Sealing Solutions For A Diverse Mobility Market

Sealing design and material developments for efficient vehicle drives – electric, hydrogen, combustion

(Bild: ElringKlinger Kunststofftechnik GmbH)

AUTOMOTIVE DYNAMIC SEALING SYSTEMS, RAW MATERIALS / MIXTURES – The increasing development of new drive systems in the automotive industry requires new ideas and creativity. In particular, developments in the field of electric motors, H2 technology, hybridization or alternative fuels, all demand innovation to produce new sealing designs and materials which meet increasingly arduous operational requirements.

In order to meet targets for CO_2 reductions in modern vehicles, various drive concepts have been developed and introduced into series production in recent years :

- Electric vehicles with rechargeable battery systems
- Electric vehicles whose energy generation is based on H2 technology
- Hybrid vehicles with conventional combustion and electric engines
- Combustion engines for synthetic „e-fuels“

Thus, the applications which require high performance sealing solutions will continue to create new challenges to maintain high levels of sealing efficiency and performance.

Miniaturization requires new solutions

In addition to driveline trends, there is also a noticeable move towards product miniaturization. For instance, miniature high-pressure seals have already been implemented as the preferred solution on hydrogen fuel cell regulators. Using a special PTFE sintered compound, ElringKlinger Engineered Plastics have developed a unique solution which is capable of operating at pressures of up to 800 bar.

These axially moving valve rods have a diameter of only 3 to 6 mm and are successfully sealed with spring-energized PTFE U-rings (Fig. 1). The sealing lips on both the dynamic rod side, as well as on the static housing side are activated by a stainless steel spring element to ensure efficient and reliable sealing performance across the entire pressure and temperature range.

Different designs of seals such as those having an integrated support ring made of PEEK (Fig. 2), are able to prevent extrusion into the gap behind the seals. With the use of these designs, PTFE and PE-UHMW base materials can be used which are both able to offer low stick-slip valve switching whilst maintaining high sealing efficiency, especially important in the case of critical gaseous media.

Safe Protection of Electronics

The importance of electronics protection is increasing significantly in many assemblies such as actuators in electric gearboxes. The growing requirements within this area present challenges which have to be faced from low-friction rotary shaft seals. Small shaft diameters in the range of 4 to 10 mm and small radial and axial installation dimensions of approx. 2 to 4 mm can be reliably sealed with modern shaft seal designs. In the case of gear actuators for example, selector shafts are activated by pivoting movements. In addition to their shaft bearings, these dynamic shaft pivoting movements of approx. ± 90° must also be sealed against the gear oils in order to protect the integrated electronics. In order to achieve this, special geometries of compact spring energized U-rings are used. If necessary, these can be injection molded in high volumes using Moldflon™ fluorothermoplastic materials. The patented spring elements for activating the two sealing lips on the dynamic shaft side and static housing side ensure a consistent radial force over the entire temperature range from -40 °C to +180 °C.

Make internal combustion engines more effective

Due to general legal requirements for CO2 reductions, there have been further developments in traditional combustion engines. One such development is to inject up to 40% water into the combustion chamber alongside the normal ingestion of gasoline. This however is a challenge for the complete fuel supply system due to the additional requirement for a direct water injection circuit.

Special water pumps and modules have to be developed which in turn require special seals in order to seal their drive shafts from the atmosphere and also to protect the sensitive drive electronics. The sealing of water is a unique challenge well known to the sealing technology experts at ElringKlinger. ElroSeal™ shaft seal (Fig. 3) was developed as a solution for this type of application.

These rubber covered metal cased shaft seals with combinations of seal lip design show reliable sealing and chemical resistance to almost all media. In order to achieve efficient sealing in applications with small pressure

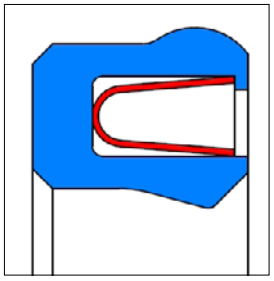

Fig. 1: spring-energized PTFE U-ring, standard (Figure: ElringKlinger Kunststofftechnik GmbH)

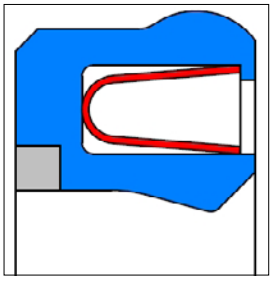

Fig. 2: spring-energized U-ring with integrated pressure support (Figure: ElringKlinger Kunststofftechnik GmbH)

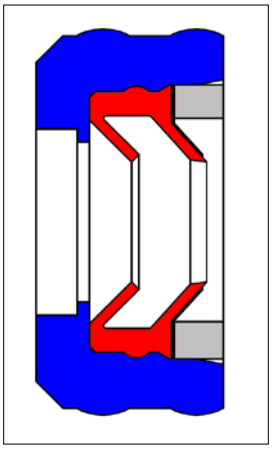

Fig. 3: ElroSeal™ Shaft Seal (Figure: ElringKlinger Kunststofftechnik GmbH)

differences, the primary sealing lip on the water side is spring energized. An elastomer coating provides the static seal against the housing. The spring supported sealing lip is designed in such a way to ensure high sealing efficiency at low media pressures and over a wide temperature range from -40 ° C to +130 °C without impacting on the service life of the seal.

Further CO2 emission reductions for combustion and hybrid vehicles

What has been the state of the art in standard internal combustion engines for years is now increasingly being used in hybrid vehicles.

Small displacement engines, primarily gasoline engines in the passenger car sector, are fed by high pressure fuel pumps activated via cam drives. These pumps have plungers that require seals capable of separating two media (fuel and engine oil) whilst being subjected to high frequency reciprocating movements. Contamination of the two media must be avoided to ensure efficient combustion and a long engine life.

In recent years, pump pressures have been systematically increased. Originally pumps were rated at 150 bar where as today, 350 bar is a standard specification. Life expectancy of the pump has also increased and is now set at 240,000 km.

Developments continue to achieve gasoline pressures up to 500 bar with life expectancy greater than 300,000 km.

The increased requirements on the seals in these pumps, in particular regarding pressure stability, tightness and wear resistance, can only be met by using the latest sealing materials based on Polytetraflon™ and Moldflon™ (Fig. 4). Furthermore, the sealing lip geometry also plays an important role which has resulted in ElringKlinger Engineered Plastics introducing a number of patented sealing lip designs. These unique 2 or 3 lip spring-energized seals guarantee the required service life and the lowest possible leakage to meet the latest exhaust gas and emission requirements. On the high pressure side of the seal, further efficiencies in pump performance can be achieved by including an additional piston ring into the sealing system (Fig. 5). This helps to further minimize leakage during normal service but especially during cold starts

The development potential in the field of engine technologies shows a wide range of options for optimizing combustion, improving consumption and reducing emissions, especially in smaller gasoline engines in hybrid vehicles.

Conclusion

These examples show that regardless of how the mobility mix develops over the next few years, design and material developments in seals will play a critical role across a wide range of drivetrain systems.

Facts for the construction

- Miniaturization, higher temperatures, speeds and pressures are the challenges that are usually met with a mix of seal design and materials

Facts for quality management

- Modern seals enable increased quality requirements, such as longer engine running times, to be met

Further Information

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Fig. 4: spring-energized U-ring for separating media (Figure: ElringKlinger Kunststofftechnik GmbH)

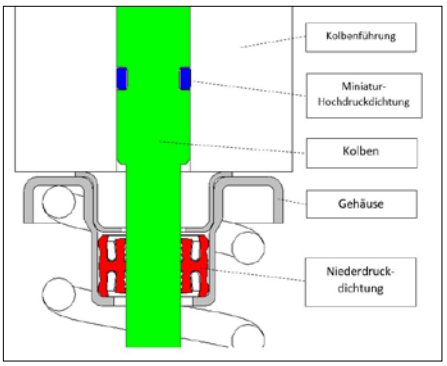

Fig. 5: Cross-sectional view of the pump element (Figure: ElringKlinger Kunststofftechnik GmbH)