Zero Friction Cycling

ZFC MAIN TEST – Full Test Brief

*Note – there is NO CLEANING of chain during main test. The wear rate performance achieved across the test is all up to the lubricant. Many lubricants claim to "Repel dust, dirt and grime" and to "Clean as they Lubricate" etc. The most difficult challenge all bicycle chain lubricants face is how to resist becoming abrasive whilst operating completely open to all environmental contamination – which especially for some cycling disciplines can be very high (not to mention wet conditions riding, and wet offroad).

So the ZFC test gives a great performance benchmark between lubricants. All lubricants are exposed to the same interval lengths, same test load, same contamination at the same amount and introduced at the same time etc. Whilst no test protocol can mimic any one persons actual cycling (and so we would expect the wear rates seen here for X product to differ – higher or lower – in your cycling), the comparative benchmark is what is valid. For instance if a lubricant tested shows a very high increase in wear once exposed to dry contamination, and another lubricants shows very little increase in wear as it resisted absorbing that contamination – then if you

are cycling offroad for gravel or mtb – you could expect a similar outcome between those two products.

Thus any cleaning maintenance during test would severely impact the ability of the test to assess key performance abilities and marketing claims. It is a difficult test, lubricants that are able to maintain a low wear rate through the full test are thus very impressive in their performance for their actual use case – **on a bicycle chain**. Not a short clean lab test. Not a tribology test. Not ISO standards tests using ball bearings or pin on disk test, or spinning wheel on bearing cylinder brugger / falex test. Or Milspec testing – using Milspec because it sounds more hardcore if it has military in it. It will have performed in its ACTUAL use case, as a bicycle chain lubricant, on bicycle drivetrain – being tested across thousands of kilometers, and being exposed to both dry and wet contamination.

So the comparative use of the ZFC test results to the real world is MUCH greater than any other test known in this space, at this time. If a lubricant performs poorly in the ZFC test, regardless of the results of other non relateable tests, then you should hold a lot of concern with regards to how it will perform in the real world on your bicycle chain, and the rapid wear and damage to chain, cassette and chainrings that may follow.

Rapid / notable wear of metal parts inside chain on on your drivetrain – that is not low friction running. And it is much more costly.

Main Test Brief document below – PLEASE take 5 mins to read just the test protocol below before sending an enquiry such as “Is the chain cleaned during the test? Is the chain re lubed during the test? How often is it lubed etc etc. All is stepped out nice and clearly in the test brief, and the main test will all make sense why it is the most robust test in this space at this time, and why it is heavily used by Manufacturers to prove how their lubricant stacks up on the league table.

You will soon see for yourself why the ZFC main test is so valuable – to cyclists of all demographics and to the lubricant manufacturers who have developed genuinely great products for this very specific use case.

To the test, enjoy!

Block 1 – 1000km. No contamination. Assess any initial penetration issues present + clean road conditions performance.

0km – Lubricate strip cleaned chain as per mfg instructions, included any needed set time before test commence. Chain is precisely check measure for net start measure.

Interval 1 – 400km – Big ring, Cog 4 – 12hrs 15 mins.

Re lube as per mfg instructions inc. any needed set time.

Interval 2 – 200km – Small ring, Cog 1 – 11hrs 06mins

Re lube as per mfg instructions inc. any needed set time.

Interval 3 – 400km – Big ring, Cog 5 – 11hrs 12 mins.

Check Measure for Block 1 wear amount vs start measure.

Block 2 – 1000km – Dry Contamination test. Ability to resist becoming abrasive when exposed to dry contamination. Ability to "clean as it lubricates" and "repel dust, dirt and grime, and "forms a high strength film preventing contamination from metal surface contact and wear" – and other marketing claims of this nature. A high wear rate in this block demonstrates the lubricant readily absorbs contamination and become abrasive. A low wear rate demonstrates an excellent ability for the lubricant to resist absorbing abrasive contamination and would be a top choice for gravel / mtb / cx etc.

re lube interval is doubled in contamination blocks as it is expected people will re lube more often when riding in harsher conditions vs dry road conditions.

Re lube as per mfg instructions inc. any needed set time.

Interval 4 – 50km – small ring, Cog 2 – 2hrs 30 mins.

ADD 5 Grams fine grade sandy loam.

Interval 5 – 50km – small ring, cog 2 – 2hrs 30 mins

Re lube as per mfg instructions inc. any needed set time.

Interval 6 – 100km – Big ring, cog 6 – 2hrs 30mins

ADD 5 Grams fine grade sandy loam.

Interval 7 – 100km – Big ring, cog 6 – 2hrs 30mins

Re lube as per mfg instructions inc. any needed set time.

Interval 8 – 50km – Small ring, cog 3 – 2hrs 18mins

ADD 5 Grams fine grade sandy loam.

Interval 9 – 50km – Small ring, cog 3 – 2hrs 18mins

Re lube as per mfg instructions inc. any needed set time.

Interval 10 – 100km – Big ring, cog 4 – 3hrs 04 mins

ADD 5 Grams fine grade sandy loam.

Interval 11 – 100km – Big ring, cog 4 – 3hrs 04 mins

Re lube as per mfg instructions inc. any needed set time.

Interval 12 – 50km – Small ring, cog 1 – 2hrs 48mins

ADD 5 Grams fine grade sandy loam.

Interval 13 – 50km – Small ring, cog 1 – 2hrs 48mins

Re lube as per mfg instructions inc. any needed set time.

Interval 14 – 100km – Big ring, Cog 5 – 2hrs 48 mins

ADD 5 Grams fine grade sandy loam.

Interval 15 – 100km – Big ring, Cog 5 – 2hrs 48 mins

Re lube as per mfg instructions inc. any needed set time

Interval 16 – 50km – Small ring, cog 2 – 2hrs 30mins

ADD 5 Grams fine grade sandy loam.

Interval 17 – 50km – Small ring, cog 2 – 2hrs 30mins

****Check Measure for Block 2 wear amount vs end of Block 1 measure for its wear rate through Block 2****

Block 3 – 1000km – No contamination

This can give a clearer indication re lubricants ability to self clean / flush clean. During block 2 as it is constantly hit with more contamination, this ability may not show up. If there is a notable wear rate drop shown for Block 3 vs Block 2 – we know that although if a lubricant did show a propensity to absorb contamination and become abrasive, it does do an admirable job of self cleaning when that exposure stops. That is very handy to know vs marketing claims, and handy to know if you only occasionally ride in a higher contamination environment (ie sometimes do some gravel but not all the time).

Re lube as per mfg instructions inc. any needed set time

Interval 18 – 400km – Big ring, cog 6 – 10hrs

Re lube as per mfg instructions inc. any needed set time

Interval 19 – 200km – Small ring, cog 3 – 9hrs 12 mins

Re lube as per mfg instructions inc. any needed set time

Interval 20 – 400km – Big ring, cog 4 – 12hrs 15mins

****Check Measure for Block 3 wear amount vs end of Block 2 measure for its wear rate through Block 3****

Block 4 – 1000km – Wet contamination

Here is where things get tough. This block puts many lubricants to their knee's if block 2 didn't do that already. Many lubricants tested don't actually even make it to this test block before exceeding the maximum amount of chain wear allowed for the main test. Over the years I have received feedback that lubricant X would have been excellent in wet conditions as it is designed for wet etc. However the reason it did not make it to block 4 was due to a very high wear rate in Dry contamination block 2. What I can say is that in every case, the wear rate in Block 4 is greater than it is in Block 2 for all drip lubricants. So if the result was poor in block 2, it will not do better in what is a harsher test block. If you are looking at a wet conditions lubricant, and it has been tested by ZFC and did poorly in block 2, and did not make it far enough into test to be tested in block 4 – it will have a wear % result that is highlighted RED. This denotes it is an extrapolated result. The extrapolation is based on the wear % increase in block 4 vs block 2 for all lubricants tested to date that made it through to the end of block 4. This extrapolation is likely kind to the lubricant because it is based off of lubricants that overall performed better, and so made it deeper into the test. In short, a lubricant has highlighted RED wear % in block 4, it is not recommended, regardless of its claims re wet conditions performance.

For all others that have done well enough to make it this far in test, or have A LOT of wear rate allowance left as have absolutely smashed it with impressively low wear across blocks 1, 2 and 3 – things are often either tough or really tough here. Water WILL bring contamination deep into the chain where in block 2 it was maybe able to largely prevent that. Will the lubricant be washed out? Abraded off? Combination of both? How does it recover on each re lube? A big jump in wear is expected – but will it just be high, or really high, or just killed it dead – always exciting to find out.

Re lube as per mfg instructions inc. any needed set time

Interval 21 – 50km – Small ring, cog 2 – 2hrs, 30 mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 22 – 50km – Small ring, cog 2 – 2hrs, 30 mins

Re lube as per mfg instructions inc. any needed set time

Interval 23 – 100km – Big ring, cog 5 – 2hrs 48 mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 24 – 100km – Big ring, cog 5 – 2hrs 48 mins

Re lube as per mfg instructions inc. any needed set time

Interval 25 – 50km – Small ring, cog 3 – 2hrs, 18 mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 26 – 50km – Small ring, cog 3 – 2hrs, 18 mins

Re lube as per mfg instructions inc. any needed set time

Interval 26 – 100km – Big ring, cog 6 – 2hrs 30 mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 27 – 100km – Big ring, cog 6 – 2hrs 30 mins

Re lube as per mfg instructions inc. any needed set time

Interval 28 – 50km – Small ring, cog 1 – 2hrs 48mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 29 – 50km – Small ring, cog 1 – 2hrs 48mins

Re lube as per mfg instructions inc. any needed set time

Interval 30 – 100km – Big ring, cog 4 – 3hrs 04 mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 31 – 100km – Big ring, cog 4 – 3hrs 04 mins

Re lube as per mfg instructions inc. any needed set time

Interval 32 – 50km – Small ring, cog 2 – 2hrs 30mins

500ml Water spray over 1 minute plus 5 Grams fine grade sandy loam.

Interval 33 – 50km – Small ring, cog 2 – 2hrs 30mins

****Check Measure for Block 4 wear amount vs end of Block 3 measure for its wear rate through Block 4****

Block 5 – 1000km – No contamination

Similar to block 3, block 5 gives the lubricant a chance to clear / clean / heal / recover post a pretty rough 1000km test block. It is very interesting if this does or does not happen. Ie lubricants that resisted dry contamination well did not have to recover much in block 3. But there is little escaping block 4 contamination penetration. Some lubricants their Block 5 wear rate is very similar to block 4 even though contamination stopped, whereas others will show a sharp drop. So far only the highest performing products have wear allowance left to even make it to block 5.

Re lube as per mfg instructions inc. any needed set time

Interval 34 – 400km – Big ring, cog 5 – 11hrs 12 mins

Re lube as per mfg instructions inc. any needed set time

Interval 36 – 200km – Small ring, cog 3 – 9hrs 12mins

Re lube as per mfg instructions inc. any needed set time

Interval 37 – 400km – Big ring, cog 6 – 10hrs.

****Check Measure for Block 5 wear amount vs end of Block 4 measure for its wear rate through Block 5****

And this marks the end of the MAIN test. For chains that still have sufficient wear allowance left to attempt it, there is an EXTREME contamination block 6, also 1000km.

I wont type that one out as its too long, but in short – take block 4 – wet contamination block as the base. The number of contamination intervals is doubled – so there are two instances between re -lube, not one. And the contamination amount for all instances is doubled – so it is 1 litre of water over 2 minutes, and 10 grams of sandy loam (vs 500ml and 5 grams in block 4).

At the time of writing this document after many years of testing, only two drip lubricants have made it too the end of block 6. The handful of others are all the top immersive waxes.

However- it is the first 5 Blocks that make up the main test, from which the COST TO RUN MODELLING is based. The total wear of the chain, and what this means re cassette wear, chain ring wear – is then costed out across different groupset price ranges. The cost of the lubricant and the amount of lubricant use is also recorded and included.

Summary

Most other lubricant testing for bicycle chain lubricants (as far as I know, pretty much all other) – are doing outright efficiency testing. This tends to be short duration (X hours). And contamination free. The outright efficiency of a lubricant in a clean lab test is of limited value for most cyclists as they will not be doing full chain reset post every ride. And it can mean very little indeed if the efficiency will be impacted quickly – such as in offroad cycling, wet conditions etc.

The Zero Friction Cycling test CANNOT assess outright efficiency. It is wear correlation based. The correlation being if a lubricant becomes abrasive and thus high wear – rapidly eating through the hardened steel parts of the chain simply cannot be low friction vs lubricants that remain, well, lubricating vs abrading.

What the ZFC test can and does measure;

- Any initial penetration issues

- Dry contamination environment performance
- Wet conditions performance
- Ability to clear contamination
- Cost to run modelling based on wear performance and lubricant cost and usage amount (note this is being reviewed due to some calculation issues for poor performing products).
- Results by block enable cyclist to choose product that suits their cycling – ie dry road, Offroad, frequent wet riding.
- Lubricant performance benchmarked on the largest open League Table – able to sorted via overall or by each block.

Aside from the issue already explained with regards to the limitations of outright efficiency test, such testing / test facilities have over time proven to had quite a number of issues worth being aware of;

- Results from one facility to another reporting wildly different efficiency loss data for the same lubricants tested.
- Manufacturers booking in testing with such facilities need to book multiple tests, as each manufacturers data is private – it is their paid for data. There is no open league table or leaderboard like ZFC. So if a manufacturer books in 10 tests – their lubricant and 9 competitors, and they are beaten by 4 competitors, they will go to market as the number one product beating 5 other lubricants. It can be to a large degree pay to win, because every manufacturer who tests with that facility will of course always be able to go to market winning that testing. They are not going to go to market showing they were 5th place.
- With ZFC – any paid private tests if they do not go well and the mfg does not wish to have results published, they do of course remain private. However, if it tests very well and they green light the data to be open – then the result is the result – the product will slot into the League Table in the position it attained, and so it is a league table that grows constantly and becomes ever more competitive and difficult to get into the top 10 or the top 15. Over the years as only the best private tests become public, this makes the league table TOUGHER – so there is no negative impact to the cyclists of the world reviewing this open data to find the best products, the only negative is to the manufacturers as the benchmark keeps getting harder.

As much as I can I also balance with open tests run on ZFC own volition. I try to rotate these open tests as follows;

- Test a product I think has a strong chance of being a genuine top product, or one that has been most requested by followers, or one that is bringing potentially new tech / new claims to the table worth a closer look.
- Test a product for which I have the most concerns re marketing claims vs reality (ie Wend wax, Prestacycle One, Muc-off)
- Test a product that is mid to low price common lubricant as a general benchmark.

Test Variance

By its nature the ZFC test is a BLUNT test. It is a test being conducted on a Tacx neo, over thousands of km's. Whilst it is a "control test", there are a number of inherent variabilities

- The first and biggest is the chain itself – even though every test chain is a Shimano Ultegra 11spd - a chain is a mass produced item with many many parts. Tiny differences in steel surface, surface treatments, mfg tolerance etc - over millions of articulations these differences will add up, and no two chains can be expected to wear exactly the same even if all other factors are kept exact. Variances have been well established from the Friction facts days where two chains the same model, same batch could have different outright efficiencies varying by around 20%.
- The Tacx Neo's have a +/- 1% accuracy claim (independent test and reviews of the Neo's hold this claim to be very accurate)
- There is potential for variance in each lubricant application and re application – I take great care to minimize any variance and apply as per mfg instructions carefully every time.
- There is potential for some variance with each contamination application although I take great care to apply the same every time.
- There is potential for very small variance in check wear measuring.

Due to the above the ZFC test has a quite high test variance of +/- 5% - although no repeat tests (and a lot have been conducted) have been close to 10%, all bar one has been within +/- 2.5% (5% total variance) – however a total variance of 10% claim will ensure that all results remain within that stated variance.

Note also that the risk of variance increases over the length of the test. Again relating back to the chain – as tests go longer and longer – there is a greater wear difference between sections of the chain. From this we can expect that results for say just block 1 will be held within a much tighter test variance, with a greater potential test variance coming into play the more thousands of kms of testing conducted.

As a general rule factoring the above – when comparing results I do not much care about results that are quite close. Ie if at the end of Block 2 one lubricant is at 17% wear and another is at 22% wear – I am classing that as basically the same result. If those two were to be retested, their results could vary a few % and the results look closer, switch positions, widen etc.

However if I look at a lubricant and its 17% wear and another is 50% wear – that is a very significant wear rate difference, that is well outside of what is possible for test variances – this is now clearly a difference in lubricant performance with the latter lubricant absorbing more contamination and becoming more abrasive.

Careful Correlations

It is important to remember also that a wear rate correlation is also a pretty blunt measure. A wear rate correlation cannot generally be directly linked to outright efficiency, as there are numerous factors affecting a lubricants outright efficiency in an application vs its wear rate.

A bicycle chain is actually quite a unique and extreme lubrication challenge – and that is even before we talk about the issue of complete exposure to environment contamination – something most lubricated machine parts are sealed against.

Each link is actual 8 parts – each of which need to move from a static position to articulating / reticulating. So there is some level of “stiction” – the friction that requires more force for something to begin moving than it does once it is in motion, as well as viscous friction of the lubricant – ie just like if you imagine a bearing – a bearing packed with heavy grease will have more viscous friction than a bearing with a drop of light oil. Similarly a chain lubricated with motor oil would have much more viscous friction than one lubricated with a light mineral oil.

The amount of stiction, and viscous friction – between bicycle lubricants – may outright be very small differences in general, and if we could compare just one moment of such on just one part – the difference could be tiny. However pedalling at say 90 cadence in a 52t chain ring – we now have 90 x 52 = 4680 articulations as the chain goes over the chain ring. The same as it reticulates back off the chain ring. The same number pulled around the bottom pulley, then reticulating back, then articulating over top pulley and reticulating back, then reticulating over the cassette and reticulating back. So we have 8 instances per link being pulled through the drivetrain of either articulation or reticulation. 8 x 4680 = 37,440 articulations / reticulations per minute.

And every link has 8 individual movements – left inner link plate moving over the pin, and inside the roller bore = 2. Repeat for right inner link plate = 4 total. Left and right sides of roller to sides of inner link plate = 6 total. Inner link plate to outer link plate each side = 8 total. 37,440 articulations/reticulations each with 8 pieces of movement from static to moving = 299,520 pieces of friction movement

per minute.

That is a lot of action going on. That is a part, mechanically speaking – working like the clappers.

Some of these pieces of friction movement are occurring at very high pressure loads (ie inner link plate bores over pin and inner link plate shoulders inside rollers articulating under pedalling load over chain ring and cog). Due to very small parts size – the pressure loads can be literally thousands of PSI. And some of these are occurring under very low load – ie side of rollers to side of inner link plate whilst on a straight chain line. Or the above through the bottom span of drivetrain.

So a top performing bicycle chain lubricant needs to;

- Have excellent efficiency and protection from metal parts wear at very high pressure loads, but – due to the huge amount of action happening, have a light enough viscosity to also;
- Have very low stiction
- Have very low viscous friction
- And then – be able to demonstrate a high ability to resist absorbing external contamination and thus becoming more abrasive – which will badly affect the performance of all of the above.

As such the lubrication challenge for ones humble bicycle chain is actually quite an extreme challenge. And it is why oh so many products that are likely just A LUBRICANT – rebranded from industry use X, and sold for cycling cos hey – it's a lubricant – can perform so poorly in this use case. Oh so many products deliver cyclists rapid chain wear, often zooming well past 0.5% recommended wear allowance, and then taking out the cassette with it (and potentially pulleys and chainrings too). Overall too many cyclists are too complacent about what they should expect from their bicycle chain lubricant as they are so used to running products that do poorly – it just happens that this poor performance is well within their expectations. The huge wear rate performance difference between the top tested products and the poor performing – but very popular big name products – from the ZFC main test is testament to this.

Products that have had a lot of GENUINE R&D and testing in the actual use case of bicycle chain lubricant, and aiming to excel in the extreme challenges of this use case, really are a world apart from those that it would appear have not (because if the mfg have done the R&D and testing and wanted to bring a great product to market, they would not have released the products they have).

At the time of updating this brief – it is my strong belief that simply a huge % of bicycle chain lubricants the mfg has likely absolutely no idea at all if the product is amazing, meh or terrible. It is just basically hey this lubricant should be good, and since we can claim literally any about its performance for cycling with absolutely zero substantiation, testing or proof on any level – lets have at it.

And so – we see very large to massive differences in wear rate performance between the top products genuinely developed to meet the extreme challenge of lubricating a bicycle chain, vs….. who knows where and what the background was on many other products.

With regards to the wear rate correlation – it can be – most especially before contamination is introduced – that a lubricant could be higher wear, but overall more efficient – due to have better performance in stiction and viscous friction vs another lubricant. Again the differences in those friction components may be small, but take a small number and multiply it by around 300,000 – and you can arrive at a tangible efficiency difference.

However, it is overall expected that the dominant friction loss component will be the high pressure friction performance, and that simply beyond a certain wear rate difference, any higher performance in stiction and viscous friction will not be able to make up for the higher wear rate from high pressure friction component.

What % wear number is, we do not know, and it would be a number that is different for any two lubricant comparisons. So again what this leads to is the ZFC test is a fairly blunt comparison, we are looking for larger differences (at least 10%+ as we go deeper in to the test) to start to draw a conclusion that the lower wear lubricant is most likely to be the higher performing. Larger differences we can be ever more confident that the lower wear will be the faster and more efficient product.

It simply must take a notable amount of friction to rapidly wear the hardened steel parts of your chain. If you set upon them with a frictionless cloth – nothing will happen. Set upon them with a bastard file – things happen. A liquid bastard file is unlikely to be lower friction than a lubricant that is acting like a lubricant and protecting those parts impressively from wear.

Check wear Measuring

After each new test chain is fully strip cleaned via 5 ultrasonic cleaning rounds, it is check measured so we have a start measure as their can be very small differences between chains / chain batches from mfg.

From this start measure, the chain is then check measured at the end of each block. The check measures are done using KMC digital chain wear checkers as they measure repeatedly with very high accuracy to 0.01mm. Multiple (minimum 2) are used for each test.

Using these chain wear checkers vs other chain wear checking methods was decided on for a number of reasons. Full chain length elongation wear to same / similar level of accuracy poses some challenges, especially as chains get very dirty, and also this does not show if a section of chain is wearing at a much greater level than the rest of the chain – which can highlight an issue with that chain which would require the test to be invalidated and re started with a new chain.

Measuring chain across 7 different sections (which is what is done) enables variances between chain sections to be monitored, and if they exceed a certain variance (which for openness sake is stated 0.15mm variance however that is only when deep into a test, if earlier in a test a variance of 0.1 or 0.08mm is seen already – then a test may be scrapped and re started with a newly prepped chain).

Using digital calipers also has some difficulties as the amount of force used to take the measure can change the measure by more than 0.01mm. And – as the chain becomes increasingly dirtly – gritty lubricant can begin to clog parts and give a falsely low wear measure. As such a high amount of tension load needs to be put into the chain for each sections check measure.

The most consistent measure method I found during a lot of testing to bed in the test protocol prior to beginning to test to build the league table was to;

- Use KMC digital checkers x 2 per measure. The KMC checkers have their own spring loaded tension so user force with the tool is not used.
- This enables me to put a large tension force into top span of chain via crank spindle to pull links apart so that a false low measure is avoided.
- Check measure starting from one link across from master link is done to begin with, and after 6 further sections measured,

this initial measure is re done, and check to ensure the same as initial measure.

- The average of the 7 measures is used to determine that checkpoints measure.

Example – end of block one a chain is showing 0.08 / 0.08 / 0.07 / 0.09 / 0.07 / 0.08 / 0.07 – the check measure is the average of those which equals 0.077. Chain wear allowance is 0.5mm (0.5%), so the wear rate % is 0.077/0.5 = 15.4% (this denotes the chain used 15.4% of the test wear allowance, with 0.5% = 100% test wear allowance).

At the end of block 2 lets say we now have a wear measure of 0.31 / 0.33 / 0.33 / 0.32 / 0.31 / 0.34 / 0.3 – we have an average wear measure of 0.32. The wear for block 2 will be 0.32 – 0.077 = 0.243 / 0.5 = 0.486 or 48.6%. Total cumulative wear will be 0.32 / 0.5 = 0.64 or 64%.

It is possible (and occurs especially with the top immersive waxes / wax drip lubricants – where the difference from one check measure to another can be extremely small. Ie the wear measure maybe only 0.01 or 0.02 avg greater – and so extremely small differences in wear % - but now that you know how the check measures are conducted and calculated – you can see how we are able to track very small wear differences across the test. But remember, due to overall test variances, of which the chain itself is the largest – we are looking for wear rate differences of at least around 5 to 10% by end of test minimum.

Strengths and limitations of the ZFC test – Summary.

It is important to remember firstly that there is no industry standards test for bicycle chain lubricants. It is important to remember next that ASTM or other industry standards tests do not assess a bicycle chain lubricants performance in its use case. Often these tests are quite removed from the unique and overall quite extreme challenges of lubricating a bicycle chain. Over the years of being involved in testing, and liaising with other test facilities such as Ceramic Speeds Denmark research lab which has a widely regarded extremely accurate outright efficiency test machine – I can say there is often little to no cross correlation with a lubricant performing extremely well in X industry standards test and the ZFC test / Ceramic Speed efficiency test etc. Simply those standards tests were developed to assess a lubricant for a very specific industry use case. A lubricant doing well in the Timken 4 ball test – that result might be just as relevant for that lubricant on a bicycle chain as it is for a Jet turbine bearing – which is to say likely not very relevant at all.

It is possible that some manufacturers may select a lubricant that already has a great test result in X industry standards test, and then

uses that as part of their marketing for it as a cycling lubricant. Prestacycle for instance market their product as “breaking” the 4 ball test (it didn’t, there is no “breaking” the test – it is passing the test. If you pass your math’s test, you didn’t “break it”), as well as listing numerous other MILSPEC tests the lubricant has been subjected too. And yet in the ZFC test with this product running on a bicycle chain on a bicycle drivetrain – as soon as exposed to some contamination – it became extremely abrasive and quickly ate the chain. Not a great sign for how it would perform in its actual use case in the real world.

This is just one example. Overall, be very wary of products using industry standards testing to market the products – I would email them and ask for what testing and data they have for the product being used in its actual use case. If they don’t have any, that is a worry. If they apparently do but it is secret, that is also a worry. The chain lubricant space is massively crowded with literally thousands of products and brands trying to get you to purchase them over other products. If one has genuine proof that their product is absolutely high performing, it is illogical to keep that secret vs shouting that proof from the rooftops to all who will listen. If behavior doesn’t make basic logical sense, it should be questioned as to why.

Back to the ZFC testing – the strengths are;

- It is assessing the lubricants performance in its actual use case
- It is not a short clean lab test of some hours, it is test that runs typically to around 3000 to 6000km depending on performance and wear rate
- It includes both dry and wet contamination – important again considering the real world use case
- The performance is broken down block by block – this helps choose / avoid options that are not suitable – ie a product that might be great for dry road cycling and be an excellent choice might be a terrible choice for offroad due to absorbing dust readily, or a product may give out quickly in wet conditions.
- Over the years we have built up a large league table so that lubricants can be instantly benchmarked against their key competitors.
- Whilst there is an overall high test variance, the test is extremely robust within that variance.

Limitations of the ZFC testing are;

- We cannot measure outright efficiency losses.
- Some level of caution needs to be understood with regards to wear and efficiency loss correlation – to a point it is possible a higher wear lubricant could still be overall more efficient than a lower wear lubricant – however it is strongly believed that there will be obvious limitations to that – simply too rapid a wear of hardened steel denotes too much friction loss to be

competitive.

- Each test takes significant time to conduct. As such overall progress to meet requested tests (both open and for manufacturers) is slow, even with 3 machines. Hindering this has been the large rise of wax drip lubricants as it is now well proven that overall the higher contamination resistance, wear protection, efficiency etc of many good wax options are proving to be superior than most / all wet lubricants – most especially for offroad cycling where wet lubricants very quickly become much more abrasive.

  However it is common for wax drip lubricants to need some hours or overnight set times post application. This significantly slows down the rate at which a test can be completed. A high performing wax drip lubricant going all the way through to the end of block six could tie up a machine for up to two months just to complete that one test, whereas a high performing wet lubricant or immersive wax would be able to be completed in about 3 to 4 weeks.

  On top of the resources needed for the main test, in amongst that we are often also trying to complete single application longevity testing for a range of conditions as well for the higher performing products – and this can also tie up a machine for around a month to complete all S.A.L tests.

- The very high amount of labor involved in conducting each test (also resetting machine post test, and for each new test prepping chain, installing new chain rings, cassette and pulleys), as well as liaising with mfg's on test results, data updates, cost to run modelling and detail reviews - the cost to manufacturers to book a test is high (mfg's email for test costs and timelines). For large manufacturers – vs the cost of conduction robust field testing – it is a small cost, for small / start up manufacturers – the cost for a test can be prohibitive.

  However – again when balanced against other testing options, ZFC normally works out cheaper and much more comprehensive. A test with a different facility might cost one fifth the cost of the ZFC main test, but the mfg is going to need to book likely 5 to 10 tests to get a comparison of their products performance vs some competitors, and then at the end of that – they still will only have an outright efficiency result in a short clean lab test – so no indication as to how it will perform out in the real world with contamination exposure – and a benchmark against only a small number of their key competitors vs the ZFC league table. In the end a mfg will pay more $$ for much less useable information.

  And this is a big reason why without any marketing at all, ZFC testing is constantly booked for around 3 to 6 months in advance to get a spot on a machine. And why many major mfg who have their own test machines have still been using ZFC for many years to get this benchmark on new products / products in development.

That will do! Hope this brief has answered all your questions and more with regards to what the ZFC test is, how it is conducted, and what we can and cannot get from it. If you have any further questions, or any concerns or other feedback - please do not hesitate to email me at info@zerofrictioncycling.com.au

VIDEO

To see how dry and wet contamination is added and to know a bit more about the test, go to the Zero Friction Cycling You Tube channel vid here;
https://www.youtube.com/watch?v=2soU9J0Z7hk

FAQ's

Q: Why are data updates infrequent?
A: As you can see each test takes significant time resources to run (a test can easily take 2months + if it goes deep and needs as set time after each re lube). Then there is the detail review to be done and cost to run modelling. And many tests each year are private for manufacturers – often as part of lubricant development – so this work goes unseen, and only private tests of production products that test outstanding greenlit to tear up NDA, as well as what open tests I can get done as well. Post each test machines need a reset, new parts, calibration etc – testing is EXTREMELY time resource intensive.

Q: Doesn't the test favor immersive waxes?
A: Yes – but that's just the nature of immersive waxing. For those whom immersive waxing suits (which is actually most!) – they simply enjoy some huge benefits for popping chain off and popping it into a bath of wax each re lube.

Low friction, and thus low wear lubrication of bicycle chain is effectively an open battle against contamination. X lubricant will absorb X amount of contamination over X time before next re lube and thus be X level more abrasive than what it was before. On a re lube with

a drip lubricant – as an average you will be adding about 3 to 5ml of lubricant onto chain. Your chain will likely be over 100 links long, so that is about 0.03 to 0.05ml per link fresh lubricant mixing it with whatever is in there already. There is only so much that can do to flush clean chain / improve the ratio of lubricant to contamination. It helps of course, but if I asked you to clean my chain and I gave you 0.03ml per link of something to do that, that then also was needed to lubricate chain – you would probably give me some sort of meaningful look. A look that says perhaps I should consult a medical professional. In the Psych department.

For immersive waxing, the re lube is rather more effective. The chain is going into typically 400 to 500ml of lubricant for a nice bath and swish around. Over time, as the chain brings a small amount of contamination into the wax – the wax will become more abrasive than a batch of fresh wax. But coupled with being a solid lubricant and thus highest contamination resistance possible – you can imagine how long it takes for the contamination level in hundreds of ml of wax to remotely look like what is happening on your few ml of lubricant at any one time on your chain.

If one doesn't want to wax but wants to get a similar thing happening, at the end of the day there is nothing stopping your putting your chain in a bath of oil. The oil will get more contaminated more quickly vs wax as its oil, it will not have the contamination gathering resistance of wax, but – it sure will get a great reset vs just dripping 3 to 5ml new lube on. But… then you have a lot of excess to deal with (excess oil greatly increases contamination gathering rate), and so this path would be a bit of a mess vs IM waxing.

But I hope all up that paints the picture of the challenge drip lubricants have to match day in, day out – the ultra low friction, wear and cleanliness of the immersive waxing option. The advantage that IM waxing has in this test is exactly the same advantage IM waxing gives you in the real world.

In reality of course some drip lubricant users will (I hope) be performing some level of periodic maintenance, but again this simply cannot be part of the ZFC test or I would not be able to assess the lubricants performance across the range of conditions as well as common key marketing claims.

And its worth noting that not all immersive waxes are created equal. One in particular tested rather poorly and another has recently tested HORRIFICALLY, and that will for sure not be the only case on the market – the market is now flooded with immersive wax products as many look to jump on the coat tails of awesomeness pioneered by the top products.

So even in this product category it is still highly recommended to choose on that has performed well in the ZFC test.

Q: Is there a conflict of interest as ZFC sells lubricants?

A: Simply no. The testing by ZFC is fiercely independent. Testing is extremely difficult to make any viable revenue or profit from. Even at a high test cost for the Mfg, the test time and labor is very high, and only a fairly small number of tests per year can be physically completed.

Simply for the open data and independent testing of ZFC to exist, there has to be a retail side. Remember ZFC does not make any ZFC branded lubricant – we simply stock the genuine best products found from over half a million kms of the worlds most exhaustive control testing.

- Cyclists get the most robust and exhaustive independent data on a product so they can choose a proven product to suit their cycling
- This data is open, and free.
- Manufacturers have the most robust test to put their own products through -pre or post production release.
- This independent testing gets to exist.

So that's it – it is simple and open business model, and has been so from the beginning. We have a testing side which conducts testing for manufacturers as well as what other tests I can get to each year, and we have a retail side that stocks the best products we find from testing, and the retail side enables the test side to exist. And quite clearly, if there was a concern, then manufacturers would not book to test and be benchmarked!

And of course there will be many in the big wide world outside of Australia for whom purchasing from Aus and high international shipping costs just don't make sense. If it does and you wish to help support the testing work – then great. But if it doesn't, don't feel

obligated. You have the data and information to purchase a great product from a manufacturer that has worked hard to bring a genuinely great product to market, as opposed to literally hundreds or thousands of others that have only brought great marketing to market. So you can hunt the suitable great product down from somewhere in your area.

There are many other great ways to support the work at ZFC other than just making a retail purchase, that includes simply subscribing to Zero Friction Cycling You tube channel and watching any vids of interest, and sharing those with friends. Positively engaging with any other cycling media you come across that features or references ZFC work, letting your friends know about ZFC work etc – all of that really helps everyone.

Q: What other testing does ZFC do?

A: ZFC has ploughed into a fair bit over the years! 28 different chain models have been tested for wear durability (so as opposed to control chain and testing lubricants, a control lubricant on different chains). We have done a good bit of tensile strength testing, currently working on testing chain prep products, hope to get to chain maintenance method test soon, as well as we have numerous other chain models not to try to get to testing for wear life and tensile strength. Component wear durability is also on the hopeful list to try to get to.

In short – ZFC is always working hard to add a lot of great information into this space that otherwise would not exist.

Oh – and where possible the lubricants tested through the main test are tested for single application longevity. This is running rather behind, and also I tend not to bother testing most of the poor performing lubricants as it is really a waste valuable test time resources – I don't really care how long a lubricant treatment lasts if it is a poor product that will never be recommended.

We also have a good amount of outright chain efficiency test data from Ceramic Speed Denmark research lab. Yes it is a problem that this is not independent, but it is the best data we can get at this time. I am always looking for an investigating other test facilities that may be able to provide accurate efficiency loss data to complement the zfc wear test data, as having that independent loss result as well would be a great addition.

Q: Manufacturers - How do I go about getting my lubricant tested?

A: Send an email enquiry to info@zerofrictioncycling.com.au and I will send out the base template information regarding booking in a test. But before that, really take in the ZFC test protocol and think how will your lubricant perform once the contamination starts. I encourage some robust field testing to be very confident of your products performance before booking in a test with ZFC, or it can be some good $$$ in test cost to receive a disappointing result, which is no fun for anyone. But if your product is looking to be a winner after your own extensive testing- then benchmarking it against the biggest open league table can be a great outcome. An example of this at time of writing is Effetto Mariposa Flower Power wax. The enviro friendly angle is a strong growth area in bicycle chain lubricants, and I have dealt with many many enquiries in the last years from manufacturers about having their bio friendly lubricant tested. But on discussion – none had anything to base their product claims on (this isn't limited to bio products….this is common with many enquries). And in the end, most do not proceed as why spend the big bucks on what is basically a crap shoot on how the product will perform. But Effetto were confident from their own testing, and at time of updating this brief (November 2024), their Flower Power lubricant is still the lowest wear drip lubricant tested to date. This result was then great for them to use for marketing and launching etc.

Q: DIY'ers – can you test by beeswax / paraffin / lanolin / carnauba / paraffin oil / xylene / moly / ptfe / ws2 / graphene home blend, I think its amazing

A: Alas no – I have tested a good candle wax base, and I hope to also test a food grade paraffin base – but that will be it for DIY waxing. It is an area that could never be satisfied by ZFC testing as I will never be able to test all the DIY blends requested. Ie oh groovy you tested that Gulf canning wax + ws2 blend, but what about my X paraffin + 5% beeswax + graphite? Or what about with this ratio of ws2 vs what you tested. Or what about if you add some paraffin oil and Teflon. Add 50 more combinations of this as you get an idea of my DIY wax testing enquiries coming in every week.

And whilst I think many DIY'ers can make a great DIY wax, and often they can easily beat many commercial drip lubricants due to the inherent advantages of immersive waxing for bicycle chains a) Overall DIY making ones own wax or lubricant is a VERY SMALL demographic in cycling, b) of that very small demographic there are endless blends of "the best" DIY wax, c) You don't need ZFC validation. If you believe your DIY blend is all that and a bag of chips and you are really happy with it, be happy with it and be at peace. Over time if you wish you can pit your DIY wax blend vs a commercial immersive wax across multiple chains each, accurately tracking wear rate data, being as fair and as even as you can regarding re wax intervals, riding conditions, types of riding workout etc to reduce the typically pretty big real world ride testing variance (as really you are not controlling any key variables).

It is a fun area for many, and some have a great product, and some make a gunky mess following some wacky crap on TikTok or Instagram and are the waxing base that give bike mechanics nightmares from when their gunked up drivetrain comes into the workshop. But sadly ZFC will not be devoting endless years of test machine time and resources to testing endless DIY wax blends, and I hope it makes sense why. (And ie where are all the DIY drip lube people / requests – there are practically none of those, why is it all DIY immersive wax?!)

As it is I greatly lack testing capacity to be there for manufacturers who need testing as there a very few options for them to independently have their products tested (in a test that actually means anything) – and it is important for manufacturers genuine about their products performance to have access to a robust independent test. And outside of that, there is just so much work to be done re commercially available products that is going to be of much higher information value to oh so many more people – so we have to focus on what is the greatest good for the greatest number of people vs focus on a very very niche segment – even if that segment is passionately engaged in this space. Hope that all makes sense. In short – if you want to play making your own amazing DIY blend, have fun, do your own testing and enjoy they whole journey of it


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