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Testing methodology for elastomers in tribology

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Elastomers are a class of materials extremely important from a technological point of view in many tribological applications, as for example for seals. Unfortunately, while metals show a reasonably predictable and repeatable behaviour, elastomers are very complicated to understand. The majority of the elastomers behave as hyperelastic materials, hence the difficulty to be described. This work is focused on the first step required for a robust and reliable tribological simulation of elastomers, the collection of consistent experimental data from laboratory equipment and component test bench.

Keywords: tribology, seals, elastomer, characterization

1. Introduction

Elastomer is the term used to define the polymers that show viscoelastic characteristics.
An elastomer differs from other materials regarding the tribological behavior. The contact mechanisms in rubber-like materials is affected by their deformation ability [1], [2]. The contact area cannot be described by Hertzian theory because it is affected by adhesion forces. The real contact area between the elastomer and the counterpart is larger than what described by Hertzian calculations and because the elastomer is able to fill the microscopical valleys determined by the roughness.
In this work, we describe the methodology used to characterize elastomers considering the peculiarities of this materials.

2. Materials

For the experiments, three commercial thermoplastic elastomers (polyurethanes) were considered:
HPU Premium, HPU Mellow doped and HPU Lubric doped.
The materials were provided by Trygonal Group and are commonly used for static seals, rod and piston seals, wiper seals and rotary seals. The counter material for the tribological tests was chromed steel 42CrMo4V.

3. Methods

Both with tensile and compression stress tests were carried out on the polymers.
The stress–strain behaviour of elastomeric materials is known to be rate-dependent [3], for this reason the elastomers were tested at three velocities.
The samples for the tensile stress were manufactured in a dog-bone shape with testing length of 25 mm.
Compression tests were carried out on round sample with diameter of 30 mm and height of 12 mm. the tests finished with a deformation of the sample of the of 66% of its initial height.
Tribological laboratory tests were realized with three configurations, as shown in Figure 1.
The tests were realized with 2 contact pressure and 2 velocity and the objective was to select the configuration that best match the behavior of the seal in actual conditions.
The tribological tests at component level were realized in the TESSA test bench in reciprocating mode [3]. The seals were tested to check their durability and the presence of leakage. The friction forces were also monitored during the tests.

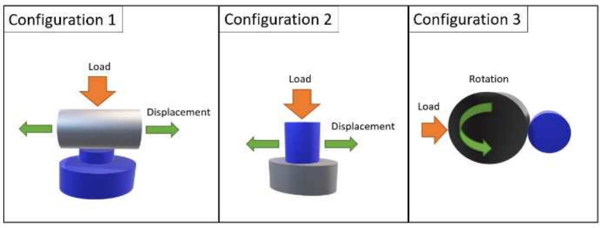

Figure 1: Testing configurations used in the laboratory (cylinder on disc, pin on disc and twin disc).

4. Discussion

The results obtained highlighted the importance of the methodology when we are testing elastomers.
For tensile stress tests, it is essential to consider that the initial resistance of the material can change if we apply a cyclic stress, so it is not enough to get the stress strain curve as for metals. Cyclic stress test should be considered. For the compression tests, the influence of the friction coefficient between the sample and the tools used can be relevant. To get valid results, it is necessary either to reduce as much as possible the friction coefficient or to use alternative methods.
Among the configurations tested for the laboratory tribological tests, the pin on disc system seemed to give more reliable and repetitive results.
The experiments with TESSA test bench showed that the correlation between friction and contact pressure are different in the case of the laboratory scale tests and the component scale tests. Working with elastomers, it is necessary to be careful when we have only the results from laboratory tests.

5. References

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