PRECISION INTERNATIONAL

presents:

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Rubber Compounds: Theory and Applications

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Section I: A Brief History

Rubber has been known to the indigenous peoples of the Americas since the early 1400's. It wasn't until Christopher Columbus' second voyage to Latin America in 1493 that he noticed the native Haitians were playing ball. His own men had brought their Castilian (Spanish) wind-balls to play during their idle hours. However, they noticed that the Haitian balls were far superior in that they bounced better. These high-bouncing balls were made from a milky fluid with the consistency of honey. The natives had harvested this fluid by tapping certain trees and then curing it over the smoke of palm nuts.

Not until the 1700's - over 200 years later, a French astronomer had returned from a trip to Peru with samples of this milky fluid. He reported that the local Indians used this fluid for lighting and made shoes from it, which were waterproof. The Indians tapped this gummy fluid from trees technically called Hevea Brasiliensis, better known as the Brazilian Rubber Tree. The Indians called this fluid Cachuchu. However, since the first production use of the substance was to erase pencil marks, it became known as "India Rubber" (since it came from the Indies), or simply "rubber."

- Natural Rubber: It will easily melt at high temperatures and become extremely rigid and brittle at very cold temperatures. It wasn't until Charles Goodyear developed the chemical process known as Vulcanization in 1839 that this problem was resolved.
- Synthetic Rubber: Although excellent for the use in erasers, tires, shoes, etc., natural rubber was not optimum to use as a sealing product. The development of synthetic rubber was as much out of necessity as it was for technological advances. Natural rubber production from the

Amazon regions was not sufficient to support the needs during World War I, so the need to accelerate synthetic rubber development was crucial. Monomers, such as Butadiene, Stryene, Isoprene, Ethelyne, Propylene and Benzene were developed in order to create various polymers, which will be discussed in more detail later.

Section II: Today's Rubber Compounds As They Relate to the Automatic Transmission and Torque Converter

By now, there are probably hundreds of different synthetic rubber polymers that have been developed. In relation to automatic transmissions and torque converters, however, there are only a few that meet the compatibility requirements. They are:

- Silicone (VMQ)
- Nitrile (NBR or Buna N)
- Polyacrylate (ACM)
- Highly Saturated Nitrile (HSN, HNBR)
- Vamac (AEM)
- Viton™ (Fluorocarbon, FKM) (Registered trademark of Dupont.)

Please refer to the chart for the characteristics of each.

Compound Name	Use Today	Automatic Transmission / Torque Converter Compatibility	Temperature Range	Hardness Duro (Shore M)	Wear Resistance
Silicone	Minimal	Some	-80°F → 450°F	65 +- 5	Low (6)
Nitrile	Minimal	Yes	-40°F → 250°F	70 +- 5	High (3)
Polyacrylate	Popular	Yes	0°F → 300°F	75 +- 5	Medium (5)
HNBR	Popular	Yes	-40°F → 325°F	70 +- 5	High (2)
Vamac	Popular	Yes	-30°F → 350°F	76 +- 5	High (4)
Viton	Popular	Yes	-20°F → 450°F	80 +- 5	High (1)

Note: The numeric values assigned to each polymer in the wear resistance column show them in order from best to worst (1-6).

When studying this chart and comparing materials, one has to consider where the rubber component utilizing this compound is going to be used, both in its functional application location, as well as the ambient conditions to which it will be subjected. So let's consider the conditions in which a torque converter is subjected to.

a. Extremely high fluid temperatures
b. High RPM components in very tight quarters

That immediately eliminates Nitrile due to its 250˚ F high-end temperature and silicone due to its poor wear resistance. That leaves us with Polyacrylate, HNBR, Vamac and Viton™. In comparing the high end temperature of 450˚F and wear resistance rating (#1) of Viton™, it is hands-down the rubber compound of choice for both the OEM's and aftermarket suppliers. While the other compounds may have been used from time to time in the past (Nitrile was used back in the Cast Iron PG and 3-Speed Fordomatics), Viton™ is all that is used today due to its obvious benefits.

Section III: Coatings/Colors on Rubber Seals

From time to time you may notice that a seal inside the converter is colored, perhaps, green, orange, etc.

a. Sometimes this color is a coating. The coating is a Telfon (PTFE*) coating and is applied after the seal has been completely cured. The purpose of this coating is to provide a lubrication of sorts to help ease the assembly of components around it so as not to catch or cut it during assembly. Many times this coating will disintegrate during the life of the torque converter, but that is okay since its purpose had already been served.
b. You may also notice an o-ring that is actually a colored rubber. A good example is the late green Honda converter hub o-ring. If you were to slice this o-ring cross-sectionally, all you would see is the green color all the way through. The purpose of the color? In this case, as in many others, it is for identification. In seeing this green o-ring, you know you have the latest re-sized Viton™ o-ring in your hand.

Section IV: Seal Types Inside a Typical Torque Converter

What type of seals will you typically see inside a converter? Here is the list from most popular to least popular:

- O-ring
- Metal Clad Seal
- Lathe Cut (square cut) Seal
- D-ring
- Lip Seal
- Miscellaneous Seal

Where would we find these seals inside a converter? O-rings, Lathe Cut Seals, D-rings, Lip Seals and Miscellaneous Type Seals are typically used to seal pistons and hubs inside the converter. Usually you will find a small Metal Clad Seal inside the converter which seals to the transmission's input/turbine shaft.

Section V: Seal Installation and Preparation

While it is imperative to have the correct seal and rubber compound for the application, it is equally important that these seals are installed properly in order to ensure a long life in the torque converter.

- Prepare the mating components.
    a. Be certain all debris has been cleaned out of piston grooves. The parts washer doesn't always get the embedded debris. So be sure to check closely. Use a scribe if necessary.
    b. Make sure all seal contact surfaces are cleaned, burr-free and prepared properly. It is recommended that a very fine Scotch-Brite® be used in order to clean any remaining glaze off of the bore surface and allow for lubricating of the contacting seal. This will greatly improve the seal's life.
    c. Lubricate seals with transmission oil or assembly lube before assembly.

Section VI: Common Seal Failures

What is the cause of premature seal failure?

- If an O-ring, Lathe Cut Seal, D-ring, Lip Seal or Miscellaneous Type of Seal was cut during installation, the seal will not apply (or seal) properly and cause premature torque converter failure. This could happen if any of the steps in Section V were not followed.

- If a Metal Clad Seal was pressed in at an angle, it will prematurely wear the inner diameter of the seal and cause a possible lock-up failure. If it was not pressed in flush (and concentrically) it may walk out of its bore, causing the same issue.
- Seal wear or "flattening": If surfaces were not prepared properly or if the transmission/torque converter were run beyond normal operating temperatures for a prolonged period of time, this could prematurely wear the seal - although this is not very common due to the use of Viton™.

The rubber seals inside the torque converter are just as important as a true, concentric hub and all of the other internal components.

If there are ever any questions in regard to seal application, please contact me, Vinny Soviero, as 1-800-872-6649 ext. 3022 or e-mail me at vsoviero@transmissionkits.com.