Crankshaft seals and sealing surface wear

by R. Panico Peres

TRIBOLOGY- what a **great** word! Tribology is a science that deals with the design, friction, wear, and lubrication of interacting surfaces in relative motion. It is very encompassing, since it looks both the design and the actual function.

Let's look at how these factors affect crankshaft seals.

Let's start by saying that the rear main seal is NOT responsible for preventing leakage. The seal is only one piece of the sealing system. The other is the crankshaft surface. No matter how good a seal is, it's impossible to ensure sealability if the crankshaft surface is not properly prepared.

The shaft surface finish spec-ification ought be 10 to 20 µin Ra with 0 ± 0.05° (that is **3'** or **less**) lead angle. To achieve those numbers, it's recommended to plunge grind the area, check it afterwards for any type of nicks and burrs, and **not** polish the shaft before installing the seal. Another important specification is the surface hardness, which should be at least 30 Rc, with 45 Rc recommended to prevent nicks, scratches, and dents.

Why shouldn't we try for the smoothest possible surface? The answer may be surprising. The 10 µin Ra minimum roughness en-sures that the rubber skin from the sealing tip is worn away (breaking the seal in) and a lubricating film remains to protect the seal lip from further wear. The seal may not break-in properly if the surface were any smoother, while a rougher finish may cause excessive wear of the lip before the protective lubricating film develops. In either case there is a chance of leakage.

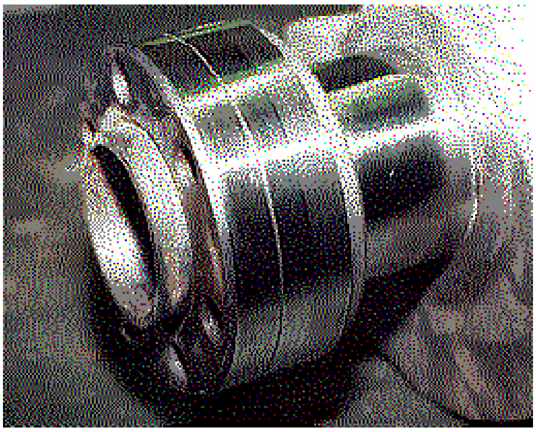
The seal lip usually breaks in less than an hour after initial engine operation and a wear track starts to develop. The width of the wear track stabilizes within 100 hours and varies from 0.010" to 0.040" in width. The seal lip wears very little during the life of the seal, however, it smooths and burnishes the shaft surfaces in the wear track.

The newer "microprofile" design seals result in narrower wear tracks of 0.003" to 0.006". They also tend to last longer because their radial force is about half of the older, more common design. For the last 5 years, all seals designed by our seal engineers for OE applications have been microprofile design.

It's hard to imagine how a seal made out of some rubber compound wears a crankshaft made out of cast iron or steel with a 45 Rc hardness. But, as hard as it may seem, abrasion is always present in any sealing system. For instance, some of the fillers used in the rubber compound are very hard elements, like carbon black and silica. Also, particles like salt and silicon can get between the seal and the shaft surface.

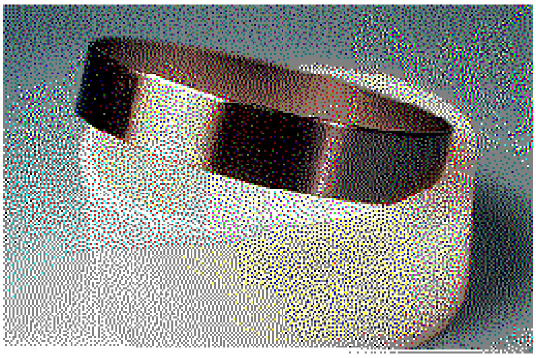
The oil temperature at the lip area (wear track) can be as much as 100°F higher than the engine oil temperature for Nitrile and Polyacrylicate seals. But, it is only 45°F higher for Silicone seals. The increase in lip temperature for FPM materials, such as Viton™, is higher than Silicone but less than Polyacrylate. This additional temperature often converts the oil into resin, which causes carbon build up in the helix of the seal. As carbon builds, the helix loses its effectiveness and leakage occurs.

Worn crankshafts show a groove where the wear track was located. Sometimes these grooves are significantly deep (0.020"), but even if they are not this deep they always represent a problem to be dealt with. So, now we come the part of problem which directly involves the engine builder. What to do???

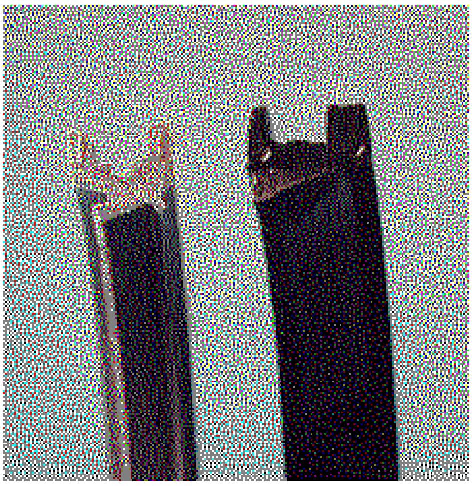


The most obvious option is to weld the crankshaft on the grooved area then machine it back to its original diameter. This used to be the ONLY option not too long ago, and many "old timers" still think it's the only option. However, today there are at least three other options available.

The first is to use a crankshaft repair sleeve, which is designed to provide the seal with the "perfect other piece" of the sealing system. A stainless steel repair sleeve, such as Enginetech's Next Generation Sleeve, provides the optimum sealing surface. They are easy to install with no machining necessary in most instances, and the sleeve is even harder than the original shaft.



However, repair sleeves can **not** be used with two-piece seals. That's how we get to our second option, an offset lip rear main seal. The photo below illustrates the difference between a standard two-piece seal for the GM 350 engine and an offset design. The lip is moved 0.070" from its original position, moving it away from the groove on the crank.



This design also works for one-piece seals, although it requires more engineering analysis. In the case of the one-piece seal, the engine builder could chose between using a repair sleeve or the offset lip. We suggest the use of the seal first, since this will allow you to have a core that can be used with a repair sleeve the next time around.

Either option can result in great savings. One of the largest rebuilder in the country informed us that it costs them at least 5 to 6 times as much to weld the shaft and machine it back than to install a stainless steel sleeve or an offset lip seal.

The latest option presented to our market is the "laydown" design seal. Although a lot of noise has been made about this alternative, we are still testing it. Our engineers have used this type of seal for years at the OE level, but they question how deep the groove can be before leaking occurs. We are evaluating prototypes now and may decide whether this is a viable alternative before the end of the year.