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Wear on Rotary Shaft Seals
- Wear Models and Influencing Parameters

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Abstract:

Rotary shaft seals prevent fluid exchange at shaft passages and have been used successfully for decades. The sealing edge of the cross-sectional geometry of a rotary shaft seal and therefore the pressure distribution between the sealing edge and the rotating shaft is not symmetrical. This results in a back pumping mechanism which is crucial for leak tightness.

Wear on the sealing edge changes the geometry of the sealing ring and therefore the pressure distribution. The functionality of a rotary shaft seal is therefore impaired by excessive wear during operation, which can lead to failure of the entire machine or system.

In order to determine and predict the wear of elastomer rotary shaft seals, suitable wear models were researched. The wear models differ not only in the number of parameters but also in the material constants and variables included in the wear equation. A 2-dimensional simulation method was developed to predict the wear on rotary shaft seals. This allowed different wear models to be used and compared.

The finite element method was used to determine the contact pressure between the sealing edge and the shaft. Based on the contact pressure, the wear models, all taken from the literature, were used to calculate the amount of material removal. As the contact pressure changes due to wear, this process was repeated iteratively until a sliding distance of 40,000 km was reached.

The 2-dimensional geometries of worn sealing edges, based on two different wear models, are shown in **Figure 1**. Depending on the wear model used in the simulation, the sealing edge wears differently, resulting in different contact pressures. **Figure 2** compares the asymmetric contact pressure distribution of an unworn rotary shaft seal with contact pressure distributions of worn seal rings obtained from wear simulations using different wear models. Not only the distribution of the resulting contact pressure but also the maximum contact pressure to be expected is different for each wear model.

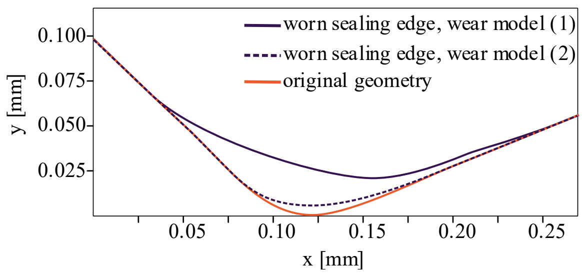

Figure 1: Outline of the worn sealing edges, determined by different wear models, compared to the geometry of the original sealing edge.

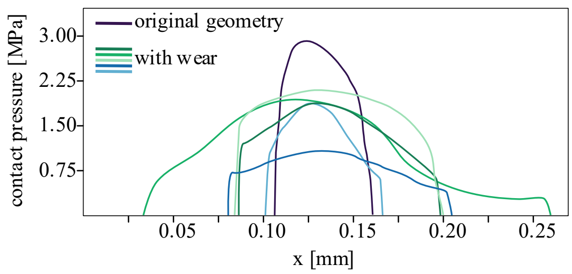

Figure 2: Pressure distribution between sealing edge and shaft.

The developed simulation method was used to analyse the wear of rotary shaft seals. The influence of different material properties and further variables included in the wear models on the resulting wear was evaluated. In addition, the impact of the wear model used was analysed.

The ability to simulate wear allows various influencing factors such as lubrication condition or material parameters to be changed quickly and easily to assess the effect on the amount of wear. This information can be used to understand experimental test results and apply this knowledge in the design process to minimise wear and extend the life of rotary shaft seals.

Keywords: Sealing Technology, Rotary Shaft Seals, Wear, Elastomers, Finite Element Methode, Finite Element Analysis