Sprocket and Chain Wear

After the "WD40 experiment" (see other article) was over, it was time for another experiment. The factory chain (an EK520SRO o-ring chain) is established as one of the longest-life chains in our KLR universe but it's pricey at well over $100. The factory rear sprocket shares the same "best in class" reputation with significant life, and is priced in the mid $40 range.

So here I was with a little over 34,000 miles on the rear sprocket, and it still looked pretty good. But if I was going to spend $100+ on a new factory chain, then I clearly should have purchased a new rear sprocket as well. But since my rear sprocket was still in pretty good shape, it seemed like a good time to continue using it with a cheap, non-O-ring chain. Besides being a cheap thing to do, there was more to learn from this test:

- How tough is that factory sprocket… could I make it past 40,000 or even 50,000 miles on that baby?
- Would there be any MPG improvement in the reduced drag of no O-rings?
- We always hear "replace your sprockets and chain as a set"… this test of putting a new chain on worn sprockets would also back-up or refute that claim.

I purchased an EK520 standard chain for a mere $28 and put it on. But of course, I was now forced to use commercial chain lube, as WD40 was a path to short life on a non-o-ring chain. I'll state the bottom line right up front, with details after that.

BOTTOM LINE:

1) **The stock rear sprocket *still* looked surprisingly good with 55,000 miles!** At this point I put all-new sprockets and chain on the bike.

2) **Fuel economy with the non o-ring chain went up by only 1 MPG.** (To be fair, this was comparing a *worn* o-ring chain to a new non-o-ring chain. It is possible that a *new* o-ring chain has more drag than a worn one, so now at 55K when I've put a brand-new o-ring chain on the bike, we will see if I ***lose*** more than that 1 mpg going back.)

3) **A new chain on worn sprockets does wear faster than a new chain put on new sprockets.** In fact, the chain wear rate was high at first, but once it got up to the sprocket wear amount, the chain suddenly went almost 10 times further between adjustments.

4) **WD40 created no mess at all.** Using standard chain lube made the bike a greasy pig that drips under the countershaft cover, has a messy swingarm, rim and rear tire.

- Continued -

THE DETAILS:

Stock Rear Sprocket:

As a forum member at KLR650.net pointed out, "maybe Kawasaki has some Kryptonite mixed in with the steel in that sprocket". Man, no kidding. Below is a photo of my stock rear sprocket upon removal at 55,000 miles:

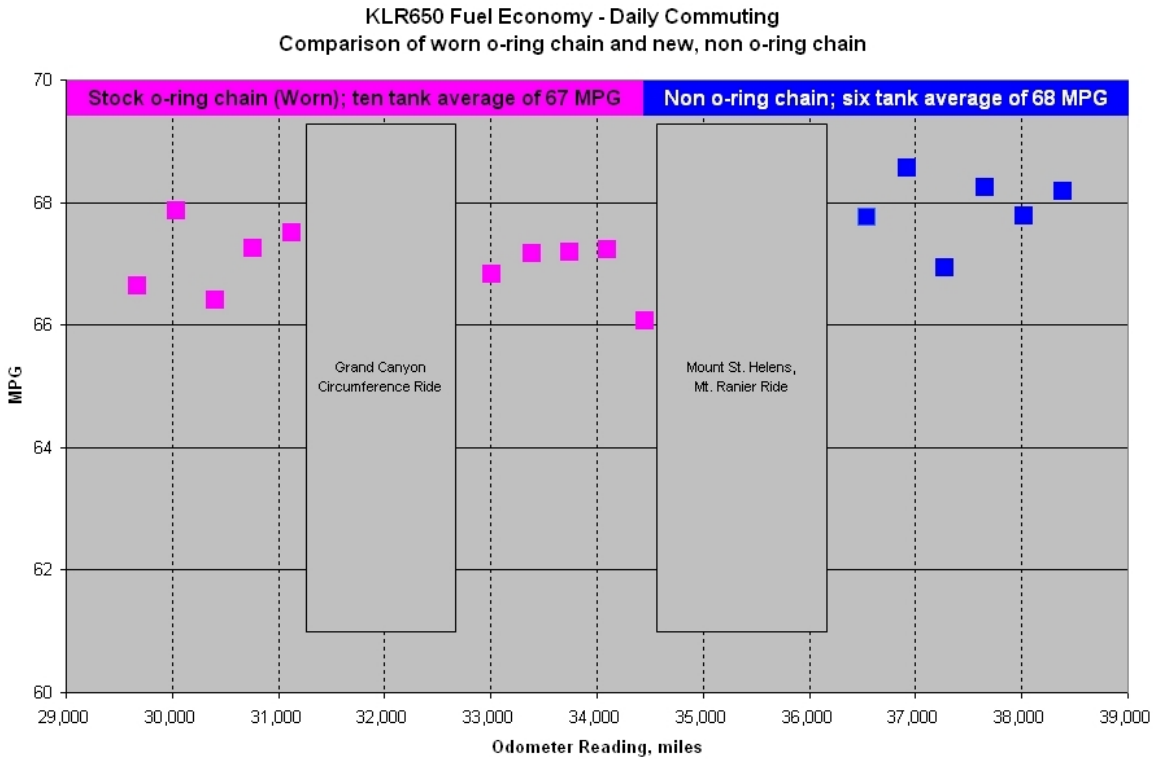
While we're talking about sprocket wear, I've run a number of PBI 16 tooth front sprockets, and more recently, run Sunstar 17s. Although I'd usually get about 7,500 miles on a PBI 16 before flipping it over (for a total life of 15,000 miles per front sprocket), The Sunstar 17's have been wearing at a much slower rate. The photo on the right shows a new Sunstar 17, as well as one with 16,700 miles. I went over 13,000 on that sprocket before even flipping it over! I have a separate article about Installing a 17 tooth front sprocket if you are interested.

Fuel Economy:

There are quite a few misleading fuel economy posts on the 'net. Not filling the tank to the same level is one issue, partial fills are another (posts where someone rides 80 miles and then buys fuel, rather than running the tank empty) are not uncommon. Throw changes in riding conditions into the mix and 'data' can be all over the place. For that reason, I tend to run multiple full tanks and average them all together before quoting what kind of fuel mileage a vehicle is getting.

Fortunately, my commuting cycle is very consistent and thus, economy varies very little from tank-to-tank. When commuting, I'll typically get to around 320 miles before switching to reserve, then run another 40 plus miles before buying fuel. So these tanks average out at over 360 miles each… these are not partial fills.

Look at the figure below. The last ten commuting tanks with the original o-ring chain are shown in magenta and average **67** mpg. They are all in a tight band, all between 66 and 68 mpg. The first six commuting tanks with the new non-o-ring chain are shown in blue and average **68** mpg. They are all in a tight band between 67 and 69 mpg. A very small difference, but as you can see by the data, I have very little tank-to-tank fuel economy variation so the 1 mpg difference does seem to be clear. But still, 1 mpg. This is clearly not a reason to switch over.



To not clutter the issue, the results for two fifteen-hundred-mile road trips over this interval are covered in the figure and not included in any math as the riding cycles are different (some dirt riding, or higher speed road work) and should not be compared. But it should be recognized that this isn't a couple hundred miles with one chain, then a couple hundred with a different chain, then quoting fuel economy to 3 decimal places (don't get me started)! These tests cover nearly 10,000 miles of riding.

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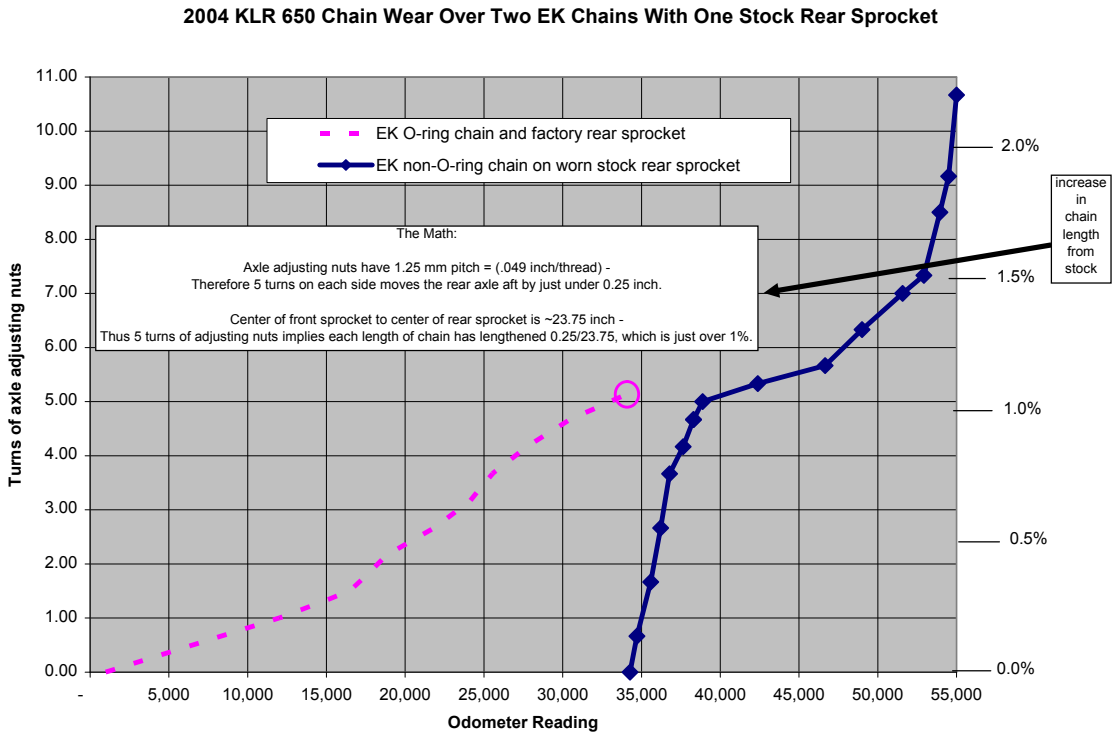
Chain Wear:

The same procedure outlined in "The WD40 Experiment" was used to monitor chain wear. There's a lot to learn in the data below – let's dissect what was learned:

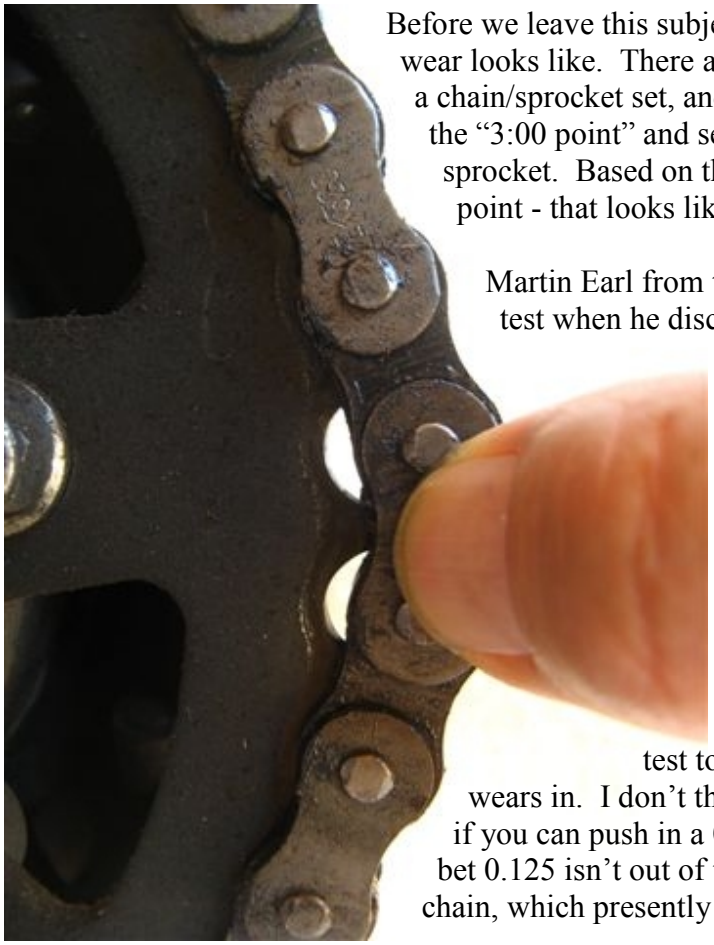


The magenta line is the stock o-ring chain data from new. It wore at a pretty consistent rate for 34,000 miles. Then I installed the new chain but kept the old rear sprocket (blue line). I think there are three things to pick up here:

At **first**, the cheap non-o-ring chain required adjustments far more frequently! For the first 5,000 miles (from 34,000 to 39,000) I was always snugging it up. Then suddenly, the wear rate flattened out. What the heck? Well, look at the plot. Note how the rear sprocket already had just over 1.0% wear when I started this test (the magenta circle represents the sprocket wear from the first 34,000 miles of use). Now look at the blue line again with the "new" chain on old sprockets - **do you see how once the new chain had "stretched" 1.0%, that suddenly it wasn't wearing quickly anymore? Wow! There's your proof that they wear as a team.**

Secondly, note how from 39,000 miles to 53,000 miles that the slope of the blue line – which is the "wear rate" of the non-o-ring chain – has a similar slope to the magenta line… telling me **the EK520 standard chain and the EK520 O-ring chain actually seemed to wear at very similar rates.**

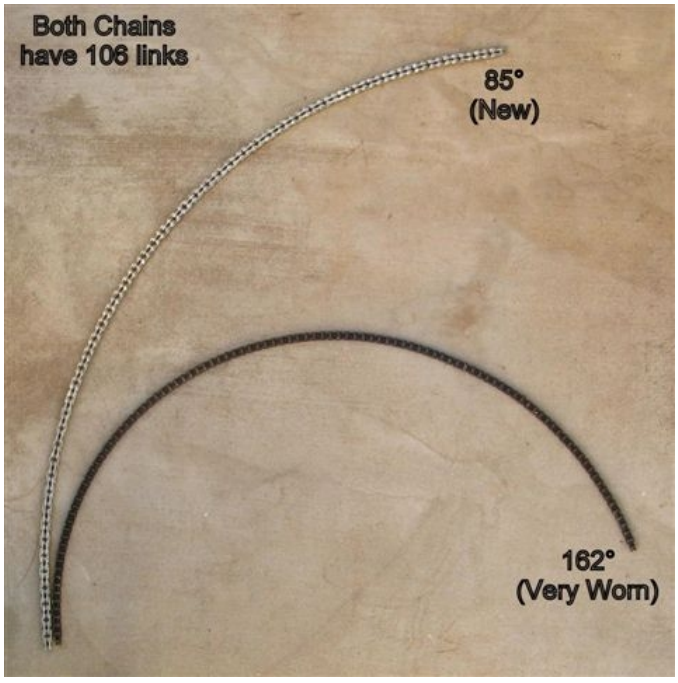
Third, once the cheap chain hit around 1.5% average stretch, the wear rate took off very steeply again – I'm guessing that the chain has hardened surfaces, and **once you've worked through the hard surface, the chain wears much more quickly.**



Before we leave this subject, I wanted to show some pictures of what 2.2% wear looks like. There are a number of ways to evaluate the condition of a chain/sprocket set, and the most popular is to pull back on the chain at the "3:00 point" and see if you can see half-a-tooth or more of the rear sprocket. Based on the photo on the left, I think we were just past that point - that looks like a little more than half a tooth showing.

Martin Earl from the DSN forum brought up an interesting second test when he discussed finding the largest Phillips screwdriver that could slide in that gap shown on the left. I modified that test slightly – to see what the largest drill bit could be stuck between the sprocket and chain, as many of us have a drill set in our garage with a number of various drill sizes. The concept is… without rotating the wheel, simply pull back on the chain at 3:00 and determine the largest drill shank you can insert into the gap. In my case (shown on the bottom left) a 0.187 inch drill bit would fit, but not the next size of 0.203 inch. Since it's a pretty easy test to do, I'll be monitoring this on the new chain as it wears in. I don't think I'd go this far next time, so I'd certainly say if you can push in a 0.187 inch drill bit, you've gone too far… but I'll bet 0.125 isn't out of the question. We'll see how it goes with the new chain, which presently fits so well that NO drill shank will fit yet.

The third way that some people use is to see how far you can bend the chain from side-to-side. I think this test has little value, but heck, the chain was off and I had a camera… you know what happens after that. I laid the new and used chains on the ground then pushed one end sideways until the other end started to move sideways as well. As you can see on the right, the worn chain could be bent about twice as far as the new chain. This test is trivia at best.



Mess:

Wow. I've been riding chain-driven bikes for over 40 years, and had forgotten how messy it used to be when using traditional chain lube. The stocker o-ring chain with WD40 was so clean… the rear rim was clean, the rear tire was clean, the swingarm was clean. You get used to it. There was rarely a drip under the bike.

And then I went back to normal chain lube with the non-O-ring chain.

At first, it didn't seem like a much bigger mess. That's because the lube is flinging off inside the countershaft sprocket cover, and it takes a while to get enough in there that it starts dripping out the bottom. Every day or two, a drop of grease would be under the bike. Then I would roll the front tire through it, or step in it with my riding boots - either way that would spread it around the garage floor. While running the non-O-ring chain, I've been placing a pan under the bike each night. I look forward to going back to WD40 now that I've put an O-ring chain back on the bike.

Final Notes:

Even if the chain would last even longer with normal chain lube instead of WD40, I'm sticking with the WD. Since a full-size can of chain lube costs almost as much as a lifetime supply of WD40, this generates some savings that helps contribute to buying the next chain and sprockets. The cleanliness factor is definitely worth something too. For the type of riding that I do, making 35,000 miles per chain on WD40 is OK by me.