Charging into the future

Recognising that a specialised sealing solution was needed for e-Mobility applications, Trelleborg Sealing Solutions has developed two new seals that could help noticeably extend the distance travelled by electric vehicles between charges, as **Harlan Hart**, technical manager, e-Mobility, explains

According to a report by the International Energy Agency (IEA)*, 3.1 million electric vehicles travelled the roads globally in 2017. This, however, is expected to grow exponentially with estimates ranging from 125 to 220 million electric cars worldwide by 2030.

One key to this growth is the availability of components that enable electric vehicles to operate more like conventional vehicles. Unfortunately, electric vehicles tend to have shorter travelling ranges, battery charging takes a lot longer than filling up with traditional fuel, and the charging infrastructure is not yet widely available. People therefore worry the vehicle has insufficient range to reach its destination. The solution to this is to build the charging infrastructure, improve charging efficiency, and increase battery capacity to extend the distance that cars can travel on a single charge.

In electric vehicles, the e-axle is a critical component. This is an electro-mechanical propulsion system contained in an axle structure that houses an electric motor, power electronics, and some form of gearing/differential. All this fits within the traditional engine space. The motor and gearbox are directly coupled.

However, while the gearbox requires efficient lubrication, the motor must remain dry, so a highly reliable seal is required between these two components.

The difficulty in sealing this system is that electric motors run most efficiently at high speeds. Gasoline engines normally run at 2,000 to 4,000 rpm, and an electrically driven transmission runs up to eight times faster, typically at 16,000 rpm. In the future, this is likely to increase significantly.

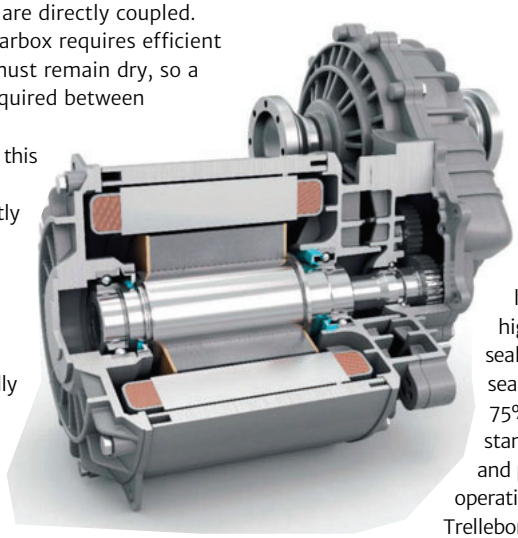
The rotational surface speed limit for traditional seals in today's e-axle is around 100ft/sec. However, to maximise efficiency, the theoretical optimal rotational surface speed of the e-axle would be greater than 200ft/sec – a speed that is currently impossible to achieve. This limits electric cars to travelling short distances.

If electric cars are going to challenge combustion-driven vehicles, they will need to be capable of travelling 250 to 300 miles on a single charge. The challenge facing e-Mobility seal manufacturers is increasing operating rotational speed to support the mission of electric vehicle manufacturers to extend the travelling distance.

DEVELOPING THE SOLUTION

Recognising that a specialised sealing solution was needed for e-Mobility applications, Trelleborg Sealing Solutions created a cross-functional agile product development team to rapidly find a solution.

Following customer consultations and detailed market analysis, the team developed two seals, both of which met or exceeded the team's target speed of at least 130ft/sec. These performed comparably relative to critical torque and power consumption and exhibited zero leakage, despite the highly demanding sealing conditions. One seal reduced friction 75% compared to a standard seal of its type, and proved capable of operating at 200ft/sec. Trelleborg Sealing Solutions commercialised both seals, offering solutions for a range of requirements including run out, dry running, fluid compatibility, high temperatures and high pressure. HiSpin PDR RT is the best option for dry running, wider fluid compatibility, higher temperature and high-pressure applications. HiSpin HS40 is better suited to applications that require run out and ease of assembly.



HiSpin PDR RT is made of Turcon QD1 PTFE-based material

To ensure tests were meaningful and representative of market requirements, the team developed key parameters and test procedures taking into consideration a range of customer requirements, reviews of multiple sets of application data, plus discussions with major Automatic Transmission Fluid (ATF) and bearing manufacturers. The team tested seals on a 38mm shaft at rotational speeds of up to 21,000rpm (130ft/sec) in temperatures ranging from -40°F to +302°F in ATF in oil mist conditions for a duration of a 500-hour accelerated load cycle test that represented real driving conditions, including reversing, city driving, stopping and starting in traffic jams, and high-speed highway driving. In addition to the 500-hour accelerated load cycle test, each seal was also subjected to more than 3,000 hours of endurance testing.

Both HiSpin PDR RT and HiSpin HS40 passed the accelerated load cycle test with no leakage and no wear on the sealing lip or shaft. In fact, the wear on the running surface was barely noticeable and Finite Element Analysis (FEA) results all proved positive.

HiSpin PDR RT is made of Turcon QD1 polytetrafluorethylene (PTFE)-based material, which is compatible with virtually all media, so no additional material tests were required for this seal. Manufactured from proprietary XLT FKM (Fluoroelastomer), HiSpin HS40 underwent long-term immersion in the ATF commonly used in electric drive systems for 168 hours at +284°F, and 500 and 1,000 hours at +257°F. Compared to terpolymer FKM, ethylene acrylic rubber (AEM), and acrylic rubber (ACM) materials, the XLT FKM demonstrated significantly less volume change and excellent retention of chemical and mechanical properties.

Today, the seals are undergoing extended testing by several electric systems and vehicle manufacturers. Provided the seals continue to perform as expected in e-Mobility e-axles, they could help noticeably extend the distance travelled by electric vehicles between charges.

The agile product development team continues to focus on improving the efficiency of electric vehicles, making them a viable option for widespread use in the future.

Trelleborg Sealing Solutions
tss.trelleborg.com

*https://www.iea.org/gevo2018/