



SEAL FAILURE - COMPRESSION SET

Frequently, compression set is misdiagnosed as excessive wear in the case of dynamic seals and overlooked as a possible cause of leakage in static seals. With modern urethane compounds, there is actually very little wear that occurs on a dynamic urethane seal as long as the metal surface finish is acceptably smooth. Even in cases of a "rough" surface, urethane compounds will "out wear" other elastomeric (elastic) seal compounds.

Nitrile materials are not as resistant to wear as urethanes. That is the reason dynamic seals (especially rod seals) used in almost all hydraulic cylinders and many pneumatic cylinders are designed and manufactured in urethane compounds. Carboxylated nitrile is a compound which has a wear resistance similar to urethane, but is generally more costly and not as readily available. Therefore, carboxylated nitrile is not used as much as urethane in dynamic sealing applications. Urethane is generally the most cost effective wear resistant compound available.

However, urethane generally "suffers" from compression set failure more rapidly than nitrile compounds. Nitrile also suffers from compression set, but generally it takes longer for the physical symptoms of compression set to become evident than with urethane (assuming comparable quality in the two compounds and physical operating conditions).

A seal suffering from compression set will become "flat" or lose its original radial shape on both the ID and OD of the seal where it contacts the cylinder surfaces. In the case of an o-ring, it will retain its round shape on the axial portion of the seal cross section but be flat on the radial portion of the seal.

The degree of "flatness" or loss of original shape will vary with the age of the seal and the application in which the seal is being used.

This failure is sometimes misdiagnosed as wear when the dynamic lip of the seal is inspected and noted that it is flat. So it is assumed the failure is due to wear. However if the static portion of the seal is carefully inspected many times the same "flatness" will be observed there.

Generally leakage, or failure, with compression set will only be experienced when the seal is at "low" pressures or is "at rest" when the machine is idle overnight. Since the seal has lost its "radial" flair there is not as much radial seal force exerted against the sealing surfaces at low/no pressure and thus the hydraulic fluid will leak past the point of seal lip / cylinder surface interface. So, when the operator inspects the machine in the morning before operation, he may find a puddle of oil on the machine under the cylinder if the rod is positioned in a "down" position.

When the cylinder is operated at "high" pressure, the seal suffering from compression set will "deform" in the gland due to the force transmitted through the hydraulic fluid and exert increased radial force against the sealing surface and perform satisfactorily.

Typical causes of compression set include, but are not limited to -

- Time - this is probably the most prevent cause of compression set. Any elastomeric compound will eventually suffer from compression set over a period of time.
- Excessive temperatures - the longer the seal is exposed to higher temperatures (temperatures at the upper level of or exceeding the temperature range of the seal) the more rapid the onset of compression set.
- Squeeze - if a seal grooved is machined incorrectly so there is excessive squeeze on the seal, it will create excessive heat and will hasten compression set.
- Poor quality compounds - higher quality compounds (which tend to be more expensive) resist compression set longer than compounds that use more "fillers" and hence are less expensive. Price is not the sole determiner of quality. Make sure the seals you purchases come from high quality well know manufactures.