7 SEPTEMBER 2017

Motorsport Design Considerations for Rotary Shaft Seals

Motorsport has long been viewed as a test bed for new technology and product development for road vehicles. The tremendous stresses of race track testing can make it especially easy to understand how components have to be evaluated and re-engineered to work with the automotive industry's constantly evolving passenger car systems and components.

Trelleborg Sealing Solutions are producing lightweight, friction-reducing rotary shaft seals that are successfully used on Formula One and IndyCar racing platforms. Torque and power consumption values vary with seal designs and material, which is why it has become so important to identify seal configurations that achieve the best possible performance for racing requirements.

Turcon® Varilip® PDR rotary shaft seals extend the boundaries imposed by elastomer radial shaft seals, utilizing advanced materials and design techniques to provide optimum sealing performance for motorsport applications. The outcome is a superior sealing solution, which retains a compact seal envelope.

> **The option of an integrated end plate can allow end users to optimize their hardware design to minimize envelope and part count**

Turcon® Varilip® PDR seal with integrated end plate

Material Specification

Standard elastomeric rotary shaft seals have a limited application range with respect to temperature, surface speed, media compatibility, pressure or a combination of these due to the inherent limitations of the various elastomer grades. Furthermore they only suitable for applications with adequate lubrication.

Turcon® Varilip® PDR rotary shaft seals are characterized in particular by low friction stick-slip-free running, reducing temperature generation and permitting higher peripheral speeds.

Trelleborg Sealing Solutions has developed a range of specially modified materials on the basis of the proven Turcon® PTFE (polytetrafluoroethylene) based material for use in Varilip PDR.

For motorsport applications Trelleborg Sealing Solutions recommends Turcon® T25.

Material, Applications, Properties	Code	Operating Temp.	Mating surface hardness	Pressure max.
Turcon® T25 Standard material with exceptional wear and friction characteristics. For lubricated running, e.g. oil, grease Glass fiber, lubricant Color: Gray	T25	-60°C to +200°C -76°F to +392°F	Min. 55 HRc At low pressure and up to 4m/s (788 fpm) min. 45 HRc	2 MPa / 290 psi

Turcon® material has the characteristic of inherent memory, whereby a distorted Turcon® component will attempt to recover to the profile it had during the sintering cycle of its manufacturing process. This feature is used to provide the necessary radial loading of the sealing lip onto the shaft, negating the requirement for the energizing spring present in elastomeric seal designs.

Integrated End Plate

Turcon® Varilip® PDR seals are constructed from only two parts – a precision manufactured metal body and a mechanically retained Turcon® sealing element. Unlike seals with pressed metal cases, a gasket is not required to provide sealing between the lip and casing. This is provided by the mechanical retention of the lip, improving both the chemical resistance and temperature range of the sealing system. The option of an integrated end plate for Turcon® Varilip® PDR can also allow end users to optimize their hardware design to minimize envelope and part count.

Hydrodynamic Sealing

The Turcon® Varilip® PDR seal is available with a hydrodynamic feature on the Turcon® sealing lip. This provides a positive displacement of the fluid as a result of the shaft rotation to give improved sealing in applications where the shaft only rotates in a single direction. The feature also increases the flexibility of the lip, which allows a wider contact band between the Turcon® lip and the shaft and helps to reduce shaft load and associated wear temperature.

Speed

The graph in Figure 1 shows the superior surface speed capability of Turcon® Varilip® PDR compared to elastomeric shaft seals.

The operating speed directly impacts the temperature generated by the seal and is an important factor when considering the requirements for the sealing system.

The actual limiting speed will depend on the temperature, pressure, media, lubrication properties, heat dissipation and the shaft condition.

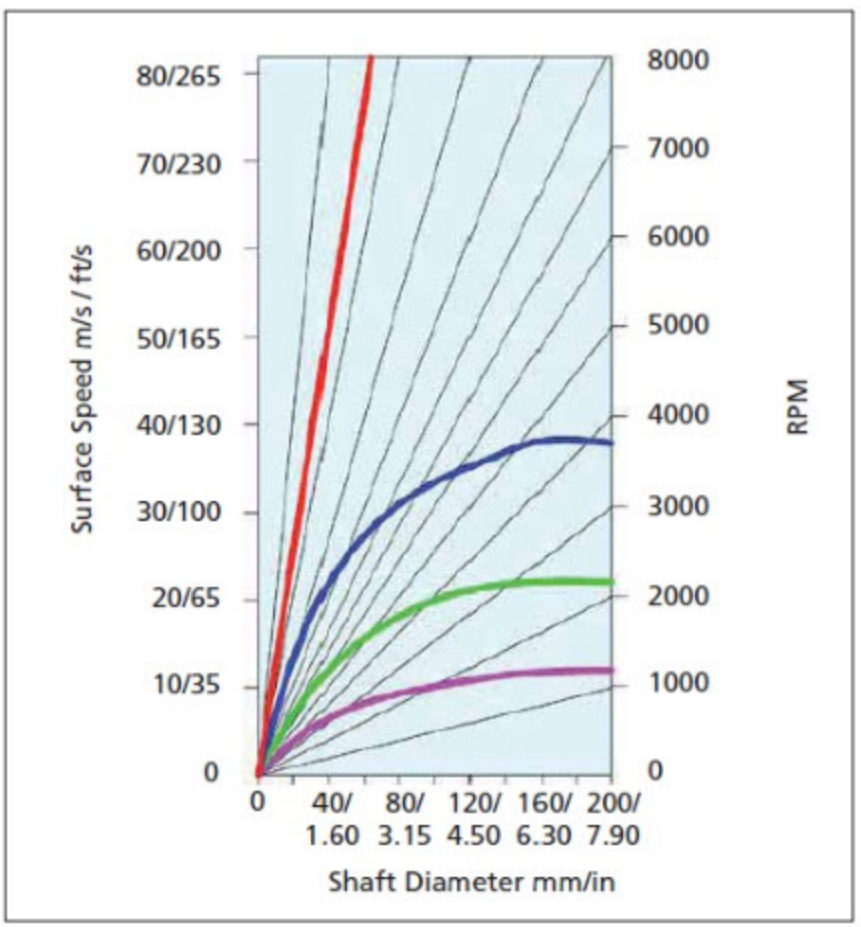

Figure 1 – Surface speed as a function of shaft diameter and RPM

General recommended maximum surface speed			
Turcon® Varilip® PDR		100 m/s	19,680 ft/min
Fluoroelastomer		38 m/s	7,500 ft/min
Silicone		38 m/s	7,500 ft/min
Polyacrylic		22 m/s	4,320 ft/min
Nitrile		12 m/s	2,340 ft/min

General recommended maximum surface speed

Power Consumption

One of the key features of Turcon® Varilip® PDR is its low friction, resulting in very low power consumption. Figure 2 shows the running torque for a 40mm /1.73 in shaft diameter Turcon® Varilip® PDR seal.

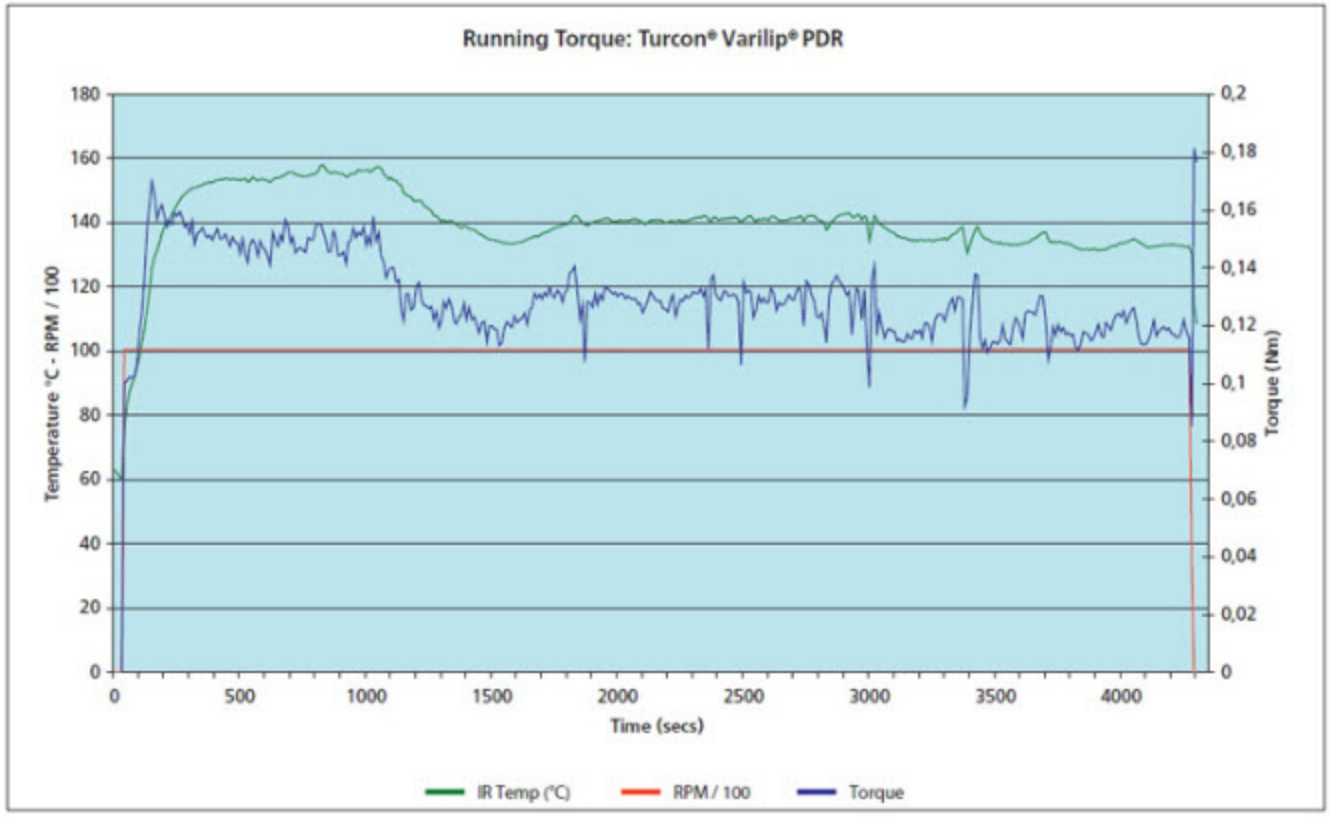

Figure 2 – Running torque for Turcon® Varilip® PDR seal

Endurance

Turcon® Varilip® PDR rotary shaft seals can provide extended service life compared with elastomer shaft seals. As with any seal, however, the life of a Turcon® Varilip® PDR seal depends on the specific operating parameters. PTFE is an inherently stable material and does not suffer from aging or degradation as with elastomers.

Temperature

All Turcon® Varilip® PDR seals are capable of outstanding high and low temperature performance compared to elastomeric materials.

Unlike other PTFE lip seals the Turcon® Varilip® PDR seal is not limited in its temperature performance by the presence of an elastomer gasket. This gives it excellent temperature range capability.

The temperatures in Figure 3 are general working limits of the seal material, and in all cases the effective limit for a rotary shaft seal application would be much lower.

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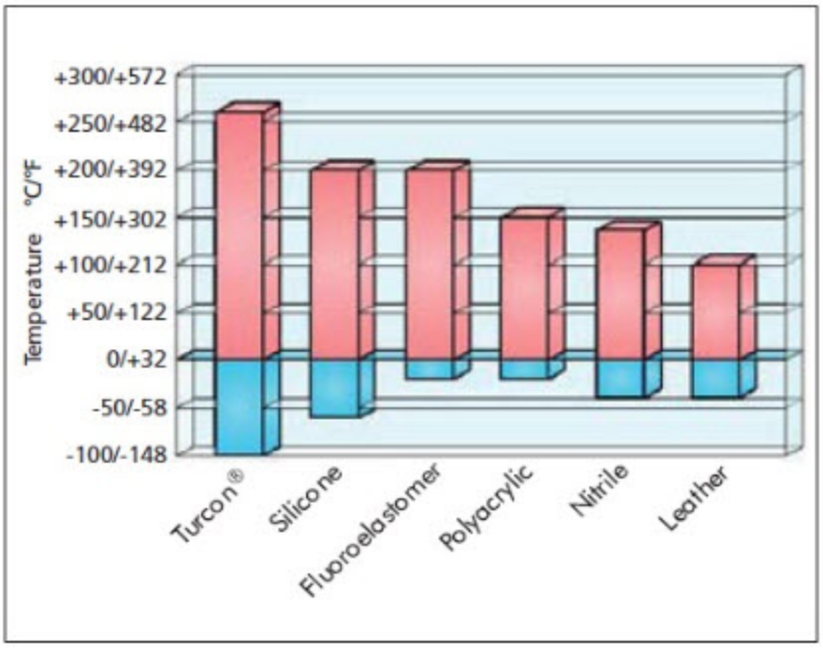

Figure 3 – Maximum and minimum temperatures for different materials

General recommended minimum / maximum temperature		
Filled PTFE	-100 to +260° C	-148 to +500°F
Fluoroelastomer	-20 to +200° C	-4 to +392° F
Silicone	-60 to +200° C	-76 to +392°F
Polyacrylic	-20 to +150° C	-4 to +300°F
Nitrile	-40 to +135° C	-40 to +275°F
Leather	-40 to +100° C	-40 to +212°F

Temperature

Pressure

Pressure significantly influences the contact force between the sealing lip and the shaft and consequently the heat generation. This must be taken into consideration when selecting the appropriate seal type.

Standard Turcon® Varilip® PDR seals are suitable for pressures up to 0.5 Mpa /73 psi, with supported lip variants able to be designed for higher pressures. PV values up to 10 Mpa m/s can also be accommodated.

Fluid Resistance

Turcon® Varilip® PDR seals are resistant to mineral acids, bases, common organic fluids and solvents. They are also unaffected by oxidation, ultraviolet radiation or ozone.

A particular benefit of Turcon® Varilip® PDR seals is a resistance to oil additives and biofuels, which have an adverse effect on many elastomers. Using Turcon® shaft seals allows the increased use of additives and a longer oil service life.

For a complete design consultation on rotary shaft seals for motorsport or automotive applications, contact your local Trelleborg Sealing Solutions Marketing Company.