TLC Still Needed For New Axles?

THE QUESTION

I have heard that new axles no longer need a break-in period. True or False?

Expert answer provided by Norm Parker, General Motors

The short answer to this question is a resounding, "false." But there is confusing information flying around that may be the source of these rumors. Let's start with the high-level goal of breaking-in or wearing-in an axle. There are two big wear mechanisms in an axle — the ring and pinion gear mesh (or hypoid mesh) and the bearings. There is some wear that occurs in the differential gears, but due to the intermittent usage, it is very slow by comparison. Providing the system is functioning correctly, most of the wear occurring in an axle will happen within the first 500 miles and then slowing down until around 2,000 miles where it eventually tapers off to into steady state. The overarching goal of the break-in period is to have the same functional axle that you started with.

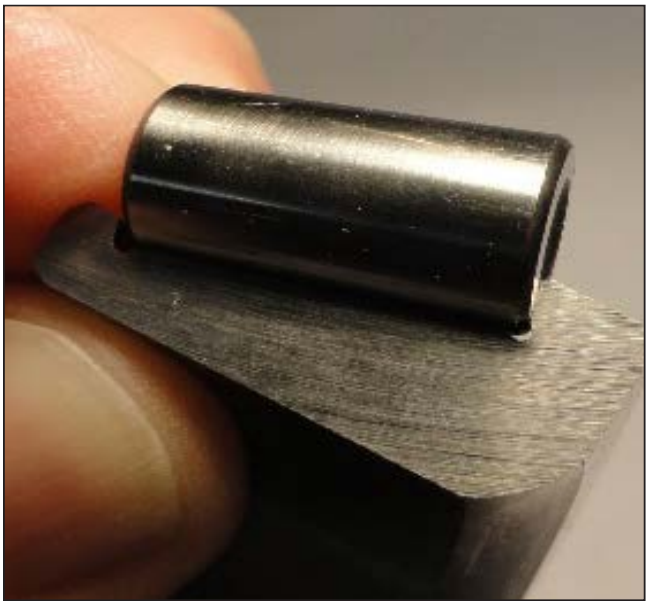
The bearing wear mechanism is fairly straightforward. All of the tapered roller bearings in an axle will wear to some extent between the bottoms of the rollers and the large rib that supports the heavy axial (horizontal) loads. Up until a few years ago, this surface started life around 2-3 µm Ra (~ 100µ in.). Over the course of a couple of thousand miles, this would smooth out to about 0.15 µm. During this period there was higher friction, which means higher heat and debris particles in the oil. Today, nearly all modern bearing companies provide honed ribs to the OEs, which are nearly standard product now. These are often marketed as 'non-wearing' or 'no-break-in' bearings. The honed rib surface is 0.1- 0.2 µm Ra, which greatly reduces the initial break-in wear (although it's not zero, as was the original intent). Honing takes care of surface finish but does not take care of part-to-part variation. There will always be a less-than-perfect fit between a new roller and a new rib. These parts must wear in *together* to achieve the perfect fit. We have found that no matter how smooth the mating parts are, there is still wear due to mating part tolerances. *Just a note of caution for rebuilt or repaired axles*: There are many aftermarket suppliers that will use cheaper bearings without honed ribs or, in some cases, have old inventory with non-honed ribs. Without having any sure way of knowing, you should err on the side of caution and assume that a rebuilt axle, or bearings ordered for a rebuild, do not have honed ribs.

The hypoid mesh is the other source of considerable wear and heat during the break-in period. Just as with the bearings, we are dealing with a surface finish that has to be polished down along with the mating gear teeth that need to run together for a period of time before there is true full contact. Unlike the bearing, there is both rolling and sliding friction in the hypoid. From a physical perspective this means that we can shear some of the surface finish off while some material can be rolled back onto the surface. You can loosely correlate this into elastic vs. plastic deformation of the local surface asperities. Higher force and lower lubrication film will force more shearing, while lower loads and a thicker film will allow more rolling. With rolling comes some surface work hardening which further adds to our benefit.

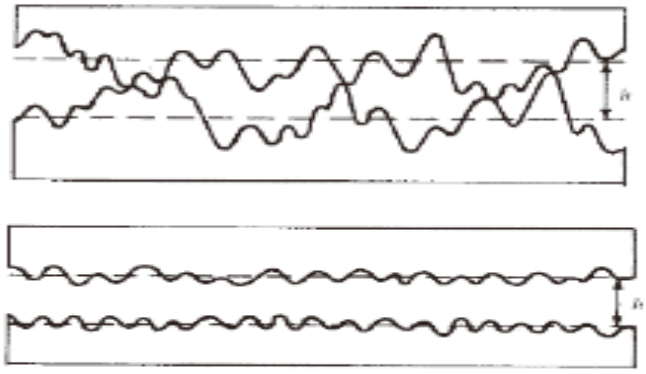
In order to help with the break-in period of the hypoid, most axles have some level of manganese phosphate coating applied to the ring and/or pinion. This is a chemically applied, hard porous coating that is intended to wear off during the first two thousand miles or so. There are a couple of benefits; the porosity allows the surface to hold more oil than a bare steel surface, which helps with lubrication during the higher-friction break-in period. Secondly, as the hard coating wears down, the surface asperities

and imperfections of the underlying gear are slowly introduced into the system, allowing the wear to occur much more slowly than two hardened steel parts mating for the first time. Phosphate coating isn't terribly expensive, but it isn't free either, so companies like to experiment with only applying phosphate to one surface vs. both. There is no industry-wide consensus on a best practice.

Similar to bearing superfinishing or honing, gear manufacturers use a process referred to as isotropic super-finish (ISF). This is exactly what it sounds like — non-directional honing. The principal behind the benefit is just the same as with the bearings. The traditional gear finish around 0.40 µm Ra with ISF can be reduced to 0.05 µm Ra. This results in much lower friction during the break-in period which produces less wear particulate running through the oil. This benefits all of the other components in the system as well. ISF is mostly used in aerospace at the current time, but is starting to gain momentum in the automotive industry as efficiency and performance demands continue to increase. This process certainly shortens the break-in period, but does not eliminate it.



TRB cross-section highlighting rib/roller interface.



New bearing vs. broken-in bearing.

The picture may start to become clearer as to why most current service manuals still recommend a 500 mile break-in period with no towing, hard acceleration or continuous driving. Even though honed surfaces can help with break-in, wear still occurs due to the imperfections of the mating parts. With all of the new surfaces coming together for the first time, a tremendous amount of wear occurs early in the life of the axle that creates heat. Heat reduces the viscosity of the oil which reduces oil film which further accelerates more wear and heat.

For these reasons, it is recommended to only drive a new axle for 15-20 minutes at a time before allowing it to cool down. Some manuals recommend not driving at highway speeds during the break-in to further protect the axle. For towing applications, it is also recommended to change the original axle oil after 500 – 2,000 miles to remove all of the wear particles generated during the break-in period. There is some question on the practicality of all of the break-in guidelines, but the error is on the side of caution; allowing for the worst case builds in the worst environments.

The long-term goal is to develop perfectly efficient axles that do not need a break-in period and never need the fluid changed. We are on our way there with honing, superfinishing and coating technologies, but in the meantime, take it easy on your new axle and you will be much happier with your long-term towing performance. **PTE**

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