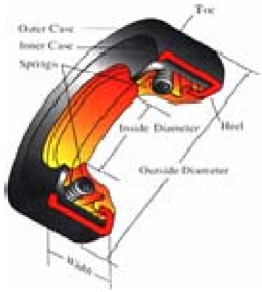

Difference between a metal OD and rubber covered seal

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Over the years, customers have asked us what's the difference between a rubber O.D. and a metal O.D and are there any special considerations when replacing a metal-cased seal with a rubber covered seal. The following article provides an explanation of the differences in seals designed with a metal O.D. versus seals designed with a rubber O.D.

Most shaft seals are typically placed in bores made of steel, cast iron or other common ferrous metallic material. These ferrous or iron containing materials are compatible with both metal cased and rubber covered seals. On the other hand, bores made of non-ferrous materials or softer alloys like aluminum require special consideration especially when subjected to temperature extremes. For instance, when a shaft seal with a carbon steel case is fitted to a bore made of aluminum, and exposed to high temperatures, the result is a loose fit and seal failure. This is because of the differential rates of thermal expansion between the steel cased seal and the aluminum housing.

To prevent the scenario as described above, a seal with a rubber covered OD can be used. Under higher temperatures, rubber expands at a faster rate than the aluminum housing and would actually provide a tighter fit and better sealability. The rate at which the case material and housing material expand in response to the change in temperature is the coefficient of thermal expansion. The coefficient of thermal expansion identifies linear, area or volumetric changes to a material when heat is applied.

Of course, a similar effect occurs at lower temperatures because different materials contract at different rates. A differential contraction can result in the less than optimum fit between the OD of the seal and the housing wall, resulting in leakage. The effects of differential thermal expansion and contraction can be countered by ensuring that your seal case is made of the same material as your housing bore. Since this is not always possible, a rubber covered seal may be used to maintain a proper fit.

DIFFERENTIAL THERMAL EXPANSION - difference in the rate of expansion between two materials, caused by temperature changes. For example, the difference in the rate of expansion between a steel metal cased seal and its aluminum housing.

COEFFICIENT OF THERMAL EXPANSION - the rate at which a given material typically expands or contracts with changes in temperature. The changes can be one dimensional (linear), in area or volumetric. All three are closely related with a change in area due to temperature at roughly twice the linear change and a change in volume due to temperature at roughly three times liner change.

Metal OD with metal inner casing for lip protection and structural rigidity

Typically, metal cased shaft seals are constructed out of a stamped metal case with a sealing lip made of an elastomer bonded to the case. The case is usually made of mild carbon steel formed using a stamping press. A Large diameter seal is usually metal spun. The purpose of the case is to protect the lip during installation and provide a snug fit between the outer diameter of the seal and the housing bore. Unless a metal cased seal is made of stainless steel, a protective coating is sometimes applied to prevent corrosion. Metal cased seals used in food and drug preparation are required by the FDA to be made of stainless steel to prevent rust. Seals operating in highly corrosive environments should also be made of stainless steel. The Society of Automotive Engineers has developed a system for identifying different types of steel. Under SAE standards, different types of carbon steel materials are identified by a four or five digit code. The code identifies the amount of iron, any other alloys and carbon present in the seal. For instance, a 1060 code represents a plain carbon steel (1), with no other alloy elements present (0) and a carbon content of 0.60wt %.

Metal cased seals are at work in several applications sealing against various media in pressurized and non-pressurized environments. Because of their materials and construction, metal cased seals provide a cost effective sealing solution. Metal cased seals perform best when installed in a steel housing. Because the bonding element used to adhere the elastomer lip to the metal case is applied to the entire seal it helps the seal maintain its position in the housing bore. The OD of a metal cased seal can be coated with a polyurethane-based sealant to prevent possible leakage caused by scratches on the casing and to assist with seal retention in the bore. Note: care must be taken when applying any adhesives or coatings because even though the coating is minimal, it materially affects the OD measurements and can cause the seal to be out of tolerances.

When properly installed and under “normal” operating conditions a metal cased seal should not fail prematurely. Metal cased seals can fail due to differential thermal expansion as explained before. They can also fail due to improper installation, while being tapped into place the seal becomes tilted or misaligned in the bore. In addition, if there are any scratches on the case or housing, a leak path may develop allowing the sealed media to escape. To prevent failure it may be necessary to change the OD finish of the seal.

A rubber OD seal is used under conditions where a metal OD seal could fail. For instance, if a metal cased seal were placed in an aluminum housing operating under higher temperatures it would probably fail due to differential thermal expansion. Since, aluminum expands at a faster rate than steel there is decreased retention force between the housing wall and the seal OD. Under these conditions, the seal could move within the housing causing leakage. To prevent this, a rubber covered OD seal should be used. The differential thermal expansion of the rubber OD and the aluminum housing results in the seal maintaining its retention force.

Rubber covered OD with metal insert, garter spring and dust lip

Typically, rubber covered OD seals have .01” to .05” of rubber coating on the metal OD of the seal. The rubber covering helps protect the metal casing from corrosion and protects the seal from installation damage. In addition, when used in an aluminum housing, a rubber-covered seal provides better retention force between the housing and the seal OD during thermal expansion and contraction. Applications requiring increased sealability and retention force between seal OD and housing bore, can benefit from using a ribbed rubber covered seal. These seals have a ribs running along the seal OD to provide a higher point of contact with the housing bore which increases the load points. To make fitting the seal into the housing easier rubber covered seals will have lead in chamfers that provide easier insertion.

On the other hand, rubber covered seals do have limitations. For instance, during installation shear stresses build up between the housing wall and seal OD that can cause the seal to unseat itself. This phenomenon is called “spring back”. Rubber covered seals are also susceptible to compression set. This occurs when an excessive load exerted on the seal is released and the rubber does not return to its original thickness which inevitably causes leakage. Operating under excessive heat can cause compression set because rubber expands at a faster rate than the metal housing. Excessive expansion results in increased pressure between the seal OD and housing wall causing possible compression set.

Finally, there is the hybrid metal and rubber OD seal. This profile features both metal and rubber on the seal. The metal portion of the seal ensures the elastomer lip is protected and helps the seal maintain its position in the housing. The rubber portion helps protect from installation damage and corrosion. Metal rubber seals come in a variety of profiles including, metal on the contaminant side and rubber on the fluid side of the case or rubber only on the OD with the metal case on both contaminant and fluid side being exposed.

Whether metal cased or rubber covered, rotary shaft seals are one of the most popular sealing solutions in use today. Their design allows for a variety of configurations depending on the application. The seal OD is only one aspect to consider when selecting the right seal for your application. Through thorough analysis of the seals operating environment you can ensure optimal performance and reduce equipment downtime.

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