up even further – To date for all lubes tested - When the test chains are fully cleaned at end of main test to ensure a contamination free chain for the single application longevity test - and again lubricated exactly as per manufacturers instructions post chain clean – the wear rate for the first 250km of longevity test has always been very similar to the average wear rate for clean block 1 of the main test. Squirt followed this trend with its first 250km interval in the single application longevity test in line with its clean block 1 wear rate.

For the longevity test with Smoove, it has now been established that it is not penetrating and so we are not seeing a true representation of what the lubricant performance could be if this issue was overcome. If I followed the manufacturer instructions again, I would simply see the same issue that presented in clean block one, the same as what occurred with Squirt for the main and longevity tests.

What I needed to ascertain was this lubricants actual performance ability, and so for the first take of Smoove's single application longevity test it was applied ultrasonically at 38dg Celsius.

This delivered a vastly lower wear rate now for its initial 250km interval vs what was recorded in clean block 1 of main test – so applying ultrasonically and negating the penetration issue to the pin showed more of what Smoove is capable of. However by 500km the wear rate had increased by quite a bit. I knew from its very low block 3 wear result that it should be capable of better and that it may "layer" well.

So I repeated the first 750km of thee longevity test again, this time following a process that could be followed at home – albeit with much time and effort – in an attempt to both overcome lubrication penetration issue as well as build up depth of lubrication "layers".

After cleaning another used chain I heated Smoove for 15 secs in microwave to get to around 30dg, and then I applied very generously whilst back pedalling in small chain ring and 11t cog to articulate links as much as possible. After finishing applying lube across chain I back pedalled for 50 revolutions, and then thoroughly wiped excess off chain. I then ran chain at very low power on motorised trainer for 3 mins at 25w (it runs at 100 cadence) remaining in smallest gears. I let dry for at least 2 hours, and then repeated the application processs but upping to a 4min run @ 50w at end, then 5mins at 75w next application, then 6 mins at 100w, and finally 7 mins at 125w – always allowing at least 2 hours to dry between re application and runs to ensure previous application had "set" as its own layer. I varied time and power across a range mostly as a scattergun approach – I really was not certain what level was required to manually articulate and press in sufficient amount of viscous lube through the lubrication gap to pin and build up layers.

So time wise this took a day to prep due to needing to allow drying time between applications – but I was rewarded with the results in the repeat of the longevity test. It recorded no wear for the first 250km block, and was still at only 3.1% wear after 500km – 3 times better than any previous lubes result at that mark. **Note that "layering" actually works is a little counter intuitive – tolerances are pretty tight and I (and others who know a bit about lubes) were very sceptical that a lube could actually effectively build up layers. It didn't really come through that well for Squirt when re tested after same prep as above – but it is hard to get past the results and evidence for Smoove that it does in fact achieve this feat quite well.*

It is clear that Smoove can be an extremely high performing lubricant and with excellent longevity – BUT one must overcome that lubrication penetration issue, and following manufacturer application instructions simply does not achieve this.

**Note I repeated this process to re-test Squirt – and it also resolved the initial high wear rates with a much improved 250km result, however after that Squirt quickly reverted to similar results to its original test from 500km onwards – showing that whilst the above process resolves lubrication penetration issue, Squirt does not layer anywhere near as well as Smoove. The difference in block 3 wear rates in main test between Squirt and Smoove are also testament to this.*

Okay – big nerdy lessons on wax emulsion drip lubes and lubrication gaps over and chain prep over- moving back to the test results ☺….

*****UPDATED RECOMMENDED INITIAL APPLICATION TECHNIQUE CAN BE FOUND UNDER INSTRUCTIONS TAB ON ZFC WEBSITE – BASICALLY SAME AS IS RECOMMENDED FOR CERAMIC SPEED UFO DRIP LUBE. ONCE YOU HAVE DONE ONCE WILL BE VERY PRACTICED WITH ENSURING PENETRATION ON INITIAL LUBES RELATIVELY EASILY***

We are now up to Block 4 – wet contamination block.

This demonstrated Smoove is moderately susceptible to water – recording notably higher wear rate than the dry contamination block and its block 3's reduced wear rate. It did outperform RNR gold by a good margin which is a much lighter lube, and was a little better than Squirt, however was also way behind Molten Speed Wax.

But unfortunately Smoove did not really recover from this for clean block 5 – so once contamination does penetrate the chain, it has a very low ability to shift it back out. Here is where Smoove's "plastic" state now works against it. Water provides a nice medium for contamination to enter the chain, but the "plastic state" of the lubricant means there is no vector to move contamination that has penetrated back out again.

One of Smoove's other claims re the lubricants properties is that the "plastic state" does not "shed" which is why the lube demonstrates such extreme longevity. However other types of wax / wax drip lubes rely on "shedding" as a way to shift contamination back out of the inner workings of the chain. Shedding will reduce the lifespan of a lubricants treatment as it is using up itself to perform this action, however it can shift back out some of the contamination that penetrates the chain.

Even if a lubricant is a proper solid lubricant such as Molten Speed Wax, or a "plastic" like Smoove – a certain amount of contamination is also going to be forcibly pressed into the lubricant from rider load as opposed to being "actively absorbed" like liquids do which simply grab and hold any particle that comes into contact with them. However Molten Speed Wax is immersive, so the next re wax simply takes care of both flushing contamination out and re lubing to all parts of chain with fresh wax – and one simply changes the wax in the wax pot periodically to ensure clean wax is going back on.

With Smoove – the contamination that wet riding brought in really isn't going anywhere unless you properly clean chain to flush everything out. It doesn't shed, it simply has no method I can see of shifting contamination back out – and this was demonstrated in clean block 5 where it wear rates remained very high after wet contamination block.

So this is quite a catch 22. One has to undergo quite a laborious initial application process to ensure lubricant penetration to pin and layers built up – and once done its performance and longevity is extremely good. However whilst it will perform and last well in harsh wet conditions – one will be running with a lot of abrasive contamination inside chain from that point onwards unless you fully clean chain, leading one back to a laborious initial application process again.

So if you rarely ride in the wet and are prepared to put in the time and attention on initial prep – this will be a great lube for you. If it is for a single event of any condition and you can put in the initial prep time, this will be great lube for you. If you often hit the gravel or dry mtb / cx – this will be a great lube for you. If you frequently ride in the wet, or mud, - unfortunately it will take a huge amount of time and effort to

remain high performing from one ride to the next as you will constantly need to fully clean and re prep or suffer wear and friction on subsequent rides in the sum similar to if you were still riding in the wet.

Smoove claims to be very clean and that if a gunky build up occurs then one is applying lube too often. During main test Smoove did remain initially clean, however as time went on, holy batman was there some build up. It is clear that the re lube intervals used in my test protocol are much more frequent than what one would or should use in real riding, and so the build up seen in the pics at end of test are not something you should remotely approach in your own use. Since this test I have been using Smoove in real world testing, and one's chain and drivetrain will remain very clean for an impressive period. The flip side is that when you do need to clean, wax emulsion lubes such as Smoove / Squirt are a bit more work. Initially cleaning chain and bits with boiling water helps – waxes don't really respond to many solvents, however melt above around 60dg c. Smoove also has a specific cleaner which I haven't tried, but I imagine it would work very well as it is designed to clean Smoove.

What is a little bit of fun though from this test is just how much build up there was as the test went on, as even though I was applying far more than necessary due to the re lube intervals on the protocol, I still didn't really use that much lubricant. I used in total approximately 60ml for the entire test. In a testament to its non shedding ability, you can see that pretty much every molecule of Smoove applied remains on or in the drive train somewhere. So even though the useage rate was quite small for that length of test, it is still much higher than needed, which makes a bottle of Smoove one long lasting bottle indeed. I used 60ml across 4600km and this was clearly far too much, but even at that rate a bottle is going to last circa 10,000km. At recommended application rates a bottle of Smoove is going to last circa 20,000km. At least. At $25 a bottle of what can be very high performing running in very tough conditions that is tough indeed for other lubes to match and makes this lube well worth a bit of periodic elbow grease when it is time to clean drive train.

So how to wrap these results?

Overall it is a slightly bi-polar wrap up here. Smoove has shown it can be an outstanding performing lubricant, however some time and effort is needed after cleaning chain to ensure lubricant penetrates properly to pin and builds up lubricating layers. You will not feel that there is high friction and wear occurring if you do not prep correctly – as the overall dampening for this lube is high, and the lubricating feel from lubricant underneath rollers will easily mask what is happening deeper in the chain. But happening it is unless you take the time and effort to ensure penetration.

However, it resists dry contamination extremely well – almost like running solid wax, and once lubrication layers are built up an application is very long lasting – by far best tested for first 500km. A bottle of lubricant lasts a frankly ridiculous amount of time, and it is cheap – making it one of the cheapest lubricant per km rates one is likely to find, and if clean chain and re prep correctly after wet rides, your overall chain and drive train wear will remain extremely low making it one of the lowest drive train running cost options found thus far. The real world results one can achieve should well exceed the figures achieved in this test – this test is brutally hard re the amount of contamination chains are hit with, and they are not given any cleaning during main test.

On the not so great side – whilst it performs likely as well as any drip lube in wet conditions, the reality for all lubricants is that water provides the vector to transport contamination inside the chain. In the real world, your chain is being hosed by your front wheel with gritty water from the road. So stuff is going to get in, and this is where one of Smooves greatest strengths work against it after the wet ride is over.

Being non shedding, contamination brought in will effectively be land locked inside. It doesn't really have any vector to get it back out again. There is no flush clean at all as an application is a very small amount of a quite viscous lubricant. So this is the lubricant equivalent of the old adage "strong, light, cheap – pick 2" – For chain lubricants – if compare Smoove vs say Molten Speed wax – MSW is solid so again has the greatest contamination resistance, but contamination will of course be transported in by water. The contamination will abrade off the wax. As wax material is shed, it takes an amount of contamination with it. However – harsh conditions obviously shorten the lifespan of a wax

treatment, so a Molten Speed Waxing simply may not last to the end of some longer and harsher conditions events. It will be amazing vs any other lubricant on the planet until suddenly it isn't.

Smoove will perform admirably vs anything in crap conditions and being non shedding the lubricant will remain in the chain and it will outlast anything in such conditions as far as I know at the time of writing this review. But whereas with wax you can just re wax and you have a clean and completely lubed chain again, Smoove you will want to do the work for a proper full flush clean and full initial re lube process post wet rides or you subsequent rides in the sun for your chain will be almost like you are still riding in the wet. The contamination brought inside chain from dirty water is not going really going anywhere. So if it is to be your daily lube and you commute rain / hail or shine then I would recommend their specific cleaner (I am assuming it will work well as Smoove have proven to be very straight up and honest in communications re their lube development and testing which is certainly NOT the case with many manufacturers. As such they give me no reason to doubt their claims re cleaning product).

So as your day to day lube – if you don't ride in the wet, are ok with a fairly involved initial prep, and don't mind a bit of cleaning maintenance, then this will be a high performing, low wearing, ridiculously cheap lube to run. If you often hit wet stuff – be prepared to take the time to clean and then repeat initial prep procedure.

As a long / harsh event race day lube (very long enduro's etc) providing initial prep done well – it is clearly best tested to date by quite a margin, and other lubes coming up for testing will be hard pressed to match / beat it – and especially at Smoove's low cost compared to many premium lubes (Muc off Nano that I have coming up cost me $106.50 landed for a 50ml bottle!) – then using Smoove to prep a race chain for such events, as well as long gran fondo's / sportif's where it might be wet – is highly recommended.

In fact - until it is beaten – ZFC has found its first new lube that we will soon be stocking and offering chains pre prepped via both ultrasonic and layering system for just such occasions. After 40,000km of testing to date, we have arrived at our first new best in class product addition to our range!

ZFC Overall Performance Ratings

Race Day Lubricant Road – 6 to 9/10

Yes that is a big range again unfortunately – it is really going to depend on how good your initial prep and lubing is. Done well and it should be outstanding and remain so for a very long time. Done as per manufacturer instructions and you will have high friction and wear in a key high pressure friction interface which you will not detect by feel.

Race Day Lubricant MTB / CX – 7 to 9/10

Resistance to dust was outstanding, and single treatment longevity was impressive – however note same as above re initial prep.

Everyday Lubricant – 4 to 9/10

Big range here as it is very dependent on initial prep – and then assuming you use sparingly and clean after wet rides. If you do that you are at 9. If you don't prep well, use too much and get build up, and don't clean after wet rides, then you may be experiencing a 4.

Harsh Conditions Lubricant – 6 to 10/10

Again depending on initial prep - If it is dry and dusty harsh – it will be outstanding, if it is wet harsh it will be good – better than most. Note it was still well behind Molten Speed Wax, so for shorter harsh conditions events such as most CX / XC distance events MSW will still be well ahead and vastly easier to prep, but for events of a length that would exceed MSW treatment longevity and re lubing during the event is not feasible / desired – Smoove is the best tested to date after MSW for wet contamination performance.

Single Application for Long event – 7 to 10/10

If penetration and layering prep done well as I did for second attempt of longevity test – then it was simply phenomenal. It is a lot of prep time though! If post clean prep is not completed so well, then its performance will be good at best if pin has poor lubrication.

*****UPDATED RECOMMENDED INITIAL APPLICATION TECHNIQUE CAN BE FOUND UNDER INSTRUCTIONS TAB ON ZFC WEBSITE – BASICALLY SAME AS IS RECOMMENDED FOR CERAMIC SPEED UFO DRIP LUBE. ONCE YOU HAVE DONE ONCE WILL BE VERY PRACTICED WITH ENSURING PENETRATION ON INITIAL LUBES RELATIVELY EASILY***

Cost to lubricate (based on blocks 1-5)

Smoove is cheap to buy, and a bottle lasts an EXTRAORDINARILY long time. I only used half a bottle for main test which lasted 4600km, and judging by he build up apparently I was way over lubing….. Unfortunately the wear rates of components was much higher than it could be due to high initial wear from lube penetration difficulties. But as for all lubes the calculations are based on what was achieved in testing, following manufacturer instructions, however like Squirt I believe these results could be greatly improved upon if change initial prep. *(But also need to re do this after wet rides to keep wear rate low so it's a bit tricky – one could either get average or amazing parts longevity depending on what level of time and effort they wish to put in).*

Extrapolated drive train running costs table per 10,000km based on blocks 1-5.

(Cost per km of lubricant & assume 2 x chains @0.5mm wear per cassette & 6 x chains per set of chain rings. Australian online + Lbs store RRP prices of ultegra cassettes and chain rings) .

Lubricant cost per 10,00km	Chains per 10,000km ($40 per chain)	Number of cassettes worn per 10,000km & cost ($90 per cassette)	Chain rings cost per 10,000km ($195 set).	Total Drive train running cost per 10,000km
$25.00	**2.26 = $90.43**	**1.13 = $101.7**	**0.376 = $73.35**	**$290.48**

(0.46 bottles used for 4600km = 1.0 bottles. 2.26 chains per 10,000km. 1.13 cassettes per 10,000. 6 chains per chainrings = 26,583km – 0.376 per 10,000km)

Pics from test

Post first 400km interval chain wipe, not a lot of black mess to wipe off, but chain was very tacky and hard to wipe.

End of main test – 4600 km of running – chain plates have a thick and tacky build up of excess Smoove, as does chain ring teeth and cassette. This is much harder to remove than most drip lubes – being tacky the chain is hard to wipe and it doesn't really remove anything anyway, and similarly the excess is hard to remove from teeth. It also does not readily respond to solvents. ***Using the recommended application amount / frequency you should not experience anything like what occurred during ZFC test, and also their specific cleaner I believe will make cleaning much easier than what I have on hand.***

End of main test – 4600km – there is good bit of build up inside cassette cage as well. ***Using the recommended application amount / frequency you should not experience anything like what occurred during ZFC test, and also their specific cleaner I believe will make cleaning much easier than what I have on hand***

End of test – Jockey wheels – 4600km mark. Can you find the jockey wheels?! This was a little bit comical here! It goes to show the non shedding nature of smoove indeed – what you apply stays on your drive train somewhere. ***Again hoewever this mostly demonstrates the application frequency during ZFC test was far too frequent vs what is needed. In real world testing I can attest that Smoove does not end up anything like the above, so the pics are a little unfair here for Smoove.***

Best internet review I found for Smoove here….

http://www.bikeradar.com/au/gear/category/tools/cycling-tools/chain-lubricant/product/smoove-lube-review-51530/

Lube Logic – Little Compendium of knowledge to save you $ and lost watts.

In the information below I go through a number of the main claims made by manufacturers, run through a bit of a reality check, and help provide a base understanding re how things may or may not work. Some lubes are getting pretty fancy – and some are VERY expensive.

Does your lube clean as it lubes? Does it form a protective membrane? Does it "condition" the metal? Is it PTFE based, or wax, or mineral oil, synthetic oil, or ceramic tech, or nano tech, or contain laser crafted micro balls? Is it a dry lube? wet lube? What is most important to you – outright efficiency? Longevity? Cleanliness? Cost to run? Do you have different needs for your TT bike vs your road bike vs your cx or mountain bike?

The below should help you make an informed decision on what is the right lube/s for you, and this information will continue to update as our testing reveals actual performance vs claims.

Lube testing – what are we looking for and why should you care?

Your chain is your hardest working part by miles, and it is working completely exposed to dust, grit, water, mud. Friction Facts testing was ground breaking and they really shone a light into the dark art of drive train friction. However, outright efficiency on a clean chain in clean lab environment tells only one part of the story.

Data on lubricant performance once contaminated is extremely scarce - and yet most performance claims centre around how the lubricant deals with contamination – cleans as lubes, forms protective films / membranes etc. They boast about many awesome things the lubricant apparently does whilst you are out riding around in the real world – but where is the testing and data for this?!

Considering that the biggest impact to a lubricant and therefore a chains performance is contamination, and that all chains are subject to dealing with this from km zero in the real world – there is a big gap of actual performance testing and data here.

Friction Facts did do a simulated longevity test across 8 lubricants representing main lubricant types (PFFE, wax, wax based, ceramic etc..). Lubricants were tested at the start, run for an hour dripping on water and sand, and tested again at the end. Some lubricants had very little shift in friction, some increased notably, and one which tested well when clean increased by 3.8w. That's in one hour.

So how a lubricant performs on a clean chain in a lab is no indication as to how the lubricant will perform once you start riding it.

How well a lubricant does or does not handle contamination depends on many, many factors. What is the actual lubrication type? What is the carrier fluid? What is the ratio of lubricant to carrier fluid? Is your lubricant actually capable of achieving the big claims it is making regarding forming protective membranes, preventing metal to metal contact or contamination to metal contact from wearing your chain metal? Does it really clean as it lubes?

Testing lubricants in a controlled longevity test is the key piece of the picture. It is all well and good to have a lube that tests very low friction on a clean chain, but if it has doubled that friction performance in few hundred km of riding then this is rather important to know. If a lubricant is fine for a 90 minute or 4 hour test buts becomes very poor over thousands of km's without frequent full solvent cleaning intervention to reset contamination – that is important to know – a large percentage of cyclists just keep dripping more lube on with little to no proper chain cleaning maintenance.

The main state of play at the moment is there is either no known or accessible testing data provided by a manufacturer, or if there is data there is no detail available on the testing protocol. We also have a rather fun situation at the moment where two major players in the industry – Ceramic Speed and Muc Off – both with a lot of very fancy testing equipment – are providing test results completely at odds with each other. One of them is incorrect. Both claim to have developed the fastest lubes and chains. Any reader who has gone through the pages and pages of info from both sites would be left quite confused and with no way of determining who is right and who is wrong (at the time of writing I am trying to clarify the testing and results from both parties).

There are also times when a lubricant may perform well if a different lubrication protocol is followed vs manufacturer instructions. Sometimes the lubricant itself may be quite good, and would perform well if the amount / re lube frequency was adjusted – however it is let down by overstated marketing claims of extreme longevity performance, or the very low amount that should be added so the purchaser can expect a vast amount of km from a single small bottle etc. There are times when sales and marketing undermine what would have been an overall fine performing lubricant if a more logical approach for that type of lube was followed.

Very little proper longevity testing has been done. Simulated lab tests have typically been between 1hour and 4 hours long, and other longeviy testing has typically been done via real world riding as who is going to run equipment for thousands upon thousands of km's per test. However real world riding is unfortunately a very inaccurate way to conduct longevity testing as there are just too many variables in the key aspects that affect chain wear. Just going out riding and training subjects chains to different loads for different times, and contamination levels that are at both varying rates and introduced at varying times in the chains lifespan.

If in my testing I subjected the lubricants on test to different loads for different times and introduced different levels of contamination at different times in the chains lifespan – I don't expect anyone would place much stock in the testing results. No proper testing process I can think of would accept such variability in the key aspects of the testing and expect anyone to accept the results. Yet that is what we have with longevity testing completed via real world riding.

Also, as the testing relies on the correlation between chain wear rates from abrasive friction, very accurate measuring of net chain wear is a mission critical component. However any other longevity tests I have seen using this correlation have simply used an analogue checker unable to deliver precise wear measures. And dismayingly chain preparation can also be off the mark – with chains prepped simply by wiping the outside – leaving factory lube inside to which the lube on test is added. Not good. Added on top of the variables in load / time and contamination – you can get an idea as to how accurate some testing results may be.

At ZFC we want to ensure we stock the genuine best in class products & chain lubes to cover your type of riding and racing – be it the best for a prologue TT, a 24hr enduro, a full mudder cx, your daily commute, and every range in between. We want to have a selection of the best products depending on your level of maintenance comfort. We want to be able to demonstrate accurately the total running costs of one lubricant vs another taking into account the cost of the lubricant, usage rate and parts wear rate. We want customers to understand more about why their chains typically contribute more friction to their drivetrain than all of their bearings combined, and just how many watts (and $$) can be easily saved with the right lubricant. We want to know what a lubricants limitations are – what performs great when dry but atrocious when wet etc. And lastly we want to help consumers understand what is happening inside their chain and just how difficult some of the manufacturers claims are to actually execute in real life.

So for the worlds first proper longevity testing – ZFC have kept things simple equipment wise but extremely robust in process. We do not have microprocessor controlled instruments accurate to 0.02w worth tens of thousands of $, what we do have is equipment that can be afforded to be run for thousands of km's and up to around 200 hours per test. Due to the correlation between friction and chain wear, ascertaining a lubricants performance via running chain through an actual bicycle drivetrain whilst alternating through specific clean and contamination blocks delivers a lubricant performance breakdown to a level that has not remotely been provided previously. With all the fancy equipment of

the big manufacturers you get a start friction figure and an end of test friction figure after usually somewhere between 90 minutes and 4hrs of testing. Whereas ZFC testing can assess the strengths and limitations of a lubricant through each specific clean or contamination run block and provide a full breakdown of a lubricants performance across each, as well as assessing claims vs reality – I,e ability to clean whilst lubricate etc. No other testing to date comes close to providing such a complete picture of a lubricants performance.

The Holy Grail Lube

Lubes are big business – every cyclist needs one – and they are all vying for your $. Some lubes are excellent, some are fine, some are rubbish – and it is simply impossible to tell what is what based on drip lubes type (ptfe, ceramic, wax based, nano based, dry, wet, oil etc), manufacturer claims or price.

But choosing the right lube for the right purpose not only gives you back the easiest free watts available – it also saves you lots of $ in drivetrain wear – especially so if you run group sets at the top of each brands hierarchy. It is like double free speed!

The holy grail is to find a drip lube that matches the performance of immersive waxing in the convenience of a drip lube. Many that have purchased Friction Facts testing have mistaken the performance results of the top performing drip lubes. They will think ah look at that – almost as fast as Molten Speed Wax but all I have to do is drip it on! But the reality is – (as far as we know at time of writing), is that all drip lubes start gathering contamination from km zero. You can ride 100km and your drip lube will be black. You can ride 50km on your indoor trainer and your drip lube will be black. You didn't put a black drip lube on – the fact it goes black so quickly is a hint as to what is happening even just from airborne dust.

So drip lubes that test close to waxing performance on a perfectly clean chain in a lab will be unlikely to test near that friction level after 300km of riding. It will certainly not be remotely near that friction level after 3000km ***(In FF simulated longevity testing –some drip lubes increased by up to 3.8w friction in 1 hour!).***

Also – in the FF testing the lubricants were applied ultrasonically, with chains fully immersed in the lubricant, at a nice warm 38dg Celsius. This is not representative of how most cyclists apply their lubricants at home. This method ensures complete lubrication of all internal parts of the chain from the first articulation. However as we have seen in our testing - especially with higher viscosity lubricants – it can take some time for them to properly penetrate through to the pin leading to poor performance for the first 1000km or so , after which time there may be good penetration but there may also now be a reasonable amount of contamination gathered slowing things down.

All up – there are numerous aspects that impact the real world friction result a lube delivers vs the FF lab test results.

To remain anywhere near the friction level tested in the lab generally requires chain to be frequently removed and given many agitated solvent baths to reset contamination levels as best as possible back to near zero, and depending on the viscosity of the lubricant – a fairly involved process may be required to ensure proper lubrication of the pin and inside of inner plate shoulders *(refer lubrication gap section)*. You also need to clean all the black mess off your chain rings, cassette and jockey wheels.

This is quite time consuming, costly, and you end up with a lot of solvent to dispose of somehow. But to date – we just have not seen evidence that a liquid lubricant can remain near its lab *performance (although we have very high hopes for a couple of lubes coming up on test – whereby this section will be amended).*

All liquid lubes quickly become contaminated, and many manufacturers claims re abilities to ***"clean as it lubes"*** and ***"form protective membranes"*** is not strong past a certain number of km's. Intervention with proper cleaning is usually necessary to reset the contamination in the chain, and a protective film can only protect chain metal for so long against contamination particles abrading against it under high pressure. In a part performing around 20,000 articulations a minute on the large chain ring, it doesn't take too long until the sheer number of articulations hits millions upon millions. A film / membrane can only withstand a finite amount of abrasion before it is worn through and wear

of hardened steel parts of chain commences. In a part working so hard, it only takes a little bit of contamination to have big impact on the level of friction losses and wear in the chain.

Which is why waxing is the tough benchmark to beat. Each re lube (re wax) is fully immersive, at around 90dg Celsius. All parts of the chain are fully coated a very slippery lubricating wax. The remaining old wax layer is melted out into the pot and fresh wax is flushed through so each re wax the contamination levels are reset back close to zero again. Forget protective membranes – every part of the chain inside and out is fully coated with a lubricant which sets solid - preventing metal on metal contact and wear. And with wax setting to an actual solid (almost all dry drip lubes do not actually go dry – just tacky) the rate of gathering contamination and the final amount gathered is extremely low vs drip lubes. When contamination contacts a liquid or tacky surface it sticks. With a solid wax, the vast majority literally just bounces off. And forget a relatively small amount of lubricant being left behind after a drip lubes carrier fluid evaporates– again the entire chain is coated with 100% lubricant.

So that is the challenge drip lubes have to try to match the outright fastest ever tested lubes of Molten Speed Wax & Ceramic Speed UFO wax. Being solid its friction performance barely shifts from the lab test performance for around 300km in normal road conditions ***(in fact it can often decrease by ¼ to ½ a watt as the wax continues to "break in")***. For day to day riding and training - with each re wax re-setting any teeny contamination levels in the chain without any cleaning required, plus putting a refreshed solid coating on every part which prevents metal to metal contact and wear – we have three distinct factors that deliver simply astounding chain and cassette wear longevity rates. Most prospective new waxee's don't believe the wear rates quoted until they experience them first hand. (And of course being a proper solid – waxing is exceptionally clean).

There are some drip lubes that would remain close to their lab test levels for "X" km each re-lube if the chain is fully solvent cleaned between each lube, but not usually where more lube is simply dripped on time after time. I am expecting a couple of exceptions to this rule shortly but be prepared to pay BIG $.

So is waxing simply unbeatable? Not quite. Despite the entire chain being coated in lubrication, the superfast type of wax used (highly refined paraffin blended with PTFE and Molybdenum) has a relatively short lifespan. Highly refined paraffin has a very low mineral oil content at around 0.5%. The wax is soft and will itself be abraded off the chain through use and from any contamination that does get into chain. It is not water soluble so it does not "wash" off easily, however in tough conditions the water being hosed onto a chain from the front wheel is full of grit, and so the wax itself will be abraded off simply from the countless articulations performed in the wet abrasive substance thrown onto it. Harsh conditions shorten the lifespan of all lubricants – solid wax is no different.

The advantage of the wax is that it absorbs contamination from harsh conditions at a very low rate vs liquids. Initially its very low friction performance remains pretty much unperturbed. The disadvantage is that the wax will itself be abraded off relatively quickly and once it is gone

friction will increase quickly and dramatically. So if you have a long wet race or enduro etc – it may not survive to the end. Remember of course that all lubricants lifespans are shortened dramatically in harsh conditions. So whatever film or membrane or lubrication vector other lubricants have will also be abraded off much more quickly vs good conditions. The difference with drip lubes is that the liquid itself is lubricating and so as long as some liquid remains there is some level of lubrication. The downside is that the liquid will itself have grabbed and held a lot of abrasive particles, so it is part lubricant, part liquid sandpaper. It is common for a chain and cassette to be pretty much destroyed at the end of a 24hr mtb race – whereas in normal riding training and re lubing one does not go through a chain and cassette every 24hrs.

So it can be a bit of a paradox – to start with waxing will be super low friction and resist increasing in friction for an impressive period, but then once gone there will be a large jump in friction. Will this work out better overall than a lubricant that will start higher friction, increase in friction notably and quickly as it becomes a bit of a liquid sandpaper – but then hold at that level for many hours? Is it better to be at 4w friction for "X" time but finish the latter part of race at 15 to 20w, or start at 5 to 8w, very quickly get to 10 to 12w – but remain in that ballpark for many hours? The length of the event and conditions will determine whether it is best to go flag to flag with wax, start with wax and re lube, or go flag to flag with an extreme conditions lube if stopping to re lube is not preferable.

So there will be events where a long lasting drip lube may be preferable to waxing overall due to its longevity – But what drip lubes perform best here? Can't wait to find them.

And of course waxing – despite being a smart choice for many who initially didn't know there was another option to drip lubes – will never be for everyone. For a lot of people there is a mental block re removing chain to put in pot of melted wax. Removing chain to solvent clean seems perfectly normal however, and so mass market will likely always want something to drip on and either periodically clean, or never clean – and look for what delivers the best results for their level of application and maintenance comfort.

Lastly - since the FF testing there have been some exciting new lubricants out with some exciting new tech and making some very big claims indeed. Some honestly I can say already will likely be hogwash, but excitingly some others look to be very very good. I can't wait to test and see. I hope to find some bona fide great product options to our stock line up.

And so here we are…. ☺

Below is all optional reading – the more you read – the more you will understand about your chain, lube choices, manufacturer claims vs reality, and how to easily save some great watts AND $$ at the same time - especially for those who race, do sportif's / gran fondo's. There will also be some links to a couple of the best articles one should read to fully understand about chain friction and this testing.

So let's kick off - Enjoy!

About chain wear in general

Chain wear is usually measured via chain elongation or "stretch". The plates of the chain are not stretched longer, however wear of the chains parts – mostly the pins being worn thinner and the bore of the inner plate links being worn larger, means that each link can be pulled a little longer than when it is new.

Measuring chain wear accurately is surprisingly complicated and often not correctly or accurately. The generally accepted "most accurate" is to hang the chain and measure total elongation vs new – and this will give an accurate chain elongation wear measure. The problem is that rather annoyingly chains wear at different rates in different sections – and the difference from one section to another can be quite large indeed. An elongation measure taken across the entire chain will not this up – and if one section of chain is notably more worn than the average wear the elongation measure shows – the section with larger elongation is still going to cause accelerated wear of cassette and chain ring teeth. So replacing one chain at 0.75% wear one time may have a rider fine to run a new chain on same cassette, and another time the cassette may be badly worn and not accept a new chain despite replacing chain at same wear measure.

Measuring multiple sections from centre of pin to pin with a digital caliper is a better way to measure chain – so long as one is very accurate with lining up two centres of pins – tiny fractions of a mm = a large difference in wear rate calculated – and multiple sections of chain need to be checked for an average result, and even tension in the chain needs to be applied. Unfortunately some lubricants that are fairly viscous and / or if a lot of contamination is built up in the chain – this can easily prevent pins from being pulled to their true wear mark as gritty lubricant is filling the gap. Under rider load however the pin will be pulled through this – and so it can be easy with some lubricants to give falsely very low wear rates using pin to pin measuring – and again to be accurate one needs laser eyes and a steady hand to get multiple true centre to centre of pin measures across a good span of say 10 links to calculate wear.

So making it easier – sort of – are a whole array of chain wear checkers, some are drop in, some are slide in, some try to isolate roller wear from the equation. If you read some forums you will often find engineers of some degree or another denouncing chain wear checkers as a huge waste of money, flawed etc – just use a ruler / digital calliper. And yes the issue with most chain wear checkers is that at the two insertion points the checker will also be measuring wear of the inside of the roller bore and wear of the outside of the inner plate shoulders that articulate inside the roller. These two areas of wear have no impact on chain "stretch" or elongation. Some checkers are designed to isolate this wear from its measures.

So, yes – many chain wear checkers are going to measure two types of wear at two points on the chain, and just elongation across the rest of the span it is checking. One can only hope that the manufacturer of the checker took this into account when calibrating their tool. What these checkers do provide however is a quick and easy way to check multiple spans of the chain, and if used correctly can be a cyclists best friend re saving a fortune on not having to replace cassettes every time they replace their chain.

Where these fall down is often in two parts;

1) Most are too generous re wear allowance – by 1.0 the chain is ruined and so will have already ruined your cassette and had a good crack at your chain rings. Even by 0.75 measure it is touch and go, and you can be almost guaranteed that if one section of chain measures 0.75, another section will be around 0.9 – and so can still easily result in goodbye cassette.

2) They are very susceptible to the amount of user pressure applied, and need a consistent tension in the chain. If one checks the chain above the chain stay with little to no tension in chain, or check chain beneath chain stay in “X” gear which will put “X” amount of tension in bottom span of chain from derailleur pulley can easily get highly varying results. With chain wear measuring we are measuring small fractions of a mm, so differences in user pressure and chain tension can easily have one person check a chain and say it is almost new, and another person check same span and say it needs replacing. And again some lubes will mask the true elongation wear unless a lot of tension is put into section of chain prior toe measuring, whereas others require very little tension to reveal an accurate elongation wear measure. For my two cents worth, the Park Tool cc3.2 is the best analogue checker, it is a drop in checker with a 0.5 wear measure mark which is perfect – used correctly I have never ever had a time where a cassette does not accept a new chain when the existing chain is replaced at 0.5 wear mark. A conservative chain wear checker is not a conspiracy theory tool to have you buying chains more often than you need – it is your best friend to save you a fortune over time in cassette and chain ring wear. (And worn chains perform like crap – a 1% worn chain will be around 2w higher friction than same chain new – even when perfectly cleaned and re lubed).

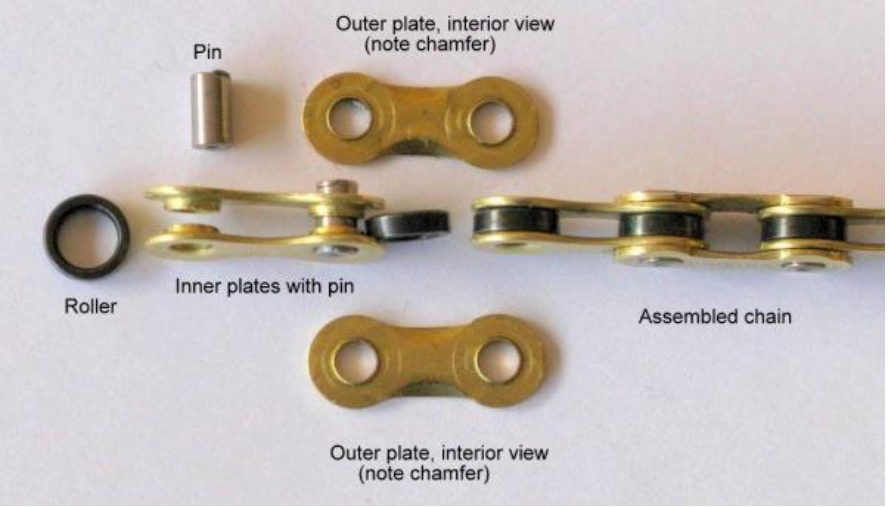
It is also worth noting that the wearing of the inside of the rollers and the outside of inner plate shoulders is still actual wear and it still contributes to a chains performance and damage to cassettes and chain rings. Some lubricants can be quite good at preventing contamination getting through tiny gap to the pins and so have a relatively good rate of elongation wear, but have gritty liquid sandpaper running inside rollers. I have seen many chains where elongation wear was not terrible but rollers were flopping about all over the place and could be shifted millimetres to the left or right. So isolating chain elongation wear only is not the be all and end all it is cracked up to be. Ideally three would be a tool that accurately measured elongation AND roller wear easily across a span of links vs trying to isolate wear measuring of elongation only – but this tool hasn’t been invented yet.

And very importantly, - chain wear and friction is not a linear increase over time. Good quality chains come with a low friction coating, and the better ones have something like a Zinc Alloy or Nickel or Ti Nitride plating on inner and outer plates, and even better chains have specific very hard coatings on pins and rollers such as chromium carbide. These coatings and p**l**atings play a big part in a chains friction performance and durability – but they are also the first to be compromised from abrasive wear. With many drip lubes this can occur frighteningly quickly. It is part of why world tour teams tend to replace their chains every 500 to 1000km. As the coatings / platings become compromised, friction and

wear rates increase. Also, without regular proper cleaning for most drip lubes the ratio of contamination vs lubricant inside the chain will generally continue to get worse and worse. As such a chain subjected to the exact same level of load and conditions will usually exhibit a higher friction and wear rate between say 2000 to 3000km than it would have from 0 to 1000km. Most times there is the double whammy of lubricant is now more contaminated, and protective coatings / platings no longer exist *(take for example the Rock n roll gold test – wear rate for 0 to 1000km was 8.9%. From 2000 to 3000km which was again a clean block with no added contamination it was 20%).*

This often catches cyclists out. A cyclist may check wear at 2000km and be impressed with low rate of wear. Check again at 4000km and find it has ripped past the 0.75 mark and now they need a new cassette as well as the chain. Most annoying.

It is also a key reason why we recommend cyclists who race or compete in sportif's / gran fondo's etc have a dedicated race chain and training chain. It is the easiest and cheapest watts savings you can get. You are always going to need another chain – so simply pre buying your next chain has a zero net cost. When training chain reaches 0.5 wear replacement mark – race chain becomes training chain, buy another chain to be your race chain.



(Pic sourced from slowtwitch)

Did you know? - When a chains roller contacts chain ring / cassette teeth etc, the roller stops moving and the inner link plates articulate inside the roller. The pin is also riveted in place to the outer plates so it doesn't move either – the inner link plates articulate around the pin. Therefore as the link articulates, the inner plates are the only rotating parts; however there are multiple friction and wear interfaces;

- The inner plates will articulate around the pin on the inside bore of plate shoulders (those flanges you can see that the roller sits on) under full pedalling load.

- The outside of the plate shoulders articulate inside the roller under full pedalling load.

- The inner plate slides against the outer plate on both sides of the link – the pressure under which it is doing this is dependant on both rider load + chain line angle.

- The inside of the inner plate sides slide against the sides of the roller – again the pressure under which it is doing so dependant on both rider load + chain line angle.

- Chain wear occurs from the pin being worn thinner, the inside bore of the inner plate shoulders being worn larger, the outside of the plate shoulders being worn thinner from articulating against the roller, and subsequently the bore of the roller is being worn larger. As these parts wear down, each link can be pulled slightly longer than when it was new, and rollers can start to flop around on inner link shoulders.

- The wear of the inner plate against outer plate and sides of the inner plate against side of rollers does contribute to friction, but does not contribute to "chain stretch". The loads here are much lower than the full rider load which causes chain elongation wear. Over time – especially for those who with large chain angles a lot – a condition known as "chain slap" may develop where the chain becomes a bit too laterally flexible resulting in poor shifting performance. Derailleur chains do need to be laterally flexible, but there is a sweet spot.

Up to 0.5mm across 8 links is very close to 0.5% wear on a 108 link chain, and this is the best limit to use as a guide to replace chain as it is getting to the maximum tolerance of the spacing of your cassette & chain ring teeth. Stay within tolerance and the rollers will slot neatly into the teeth without abrading their way down the face of each tooth. Let chains get to 0.75 and the rollers are starting to hit the tips of each tooth first before being forced to sliding down the face. By 1.0 – things are getting pretty bad – the more chain stretch the more your chain is rapidly eating all your teeth thinner.

And not surprisingly, having your chain eating through the metal teeth on your cassette and chain rings is not exactly low friction either. It should not come as a shock that abrading through metal whilst pedalling along eats up watts as well as $ from your bank account.

So, replace chains at 0.5, and save a bunch of watts and cash, and have a beautiful running drive train. It is also a lot safer. A worn chain is much more likely to fail – with very thin chains and greater chain line angles of 10, 11 and 12 speed drive trains, running clapped out chains greatly increases chance of failure. This can have you over the handlebars in a sprint and bringing down a pack, or if your chain goes into back wheel it can cause a spectacular amount of damage to bike and frame as it rips your rear derailleur from frame and into back wheel etc. In summary – your chain is your hardest working mechanical part, and running completely exposed dust and the elements. This makes it a highly consumable part – stay on top of chain wear for watts, $$, the silky smooth pleasure of not riding a clapped out drivetrain, and safety.

(New vs worn chain ring teeth. The exact same thing happens with your cassette teeth only much faster. Abrading away metal is not low friction. Replace chains at 0.5 and your chain rings will last almost indefinitely, and you will always get 2, often 3 chains per cassette. Let run too long and it is almost always new cassette time when it's new chain time, and can also easily lead to new chain ring time too. This is a very expensive way to run your bike vs simply replacing chain when it should be replaced.

The lubrication GAP!!

There are three critical area's to ensure lubrication for the chain as it articulates under load. The two most important areas are;

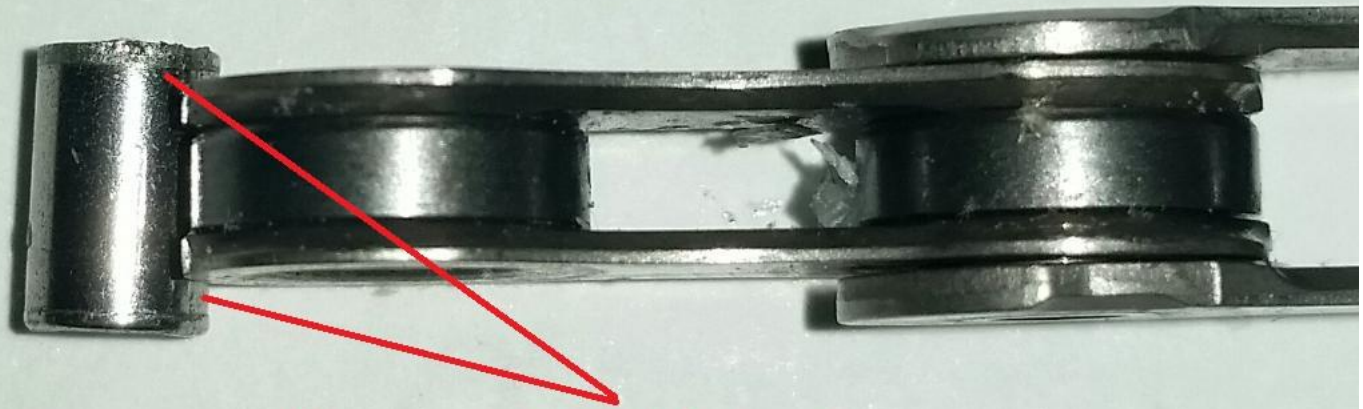
1) Between the roller and the outside of the inner plate shoulders as they will rotating inside the roller under full rider load.
2) Between the pin and the inside of the inner plate shoulders. It is wear of the pin and inside bore of the inner plate shoulders that is measured with chain elongation wear measuring. These two interfaces are also articulating under full rider load.

The last place that needs to be lubricated is between the inner and outer plates on both sides of the link as they will slide against each other as the link articulates, however when chain line is straight there is very little load here – it increases as chain line angles increase (and similarly there is friction between side of the roller and side of the inner plate which will come into play more at greater chain line angles).

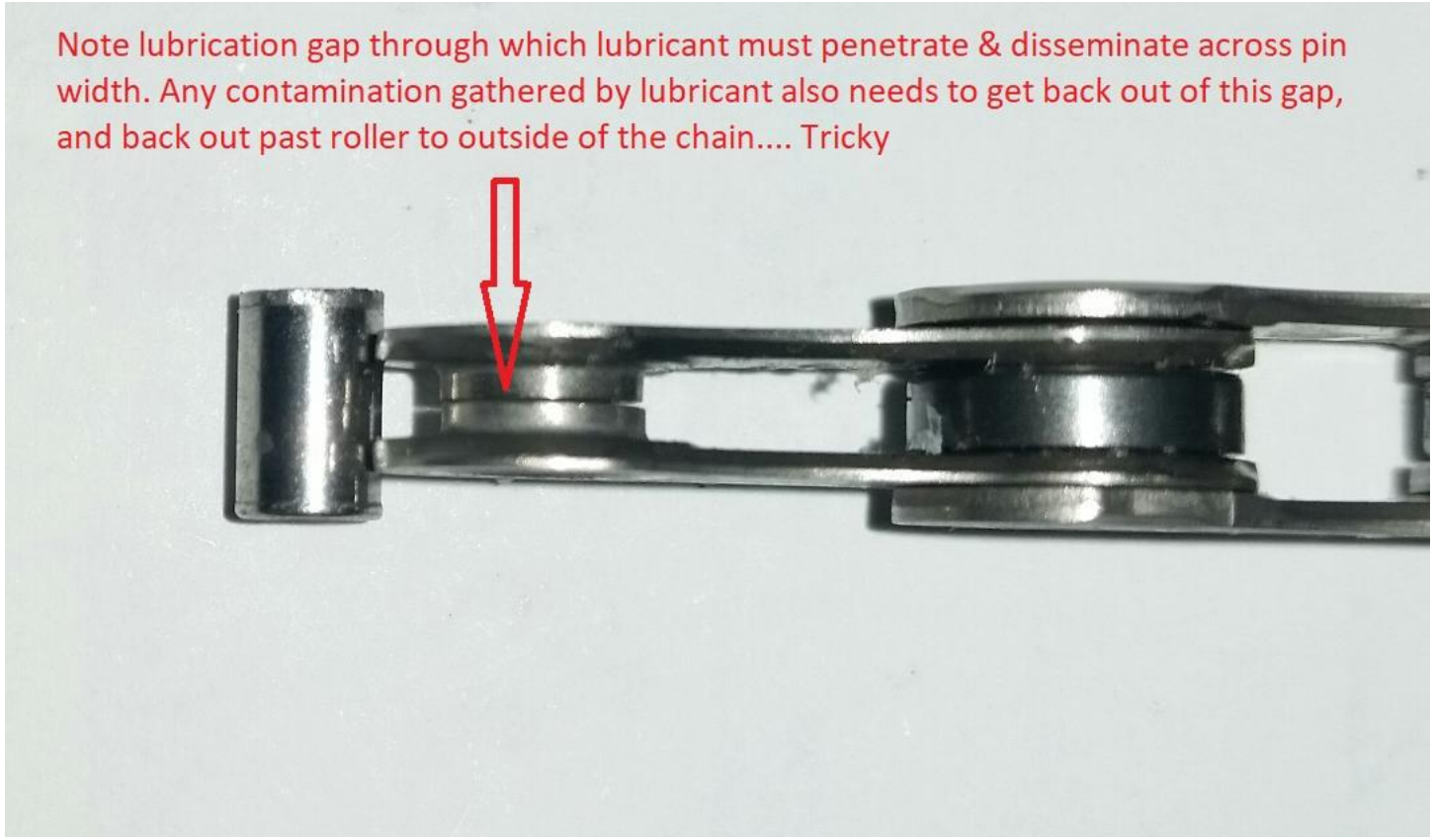
In general lubricants will not have too much trouble penetrating and lubricating between roller and outside of inner plate shoulders or between the inner and outer plates interface, side of rollers and inner plate interface.

The trickiest part is to get lubrication into the other extremely important area under high pressure friction load – the pin and inside of the inner plate shoulders. Access to get into here is very limited now that chains have become super narrow as demonstrated by image below.

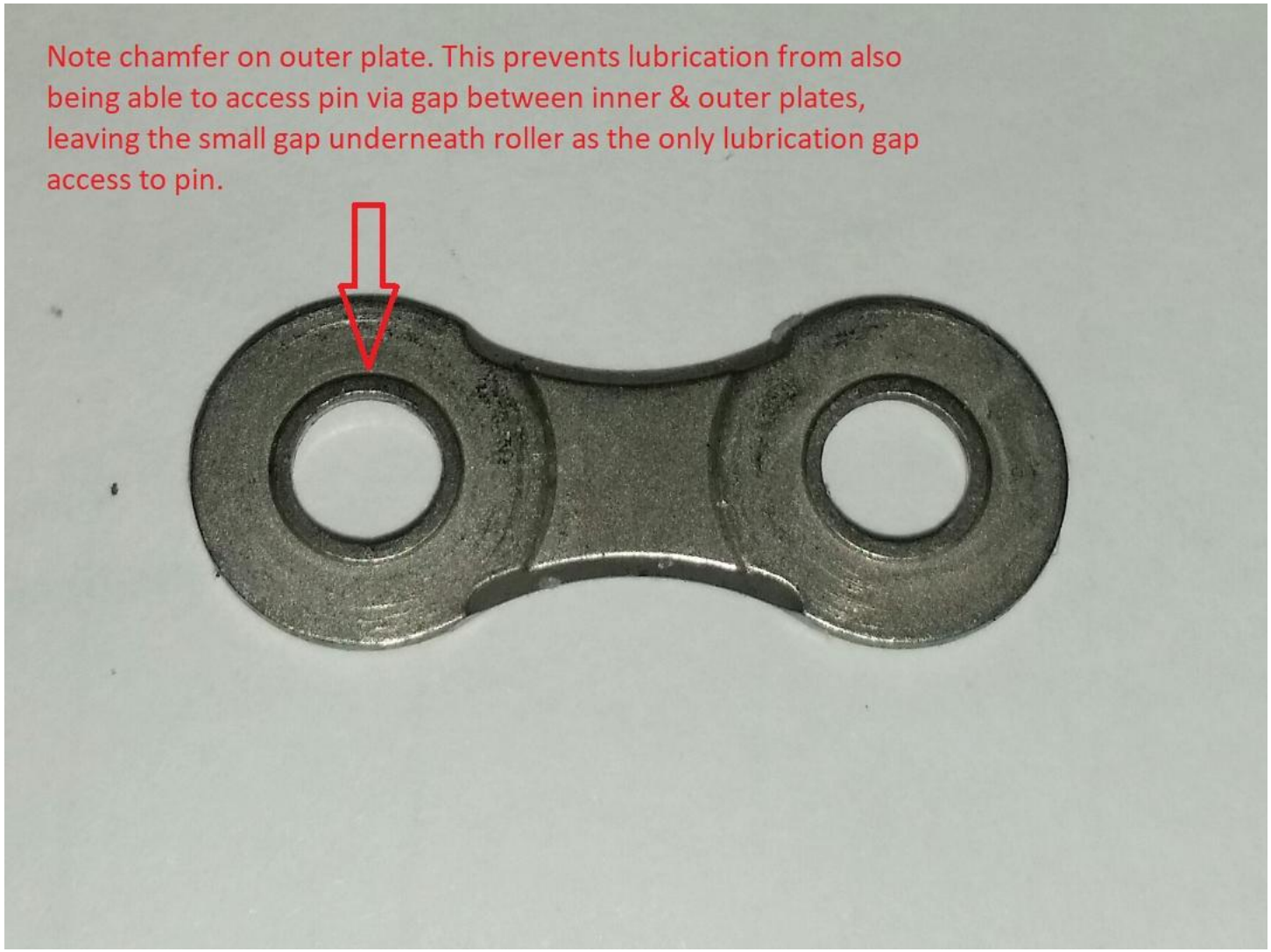
Pin is riveted to outer plates & does not move. Inner plate articulates around pin. When roller contacts teeth roller stops, and so inner plate also articulates inside roller.



Note amount of pin width that requires lubrication - inner plate shoulders articulate around this area under full rider load.



Not all chains are the same here – some chains will have thinner plate shoulders and a larger lubrication gap, some will have wider plate shoulders and a very narrow lubrication gap. Thin lubricants will generally not have too much issue penetrating across pin quite quickly, however more heavily viscous lubricants most definitely can.


Note chamfer on outer plate. This prevents lubrication from also being able to access pin via gap between inner & outer plates, leaving the small gap underneath roller as the only lubrication gap access to pin.

As we discovered with testing for some of the top wax emulsion drip lubes with Squirt and Smoove – the importance of this lubrication gap was demonstrated very well with initial block 1 wear rates vastly higher than expected, and then showing an improvement trend - in Smooves case the improvement as km's went on was very stark indeed – showing only 2% wear from 2000 to 3000km block vs a 19.1% wear rate from 0 to 1000km. This is the opposite of what normally occurs with drip lubes without regular cleaning maintenance whereby as the contamination to lubricant ratio continues to increase – so does wear rates so the block 3 wear for most drip lubes will be much higher than block 1 because more contamination is running in the chain and any chain platings / coatings have been compromised.

However with certain lubes such as viscous wax emulsion lubes – the opposite effect was seen as over time and many re lubes more of the viscous wax was able to penetrate to through this lubrication gap to get to where it is needed build up layers of lubricating wax.

As such one will see in the reviews for Squirt and Smoove a recommended technique for initial lubrications after cleaning chain of factory grease that is **much** more involved than the manufacturer instructions which yielded very high block 1 wear rates due to lack of lubricant penetration through this gap.

This gap is also important to take into account as we move to covering other common manufacturing claims such as forming clean protective membrane on chain to prevent metal on metal / contamination on metal contact, as well as cleaning as it lubes by shifting contamination to the outside of the chain leaving just clean lube inside the chain. Both are a tricky promise to deliver on.

So let us ponder this challenge a little bit. Take your current chain and run your hand or cloth along it. You get a lot of black contaminated lube on your hand / cloth. If you were to completely clean the outside of the chain so that it looked brand new, and then take chain off and put in a container of solvent and give it a shake – the solvent would instantly turn black from the black contaminated lube running inside the chain that is now flushed out.

So when you add fresh lube, this liquid is running through all this black contaminated lube on its way to the inner workings of your chain. And if most manufacturer claims are to be believed – it is apparently doing so without getting contaminated itself, penetrates through this very narrow channel to lubricate the pin without bringing any contamination in with it, shift any contamination that is in there back out of this very narrow channel, and then shifting it to the outside of the chain. And after having achieved those feats it then leaves a nice clean film / membrane of lubricant behind protecting chain metal from contamination abrading against it causing wear / prevent metal on metal contact.

Tall orders. All of them.

The level at which a lubricant does or does not achieve these claims has a very large impact on chain friction and wear once the lubricant leaves the lab and has to contend with contamination. Different lubricants grab and hold contamination at different rates. Different lubes penetrate the lubrication gap to pin without difficulty or with great difficulty. They have differing abilities to shift contamination from inside chain back outside again. They form differing strengths of any protective films / membranes. The combination of all these factors and many more will determine a lubes day to day performance in the real world, how close it remains to it lab performance and for how long, how much maintenance / intervention is required to keep it performing well, and what conditions it can or cannot handle.

So far our proper longevity testing has delivered some important learnings in this area vs short lab testing.

1) Highly viscous lubricants such as wax emulsion lubes (Squirt / Smoove) when applying to a chain stripped clean of factory grease, I would recommend re lubing very frequently early – after every ride – for at least the first 5 rides to ensure sufficient penetration through the very narrow lubrication gap to the pin and for it to begin to build up lubrication on the pin. Try to ensure applying whilst lube is warm and chain warm (i.e indoors vs outdoors in winter). Don't worry about that you will build up tacky stuff on the outside of chain and drive train more quickly - you can clean the outside of the drivetrain as you need. After this initial lube rate you should then move to normal manufacturer recommended re lube rate – just keep ensuring lube and chain warm for application and thoroughly work in with lots of back pedalling in small cogs whilst wet after applying.

(**If I was preparing a chain for a big event like a 12 or 24hr mtb race or long gran fondo like 3 peaks – I would follow the detailed prep instructions as outlined in detail reviews for those lubes. One lube in particular has demonstrated it effectively "Layers", so allowing each application to thoroughly dry after taking pains to work into chain whilst still wet, and repeating to add another "layer" – has shown to be effective with Smoove – but that is the only lube seen to date where this is the case).*

2) For normal / light viscosity lubes – the concern is not about penetration through this gap – but more so regarding how much abrasive contamination it brings in with it on its way through, and how does it get contamination back out through this gap and leave behind clean film / membrane only? So when prepping a chain here it is simply ensuring a proper clean first, then thorough lube whilst articulating chain around drive train, and thoroughly wiping excess. Repeatedly adding more and more lube - as recommended to ensure penetration with highly viscous lubricants - is not recommended here. Penetration is not a concern and excess lube is simply going to gather more contamination. Properly clean, thoroughly lube, wipe excess , let dry if specified – prep done.

About Chain Break in!

There will be a surprising amount of metal particles released when you first ride a chain – left over from the manufacturing process. The factory grease is quite good at absorbing these metal particles, and also forming an initial level of smoothing / polishing the metal surfaces. There is a nice little butter zone here to set a chain up well for its future performance, a bit like a proper break in for a new engine.

Too often cyclists buy a new chain, ride the factory grease until its getting dry, then start adding drip lube. Aside from the fact that the drip lube will be highly tainted by the factory grease and unlikely to be able to perform as designed (bond to metal surface, form lubricating protective film / membrane etc), but also without proper clean post a couple of initial runs – you are going to be leaving a lot of metal particles running in your lubricant. These particles are – like your chain – made from hardened steel.

So in the same way you wouldn't tend to sprinkle hardened steel particles on you chain for fear of greatly increasing friction and wear, one should also look to remove hardened steel particles after an initial 1 to 2 hours of riding with factory grease.

Friction Facts have tested that even a rudimentary break in such as the above will reduce chain friction by around 0.5w, and this will carry forward for the chains performance once cleaned and lubed with your lube of choice. You will find that all race prepped chains have had an initial break in with factory grease prior to ultrasonic cleaning (if a company is making race chains without an initial break in, they are short cutting a very important step.

You can see from the images below the amount of metal that initially comes out, and so left in after an initial break in is likely to start causing premature wear and damage – especially to the special plating and coatings your chain main have depending on the level of quality of your chain.

- Note for waxing customers – if purchased a pre clean and waxed chain then a nice amount comes out from the many rounds of ultrasonic cleaning, and the remained will come out over time as you re-wax. This does mean it is going into your wax, but you will still have vastly less metal particles running in your chain vs those adding drip lube on to factory grease.
- There is now an option to purchase chains that have been broken in , ultrasonic cleaned and waxed, as mid price option between a clean and wax and a fully optimised race chain.
- However if you want to save your $, you now know what to do with your new chain at home. Ride for 1-2 hours with factory grease in clean conditions – fully solvent clean with agitated solvent baths, always finish with methylated spirits to ensure no film left from degreaser or similar so that new lube has direct access to chain metal, and away you go.

About having a dedicated race / A chain

So as discussed - your chain is a very consumable item. Sooner or later you are always going to need another chain, and for those that race or do sportif's / gran fondo's and so tend to clock up some training miles, needing a new chain is never too far away – especially if replacing at recommended 0.5 wear mark.

It doesn't cost any more to simply pre-buy your next chain and have a dedicated race chain. This chain you break in with around 100km of riding with factory lube, remove and fully solvent clean, lube as per instructions with your chosen race lube, and keep it wrapped in cloth ready for next race. Properly clean and re-lube after each event to keep it mint. Most especially so if using drip lubes - this will give you some of the cheapest and easiest watts savings you can get. Versus racing on the same chain you use in training that will be contaminated, compromised coatings / platings, some level of wear – you can expect to save at least around 3w @ 250w load, possibly quite a lot more, and with this figure nearly doubling by 500w, nearly triple at 750w (power climbs, attacks etc) as chain friction increases at an almost linear rate to rider load.

When your training chain reaches 0.5 wear, your race chain moves across to become your new training chain, get new chain to become dedicated race chain – break in, clean and lube with your chosen race lube. This method is simply one of the smartest, easiest and cheapest ways to save a bunch more watts than you will with very expensive bearing upgrades – and it will save you money on drive train parts by having them last a lot longer. Double free watts!

There are also numerous options to buy a pre prepped racing chain to skip the above hoohaa, and then all you need to do is the keeping it mint part.

**Note - New chains will decrease in friction by around 0.5 to 1w after being "Broken in". Break in your new race chain by riding for around 100km in clean conditions and then properly clean – ensuring flush out ALL the contamination you can. If it is not properly cleaned – friction losses from contamination will undo the friction gains from break in*.

Ok – onto manufacturers claims!

Forms a protective film / membrane

This is the big one. A lubricants ability or lack thereof to form a film / membrane to protect the chain metal from either metal to metal contact under rider load, or abrasive contact from contamination on chain metal under load - will have a huge impact on chain lifespan and real world friction performance. This is a big part of what can separate those with a good lab performance but poor performance outside of clean chain clean lab testing and those that remain close to lab test results for an impressive period of time.

Almost all lubricants claim to form a high strength film / membrane that protects chain from metal to metal contact & contamination to metal contact – both of which cause high friction wear to a chains hardened steel parts. And there is huge variance in the industry regarding which lubricants do this well as per claims and which do not.

The challenge of achieving this well with a drip lube is substantial. Initially – assuming one has properly cleaned chain and applied lube as per instructions – it is likely that if a manufacturer is claiming this property for their lubricant – it is doing so. But how well…

The variances come into play with;

A) How strong is this protective film / membrane – can it prevent metal to metal contact / contamination to metal contact under high power rider load?
B) How long can this protective film / membrane last against the abrasive assault from contamination?
C) Part B may be determined by how much and how quickly the lubricant gathers contamination, as this will determine the level of abrasive assault being mounted against the film / membrane.

There can tend to be two stereotypical scenario's;

1) A light bodied drip lube which may go semi dry and have a lower amount of contamination gathered to abrade against film / membrane. However the film / membrane formed may not be strong enough to prevent metal to metal contact under rider load, and it may be worn through quite quickly even from the relatively small amount of abrasive contamination gathered.

2) Or it may be a heavier / wet lube that may form a stronger film / membrane – however wetter lubes also tend to gather more contamination more quickly. A stronger film / membrane will resist metal to metal or contamination on metal contact at higher loads, however if it is under assault from a veritable battalion of gathered contamination – it may still be abraded away in short order.

The best possible scenario is a lubricant that has a very strong layer of protection against metal to metal & contamination to metal contact under load, and that also gathers a very low amount of contamination very slowly. Unsurprisingly immersive waxing is extremely hard to beat here – every surface of the chain metal is protected with a completely solid layer of lubricant vs the very thin film / membrane from a liquid. And being completely dry and solid it gathers extremely little contamination – most literally just bounces off. Whereas with the exception of the Ceramic Speed UFO drip lubes, other "dry" lubes do not go truly dry – either less wet, or very tacky. The abrasive assault against the wax layer is typically very low compared to what the liquid film / membranes need to contend with.

The other extremely important aspect to consider is what is happening when you are re-applying your drip lube. Few riders are going to fully clean their chain after every ride, or even perform frequent proper maintenance with a full flush clean every 1000 to 1500km.

So the drip lube is added to a chain full of black contaminated lube, upon which the lubricant needs to pass through all this without becoming contaminated itself and form a new clean protective membrane between the contamination and the chain metal. Honestly that is some feat. The fact that the majority of chains on drip lubes will hit 0.5 wear mark within 3000 to 6000km speaks to the general level of success here I think – the hardened steel parts of your chain are still being abraded through – if a membrane was preventing metal to metal contact or abrasive particles contacting metal and the links were articulating just on a nice clean membrane – the links would not wear.

At the time of writing – I find this claim to be a stretch for most lubricants. I think many form a decent film / membrane when applied to a clean chain and that this membrane will reduce friction and wear for a while. However just adding more lube on and expecting a nice new clean film to form despite chain being contaminated takes a bit of faith, and I expect any new film / membrane to hold up for lesser and lesser time as contamination assault against it continues to build.

This is demonstrated well in our testing by much higher wear rates in subsequent clean blocks during the test vs the lubricants clean block 1 wear rate (in most cases – but not all ☺). The usual continual acceleration of wear is an indication re how well this claim is being executed.

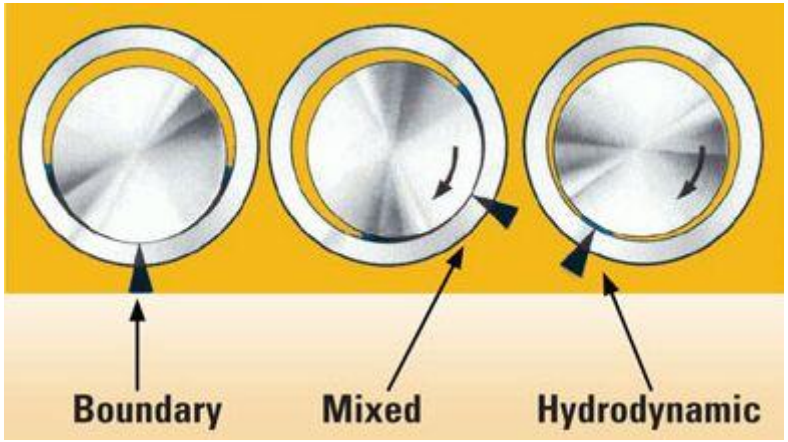
So – in summary – almost all lubes will claim to do the above – but in practice how well they actually achieve this aspect will have a huge bearing on their real world friction and wear performance – and the level to which the lubricant performs here is be uncovered in our longevity testing, and not usually revealed too well in lab testing.

The below is from Bike Mechanic website (makers of bike milk / bike mix / bike syrup) and may help explain what we are talking about re lubricant preventing metal on metal contact. Many thanks to Owen for sharing some great extra knowledge that assisted me in solving the mysterious initial wear rates for Squirt / Smoove – very few people have Owens level of knowledge on chains and lubricants!

MECHANICS OF CHAIN LUBRICATION & EXTREME PRESSURE ADDITIVES

The extreme pressure additives in BIKE SYRUP are designed to coat and bond to the metal surface. This prevents metal-metal contact and reduces noise. It is the fundamental reason the chain runs so quietly.

Lubricant mode of action can be simplified into 2 types: boundary and hydrodynamic. Hydrodynamic lubrication requires a film of liquid to remain in between the two surfaces. Under high pressure loads such as those experienced in between a chain pin and the bushing the liquid lubricant required for hydrodynamic lubrication is squeezed out of the space between the two surfaces and boundary lubrication is required for effective protection.



The best boundary lubricants are long chain molecules with an active end group. The active end group attaches itself to the metal surface and gradually builds up a surface layer. The long chains form a layer of lubricant which separates the metal surfaces and there is no direct contact of the sliding parts. This situation is required for many extreme pressure applications to prevent severe wear or high coefficients of friction and seizure

Drip lube “Cleans as it Lubes” claims.

This is the next big one. Again just about all lubricants claim to do this - and there are various methods via which lubricants claim they achieve this feat.

Firstly let us look at the manufacturer claim for one of the lubes tested so far – Rock n roll gold;

“The formulation goes deep down into the chain and traps any dirt. Then, with the energy of the chain freewheeling backwards, the dirt and grit floats to the surface so you can wipe it all off, leaving a new and clean application of lube inside the chain, where it’s needed. The lube down inside the chain creates a protective membrane to seal out dirt and moisture from the moving parts of the chain. As well as holding in place the best lube on the planet, for longer chain life, super smooth shifting and pedalling”

And yet during the test, the wear rate in block 3 which had no added contamination was over double the wear rate for block 1 which started on a clean chain. When the chain was properly cleaned after main test for the single application longevity test, the wear rate for the first 250km was reset be extremely similar again to the wear rate recorded in clean Block 1. In short – properly cleaning the chain removed a heck of a lot of contamination that the re lubing didn’t. Rock n Gold did perform some level of cleaning as the wear rate reduced by nearly a third on block 2 wear rate which had added contamination – so their claims are not all hyperbole – but it is up to you as the consumer to decide if “less dirty” can be classed as “clean”, and if the level of cleanliness achieved matched your expectations after having read what the manufacturer has advised it would do.

So drizzling on a lot of new lube and wiping away excess may perform a level of cleaning. But it may be quite small.

When I properly clean a customer’s chain it takes around 10 x 200ml agitated solvent baths to flush chain clean. The first bath goes instantly black. The second bath goes instantly black. And again, and again. After about 1 litre it is now starting to turn grey, then lighter grey, until finally around 2 litres later the mineral turps comes out similarly clean vs how it went in. The amount of particulate contamination captured when I pour the turps through paper towel as I go is huge. You can obviously easily test this yourself with your current chain at home! So – just how much contamination can really be flushed out with about 10ml of a lubricant across 108 links is worth pondering. I find these claims

akin to the following analogy - Think of a sink full of dirty water from washing a pile of greasy dirty dishes. Imagine turning the tap on for 1 second whilst simultaneously pulling the plug for 1 second. Is the water in your sink now clean?

(Solvent clean of Rock n Roll gold after 3540km. 2 litres of mineral turps before it was coming out similarly clear to when it went in. So, was RNR gold cleaning as it lubed? You can see what is running inside the chain along with any new lubricant that is added, and you can imagine the task for the lubricant to form a new clean film between contamination in the chain and the chain metal. And if it does achieve that feat, how long can said film last against such an abrasive assault? It is also worth noting Rock n Roll gold is one of the better performing lubes, what is happening with lubes that achieve claims to a lesser degree?

Use of sandy loam as our contamination also really highlighted what happens when more lube is applied / chain wiped during re lube. Sandy loam will crunch away very audibly when it penetrates inside the chain. After running for a while, this crunching / grinding sound stops as now the worst of it has now either been ground to dust or it has been worked to the outside of the chain. However when lubricant is added again at next re-lube interval – the crunching and grinding sound immediately recommences. This proved a long held concern - drip lubes are applied on the outside and work their way in, as such they risk bringing contamination sitting on the outside of the chain back in with it. If one was to carefully apply a small drop directly onto roller – this seems to minimise this occurring, however lubes that want you to drizzle on whilst back pedalling and then wipe chain clean – there is a big pick up in crunching going on inside chain after each re-lube. So during re lubes – yes fresh lube is being added, and yes to a very very small degree the total level of contamination in the chain may be diluted. But things may also get worse for a while before they get better where it really counts – inside the chain. The outside of your chain looking cleaner counts for very little. It is hard to imagine a liquid applied to a contaminated chain won't itself become immediately contaminated on its way through penetrating from outside in. At the time of writing I have not seen a drip lube that is "cleaning as it lubes" to any feasible definition of "clean". It may make chain look clean on the outside for a while, but pop chain off and give it some solvent baths and you will see what is running as lubricant inside the chain where all the action is happening.

- Lubes that contain solvents – these may help in a couple of ways. If you haven't cleaned your chains factory grease / oil (which tend to grab a lot of contamination), these solvents can help remove factory grease / mineral oils so that more and more you are left with the lubrication you have purchased being what is lubricating your chain. But these solvents are not acid – they are not going to dissolve dust and grit. These lubes can gather less contamination overall and at a slower rate than a mineral oil / factory grease - but the solvents themselves won't "clean" your chain of dust and grit.

- Note - for the vast majority of lubes - removing chain and properly cleaning will deliver a significant reduction in friction and wear, and this is highly recommended to do prior to races / events if you use the same chain for racing as you do in training. However – there are some lubes which focus on building up a lubricating layer inside chain and so do not wish the user to fully clean chain as that will remove lubricating layers built up. The longevity testing has proven this to be correct for these lubes, however I find it would be a big call to say that a very clean chain with a fast lubricant is not going to outperform a chain that has simply been re lubed for "X" hundreds or thousands of km's and will have gathered an amount of contamination. So for those running lubes that require time and layers to build up, I would still highly recommend fully cleaning as contamination always ruins a low friction party, and then follow my more

involved recommendation re building up lubrication layers in a way that keeps contamination gathered to an absolute minimum. The goal always for a race chain is a perfectly clean, perfectly lubricated chain.

- In testing an issue has been discovered with some the drip lubes that go quite dry or become like a “plastic” state. These lubes can resist gathering contamination well during normal dry riding and also in dry off road conditions. However during wet ride conditions, the water provides an easy vector into the chain, however the lube may have no mechanism to shift the contamination back out again. Some dry / wax lubes “shed” – and so use up some of themselves in an attempt to shift contamination back outside the chain – which can provide a small level of cleaning at a cost of longevity for the lube application, however some do not really shed and have simply no way of getting contamination back out. These lubes typically have a frugal application process, so there is no flushing out of contamination either. Lubes of this type can be a bit of a catch 22 as whilst they can be excellent at resisting contamination in the dry, and perform at a comparative high level during a wet ride or event, one can be left with task of fully cleaning chain after wet rides or the contamination hosed in by front wheel is simply going to stay there resulting in high friction and wear for subsequent rides post any wet ride. Compounding this is that some of these lubes can also be quite viscous and take time to properly penetrate through lubrication gap to pin again after chain has been properly cleaned – again leading to either high friction and wear rates for a while post clean, or if wish to avoid that quite a rigorous process post clean to negate this.

DRY LUBES

Most manufacturers know that many customers covet a clean drivetrain with a minimum of hassle & cleaning maintenance. When it comes to dry drip lubes they are attempting to act like a solid lubricant. They are a lubricant (often a type of wax or a blend of multiple types of wax) suspended in a carrier fluid which then evaporates to varying degrees, leaving behind said lubricant. In reality this is not always executed well – very few dry lubes go actually dry – they go sort of less wet and become tacky, and some leave behind very little actual lubrication. As a grouping dry lubes often friction test poorly and can have a frighteningly short lubrication window.

(Lubricant vs carrier fluid. Imagine if you will the amount of actual lubrication left behind each re lube vs other lubricants where the majority of what is being applied is the actual lubricant. You could drizzle half the bottle on, and across 108 links the amount of lubrication per link will still be not much! The above lube tests terribly in every test it has been subjected too)

There are a couple of good exceptions to this rule though where this approach is done very well, with a large of amount of lubrication left behind after carrier fluid evaporates leading to a slower and lower rate of contamination gathering. The best have tested very well for efficiency and longevity, however as a nice paradox these most certainly do not remain clean. In fact one of them built up so much gunk during test I was no longer able to back pedal the drivetrain when reapplying lubricant – so cleaning maintenance for these lubes is high if you want a clean looking drivetrain. Done poorly – and these are often the cleanest looking ones - there can be so little lubrication left behind that quite quickly after each re lube there is simply so much metal / metal and grit / metal contact they deliver very poor friction levels and very high wear rates. And you certainly would not want to be out on a wet ride or you have about 30 minutes of lubrication, after that the water being sprayed onto your chain will be doing the majority of the lubrication! So, some may look cleaner on the outside vs a wet lube, but in a lot of cases the beauty is only skin deep – what is happening inside where it counts can be not great.

So in short - dry lubes done well can be very good, done poorly and they can be pretty shocking.

About “metal conditioning”

There are some lubes (of which we will get around to testing hopefully) that make some other interesting claims re why their lubrication is the best. One of them is that if you were to look at the metal under high magnification you would see that the metal is not perfectly smooth but the surface is covered with fissures, and that their lube fills these fissures to leave a completely smooth surface. I have no grounds to believe their lubes are not actually doing this, or trying to do this, however I speculate that contamination is merrily scratching in new micro fissures every time the link articulates. Which is a lot. I imagine it as something akin to you have a team of people shovelling to fill in trenches, and a team of people right next to them digging trenches. To date I have not seen a lube with this claim test well for outright efficiency, nor seen obviously better longevity rates. One will note this is believed to be different for claims re wax (paraffin, Molten Speed Wax, Ceramic Speed UFO and UFO drip lube) where it has been tested and proven that wax increases in efficiency and decreases in friction whilst being ridden in part due to wax surfaces becoming highly polished so one has two super slippery solid lubrication layers sliding against each other – contamination free. The two conflicting teams of trench fillers / diggers is largely negated as the vast majority of contamination simply bounces straight off the chain, whereas with a liquid lube contamination is immediately absorbed by the liquid and is now able to abrade against whatever surface it is in contact with every articulation.

Another claim under this banner is that they “condition” the actual chain metal by polishing it to a smooth shiny surface. There is a high profile lubricant in particular that claims this, and it did not efficiency test well at all. It may well be polishing away the metal, but that would ***have to take friction to do so***. You can’t polish anything with a frictionless substance. So the lubricant basically claims it is performing the duties akin to a very fine emery cloth, and even if it is super fine – it still MUST take friction to polish metal. Add a small amount of friction across multiple surface interfaces articulating 20,000 times a minute – and it is not surprising it friction tested right near the bottom of 55 lubes tested. (Again comparing to wax – wax is soft and becomes polished quickly and easily – but the fact friction typically drops by around 0.5w from when it starts the process to when it quickly finishes the process – it is still taking some friction to get from not polished to polished.

Polishing hardened steel – that is also often plated with specific hardened coatings like chromium carbide, titanium nitride, nickel, or a zinc alloy etc - would take somewhat more polishing than wax.

And yet again on this – surely in short order contamination will be scuffing and scratching the surface ceaselessly putting micro scratches back in. Attaining their smooth polished surface would be quite the ongoing tussle.

As yet I am not convinced “metal conditioning” is the best approach re achieving a high performance chain lubricant and I would have concerns paying big $ for a lube in this category.

About Factory Lube

A common mistake many people tend to make is to just ride factory lube and then start adding their lube of choice on top of that. Factory lube may feel good and smooth, but that’s simply because the chain has been immersively lubricated, is brand new, and so vs the old chain worn out full of grit chain you just took off, it is going to feel good.

But factory lubricants are not really designed to compete with the best chain lubes. Testing shows that in general factory lube tends to range from mediocre performance to frankly terrible. One can 2 to 5w just by cleaning off factory lube and replacing with even a mid pack lube.

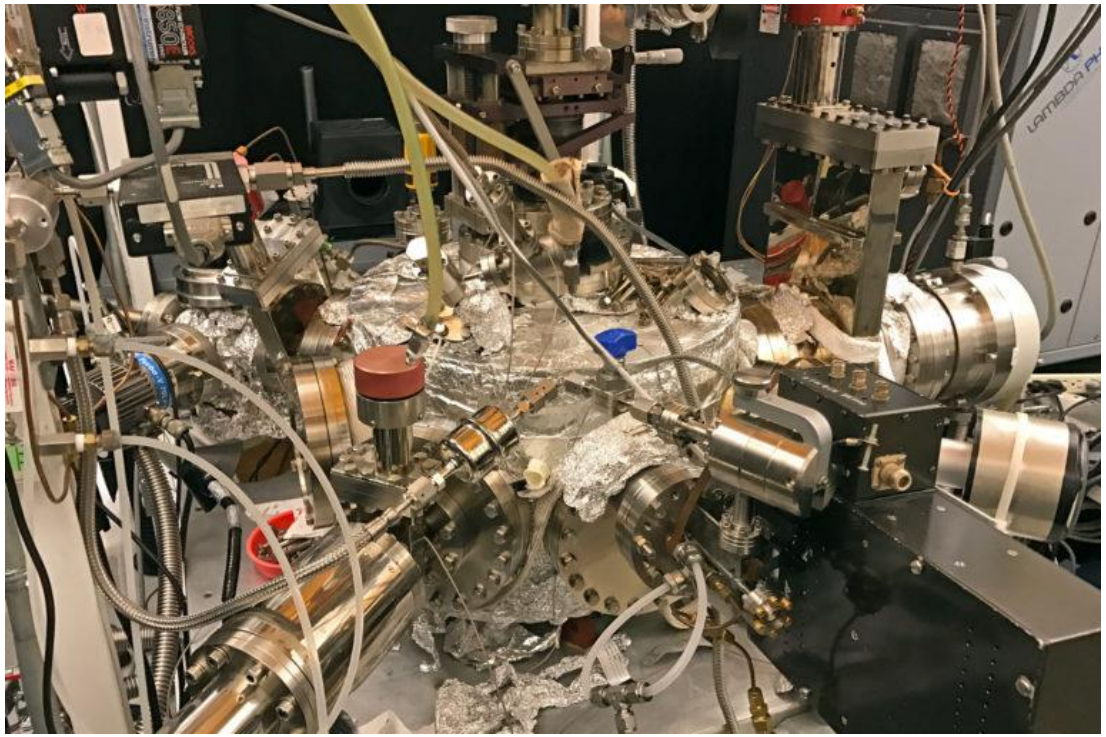
Factory lubes also don’t tend to focus too strongly on contamination resistance – most gather a lot very quickly.

So riding your new chain with factory lube and then adding your selected drip lube on top – likely a completely different type of lube which may not mix well – can totally undermine that lubes ability to perform as per manufacturers claims. You will find a lot of manufacturers do state to apply their lube to a clean chain – but most cyclists either do not clean off factory lube, or perform a very inadequate clean such as wiping the outside / spraying on some degreaser and wiping etc – it takes a lot more than that to properly clean a chain.

No matter what is your chosen lubricant – always properly clean off factory lube, and give your lube of choice a chance.

****However – it is good to ride factory lube to “break in” new chain for 50 to 100km in clean conditions – and then clean factory lube off properly – especially recommend this for prepping race chains.***

Latest Tech Lubes



(apparently the making of cyclestar nano tech lube…)

Since FF lube testing there have been a number of new high tech lubes released, and some exciting new ones are on the way. - Some of the new lubes from big respected companies will be claiming some pretty big performance, and I've seen a bit of snippet into some of them that have extremely good friction performance - on a clean chain. But the trick as always is how does a drip lube deal with contamination. Will we find one that stays close to waxing? Or match waxing? Or beat waxing?

A couple of the extreme high end drip lubes – Muc Off Nano and the just released Ceramic Speed UFO drip lube – are extremely fast drip lubes – both have actual proper friction testing equipment so there is actual testing of their performance. The key as always is how do they handle contamination. CS UFO sets to a proper solid so this bodes extremely well, Muc Off I am trying to find out a bit more but appear to be hinging on a very strong protective membrane that delivers extreme high pressure friction performance and be able to protect chain metal for a long time. They claim their lubricant withstands harsher conditions for much longer than any wax based lube or solid wax – so I am excited to see how this tests – as usual actual detail information on testing protocols is not available.

There is another one – Cyclestar Gold – with some rather big claims on tech and performance but with NO data to back up, and if one writes to them (and Im not the only one who has) to ask questions re data and performance – they simply do not answer back. Funnily enough they include a letter with the purchase in case you are interested in being a retailer – so they are happy to talk to you then, but look for some data to back up the big claims and your enquiry is simply consigned to the waste bin. An interesting approach. Here is high tech company boasting about the amazing tech used to create the best lube ever - you would think they would want to talk your ear off about how they ascertained these results to back their claims. I find it odd in the extreme they flat out ignore any correspondence re testing and performance. So that will be interesting to test but for the price and claims their approach to questions is not confidence building. *(Just for fun It is also worth noting all their laser crafted low friction tech is suspended in mineral oil. High grade mineral oil tests at 6w efficiency @ 250w, Cyclestar tests at 7w. So at a quick glance one could be forgiven for thinking a lot of tech has gone into finding a way to make mineral oil slower. And mineral oil is not great on the gathering and dealing with contamination front – so it is hard to see how all the super tech suspended in the mineral oil won't also be negatively affected by contamination. At $60 for 30ml delivered to my door, I really wish they would answer my questions.*

Careful correlations…

The longevity testing performed here hinges on the correlation between abrasive wear of the pins / plate shoulders and rollers. If a lube was frictionless and remained frictionless, these parts would not wear, and chains would not "stretch" and last forever. There are a number of components of friction in a chain (to properly understand you really need to read full test brief, or at least Friction Facts White Paper – this is just to cover a little for those who haven't / won't). There is high pressure friction between pins / plate shoulders / rollers under direct rider load. There is same but low pressure friction as links snake through derailleur pulleys. There is viscous friction as the links articulate, and there is static friction (stiction) as links constantly need to start moving from a static position. And this is happening in around 40,000 friction points per minute. There is so much mechanical work being done by your chain that this is why chains and lubes are where it is at for the biggest and easiest watts savings vs bearings that spin lazily in a sealed environment.

In outright efficiency tests on a clean chain in a lab – the percentage of the overall friction equation that low pressure friction, viscous friction and static friction play will likely be a much greater percentage than on a contaminated chain. On a contaminated chain where the high pressure friction movements are being performed with a lubricant that is now abrasive to some degree – this part of the friction equation will likely grow and grow over "X" km to overshadow the other aspects re overall efficiency being delivered. And it is the high pressure abrasive friction aspect that is responsible for the vast majority of chain wear as it is this that wears the pins and plate shoulders thinner and roller bores bigger.

Hence a lubricant simply cannot be a high efficiency lubricant out in the real world if it is eating through hardened steel parts at a prodigious rate.

Out in the real world different lubricants gather contamination at vastly different rates – are they solid? Contain mineral oil? Carrier fluid with solvent that dries to some degree?

How do they handle the contamination they gather? To what degree do they actually "clean" as they lube, or form protective films / membranes?

So a lubricant that tests well in a lab can start acting like a bastard file in short order once ridden outside. Or one that tests quite mediocre may remain similar to that level for an impressive period slowly changing to something more akin to a mild emery cloth. The mild emery cloth is going to be a lower friction lube with lower chain wear rate than the bastard file and be a better choice of lube unless your race is a short race being held in a laboratory.

However – it is possible that a lubricant can exhibit excellent longevity results but still be a relatively poor efficiency lubricant. It may simply perform poorly in viscous and static friction. An analogy would be heavy duty grease in bearings – it may exhibit excellent bearing life, but fast and high efficiency it will not be vs time trial grease. So the worst efficiency lubes on the FF testing – is it simply that high static and viscous friction contributed heavily to this result and is not necessarily a predictor that it will have a poor longevity result? – that will depend on how well it goes re gathering and dealing with contamination, how abrasive it becomes and its high pressure friction performance. *Maybe it will be like a heavy duty grease and deliver an excellent longevity result – but in this case we know from the efficiency testing this does not translate to a fast lube. It is possible it may be a good choice for your commuter bike etc. Or maybe it will return an average longevity result and so overall just have not a lot going for it.

(we say maybe as stereotypically lubes with poor static and viscous friction are a heavier viscosity wetter lubes, and these tend to gather and hold a lot of contamination quickly. They can be great for riding for hours in the rain and muck and chain still be "lubricated", but the lubricant can literally become like sandpaper. There is often a big trade off between outright longevity of a lubricant and how contaminated it does or does not become).*

So what we are looking for are the best lubricants that have high outright efficiency and if used and applied correctly as per manufacturer's instructions deliver impressive wear longevity results and stay very clean. This demonstrates that it does not become notably abrasive and have a big decline in high pressure friction performance - therefore retain great efficiency levels outside the lab.

Where possible we will match longevity results with outright efficiency results if known and freely available. If a lubricant achieves excellent longevity results in our test here however is matched with a fairly medium or poor outright efficiency result – maybe that is good choice of lube for your training bike / commuter but not your race bike / race chain etc.

Where lubes do not have readily available data we will work with manufacturer to see what we can get, and / or try and twist FF arm to test – sometimes they still can't resist ☺

I have asked Friction Fact re testing our chains when they have reached their end of test mark, as that would complete the circle of knowledge – clean chain efficiency, longevity result, end of test contaminated efficiency result. At the moment – the answer is no due to conflict of interest – but I will keep asking, and I will keep all end of test chains in hope of this situation changing in the future.

A bit of a wrap!

- Be wary of "cleans as it lubes" claims – there is huge variability in performance, and a rather loose definition re "clean".
- Be wary of "forms a protective film / membrane" claims. Again – huge variability in performance.
- Be wary of "conditions the metal" claims
- Current knowledge points to minimising the amount of contamination gathered is generally superior vs ways of trying to handle contamination gathered.
- Solid wax or drip lubes that dry to a proper solid coating have an advantage re contamination, as well as viscous friction (solid lubes have no viscous friction). Dry / Semi dry lubes that go tacky MAY perform well, they also may not.
- Be aware however that a poorly executed dry lube will not give these advantages – one is simply left with very little actual lubricant after carrier fluid has evaporated. They can have very short lifespan, high friction and high parts wear rate.
- Liquid lubes increase in contamination from km zero and the ratio of contamination to lubricant usually continues to build and build, although there are exceptions. Real world friction results will typically be much higher than clean chain lab test results – even the longest lab testing tends to only go to around 4 hours. The friction increases from contamination will correlate with increased rate of

chain wear. If a lubricant gathers very little contamination, and / or truly keeps contamination from acting against chain metal, chain wear rate will be low and friction increases vs its lab performance will low.

- Wax emulsion lubes that go semi dry or “plastic” may have excellent dry contamination resistance, however water will provide a medium for contamination to penetrate, and once in, they can have no effective mechanism of getting back out again. They can also take a lot of time and effort to properly prep after cleaning chain to ensure the viscous lube penetrates through to pin through the very small lubrication gap.
- A chains PTFE coating and any platings can be quickly compromised from abrasive friction leading to an increased rate of friction and chain wear.
- Solid lubricants gather contamination at vastly lower rates, and for a good period after each treatment have two solid lubricating surfaces sliding against each other preventing metal to metal and contamination to metal contact. Hence they can remain close to lab friction performance for an impressive period after each treatment and not begin increasing from km zero. In fact most completely solid wax treatments will show a decrease in friction vs lab tests after the wax has been fully broken in. Consequently they can also deliver extreme chain longevity by truly preventing anything actually coming into contact with chain metal. This is dependent on not exceeding the treatments lifespan for the conditions.
- Note however that solid lubricants – once all of the lubricant has been worn off- friction can increase quickly and dramatically. They need to be kept within the treatments lifespan and so may not be suitable for long wet events or enduro’s unless one is able to re-lube during event.
- To retain good performance most – but not all – drip lubes require frequent full solvent cleans to reset contamination levels in the chain or friction performance will continue to degrade. Some can have a frighteningly quick change in performance vs lab results, some will remain in the ball park of lab results for an impressive period – but without periodic proper cleaning a notable increase in friction and wear is usually inevitable.
- Some drip lubes – usually wax emulsion lubes – can perform better over time without cleaning due to building up of wax layers inside chain and low contamination gathering rate in dry conditions.
- These lubes can have an initial high wear rate due to poor initial penetration to pin through lubrication gap.
- These lubes can also retain high friction and wear rates post wet rides due to lack of vector to shift contamination back out, resulting in need to fully clean chain post wet rides to reset contamination – leading one back to initial issue of getting lube penetrating through to pin again.

- Consider the apparent “convenience” of drip lubes vs “inconvenience” of waxing application. Drip lubes are easier to drip on but require a large amount of cleaning time and care to remain remotely near lab performance, and drive train parts wear will range from poor to good – typically 3000 to 6000km to reach 0.5mm for most road cyclists. Waxing takes a few minutes longer to apply at the front end, however the performance is always very close to lab performance for the lifespan of each treatment, and no cleaning maintenance is required of chain and drivetrain which remain exceptionally clean. Each re wax – being fully immersive in hot wax - resets any small amount of contamination gathered and ensures complete lubrication to all surfaces of the chain. It is the only time re lubing properly cleans as lubes, your chain comes out like brand new every re-wax. Drive train parts longevity can reach simply must experience to believe levels. So for those who never ever clean drivetrain, then yes – waxing will add time. For those who try to stay on top of drip lube drivetrain, waxing usually saves a lot of time due to no cleaning of chain and drivetrain required, and it is always near lab test friction performance as long as kept within its treatment longevity limits.

- A dedicated race chain is a very cheap, smart and simple way of saving a stack of watts for events. This chain can be properly prepped and kept in a very low friction condition and with low wear, as opposed to rocking up to races on same chain that is hammered in training. It costs no more to pre buy next chain, and when training chain hits 0.5 wear, race chain becomes training chain, get new chain to prep for racing chain.

Thanks for reading!

PS - We love questions – so if you have any on any fronts – zing them through to info@zerofrictioncycling.com.au

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Summary of tests – full test protocol running sheets available on request.

Best articles to read!!!

http://www.friction-facts.com/media/wysiwyg/Friction_Producing_Mechanisms2.pdf

http://www.velonews.com/2015/12/bikes-and-tech/technical-faq/technical-faq-chain-wear-measurement_390085

http://www.velonews.com/2017/08/bikes-and-tech/ufo-drip-might-be-the-fastest-chain-lube-ever_446861

http://www.velonews.com/2013/04/bikes-and-tech/velolab-revisited-testing-chain-friction-over-time-with-progold_282854

*Note – msw tested at 4.6w on velonews / FF testing. Race chains with break in, ultrasonic cleaning, waxing, break wax in and powdering are something else again. Hence MSW race chains or CS UFO chains will make a lot of sense if you have read everything to this part as well as why we sell wax ☺

https://cyclingtips.com/2016/05/friction-facts-how-lubricants-and-seals-affect-cartridge-bearing-friction/

Test equipment : Ultegra 11spd chain on shimano 105 11-28 cassette, Shimano 53/39 chain rings. Industrial 250w motor geared to 100 cadence, coupled to chain set axle. Tacx Neo smart trainer to control load- goal load per interval 250w +/- 2%.

*Test protocol outline: (*refer full test brief for full details). Test chain is shimano ultegra 11spd. Chain is initially perfectly cleaned with multiple agitated solvent baths, ultrasonic clean and methylated spirits + acetone rinses. All chains are measured for initial manufacturing tolerance across 7 separate sections of chain accurate to 0.01mm. All check measures*

at end of each test block are repeated the same. Simulations are run at as close to 250w +/- 5w resistance window as possible. Each block is 1000km – with both Flat and Hill simulation intervals in every block. Flat simulations are run on large chain ring and alternate through cogs 4, 5, & 6 (21, 19, 17t), hill simulations are run on small chain ring and work through cogs 1, 2 & 3 (28, 25 23t). Intervals on clean blocks are 400km for flat simulation, and 200km for hill simulation. Each interval runs for approximately 10 to 12 hours depending on ratio – and so each 1000km block approx. 30 to 32 hours. Lubrication is applied as per manufacturer instructions, and re-applied either at start of each new intervals as per test protocol (every 400km flat sim, 200km hill sim) – unless according to manufacturer instructions this frequency may be detrimental to performance - in which case re lube intervals will be adjusted and this noted accordingly. During contamination blocks - contamination introduced is sandy loam which is a mix of sand, silt and clay – wet contamination blocks also have water spray. During Dry & Wet contamination blocks, the interval lengths are halved (most cyclists would re lubricate more often if riding in harsher conditions – so every 200km flat and 100km hill simulations. Contamination is introduced mid interval – 100km mark for flat and 50km mark for hill. Extreme contamination block the amount of contamination is doubled, and this is also done twice per interval vs just mid interval. If a lubricant specifies / recommends drying time before riding – this is done – all manufactures instructions are closely followed. Blocks of no contamination are alternated in with blocks of contamination to give lubricants the best chance to prove any "clean as they lube" ability – a common lubricant claim. Contamination is introduced in both dry and wet format – dry the contamination is 5grams of sandy loam released at a controlled rate over the chain whilst running via small nozzle, wet is 500ml of water sprayed at low pressure onto running chain, and 5grams of sandy loam added. During extreme contamination block the amount of contamination (wet and dry) is doubled, and the frequency it is added is doubled. Km's achieved in this test should in no way be interpreted as km's you can expect to achieve in your own riding as the power and contamination you subject your chain and lubricant to will be different, as may be your chain and drive train maintenance – it is expected most should achieve more km's vs this test – the test averages higher watts than most, there are no rolling or descending km's, an overall level on contamination may be higher that what your chain is exposed to. Note this is road simulation and will not be able to be equated to mtb and cx km's as they eat through chains much much faster. The extreme contamination

protocol is more akin to tough off road conditions – however not all lubricants will be test through that protocol if they have not made it that far into the test – if the amount of wear from other blocks has been sufficiently high, it is not going to be a lubricant suited for harsh conditions riding.

**To properly understand testing and results strongly recommend reading Test Protocol Synopsis as a minimum, better yet is to read full test brief and friction facts white paper – you will learn a lot about your most crucial component & its lubrication – it will save you both watts and running cost $. Full Test protocol running sheet for each lubricant tested is also available on request. All docs freely available from lube test section on www.zerofrictioncycling.com.au*