Creep Recovery Tests for Elastomer Seals?

The DMA GABO EPLEXOR® 2000 N Delivers the Response

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Introduction

In technology, the term "seal" is used to describe elements or structures that have the task of preventing or limiting unwanted material transfers from one place to another. If, for example, a shut-off tap is still dripping, its seal is defective [1]. Elastomer seals are used in technical applications and perform a wide variety of sealing tasks. Depending on the application, the areas of fundamental importance include selection of the materials, their design, the required seal geometry or seal shape and, of course, the physical and chemical boundary conditions under which the tailor-made seals are to be used.

For this reason, detailed knowledge of the physical and chemical conditions to which the application is exposed – such as temperature and pressure ranges, chemical resistance and thus the selection of suitable inert substances – are prerequisites for successful design of a seal.

Media Resistance

However, it is not enough to consider just the media resistance of the source materials (educts), for example, within a technical chemical production chain. The seal must also be chemically resistant to the products produced in the manufacturing process. The required media resistance therefore is affected by the media in contact with the media to be separated or sealed, the media created during operation, the ambient air, additives such as lubricants, and consumables such as cleaning agents.

Temperature Stability

The operating temperature range for sealing materials is determined on the basis of a possible continuous operating temperature with sufficient safety reserves. It should also be borne in mind that decomposition reactions may take place during operation that cause the sealing material to shrink or swell. In addition, the starting conditions can change due to temperature, pressure and wear.

In addition to the suitability tests, an important part of the development process for elastomer seals is thorough material testing. Creep recovery experiments play a key role in this.

What Are Creep Recovery Tests?

During a recovery test, an elastomeric specimen, usually a cylindrical specimen being subjected to a compressive load, is deformed at a constant temperature for a predetermined period of time. This is followed by a relief phase (i.e., no load/force), which usually takes place at the same temperature. Here, too, a defined period of time is set for the "sample recovery". Upon relief, an ideal seal would immediately "straighten up" without any time delay to the starting height (e.g., elastic spring).

However, real seals behave differently from this. Depending on the material, its internal structure, the ambient temperature and the influence of the medium, the "raising" or restoring processes may run very differently. It can often take several hours or even days before the initial height is reached again. There is also the possibility that materials may no longer reach their original height and remain permanently, irreversibly deformed. An important quality criterion for a seal is its restoring property:

How quickly and at what level compared to the "virgin" initial level does the material restore itself in the test?

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Measurement Conditions

As a rule, so-called "bulk" properties are required in materials testing in order to draw significant, reliable conclusions. What is meant here is a large-volume specimen. If the dimensions of the specimens are too small, the ratio of specimen surface to specimen volume becomes unfavorable. The test results determined can then no longer be directly used to infer the material properties. For this reason, large-volume test specimens should be exposed to the deformations that occur in the application.

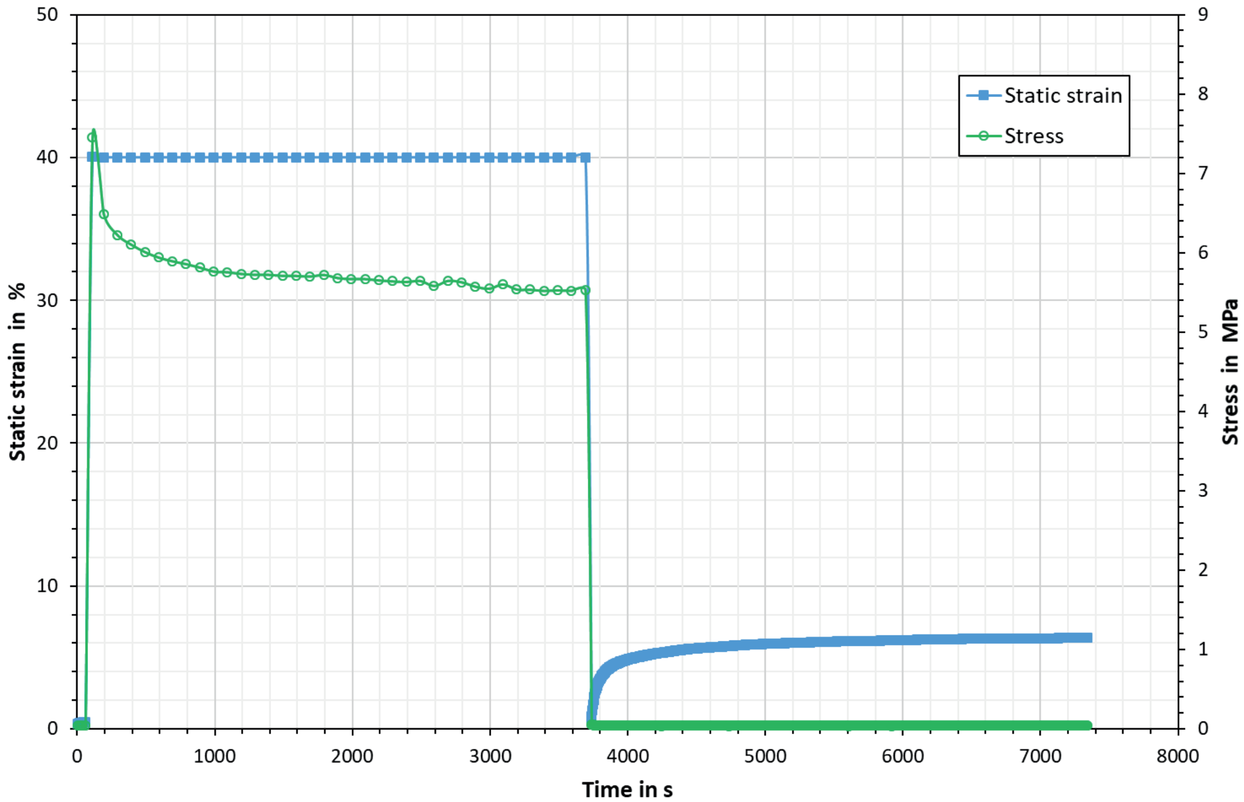
Creep recovery tests are carried in this example out on a cylindrical carbon black filled sample (height: 25 mm, diameter: 20 mm) of an elastomeric sealing material at room temperature in a high-load DMA GABO EPLEXOR 2000 N.

For this purpose, a static compression of 40% based on the initial sample height was applied. This deformation was regulated for a period of one hour and kept constant. Then, the static force that was required to compress by 40% was "abruptly" removed, a contact force of 2 N was applied and the resulting recovery process was recorded for one hour. This low-force component has no influence whatsoever on the "straightening" process, but is required to hold the sample tight.

Measurement Results

Figure 1 shows the time course of the deformation and stress during the creep recovery test.

The sample is compressed by 40%. Initially, the mechanical stress increases sharply. The required initial force is approx. 2,400 N (7.5 MPa x 314 mm^2 ~2,400 N). If the deformed state is maintained for a period of one hour, a drop in the applied stress is measured. Depending on the materials used, their internal structure and composition, the substance-specific intrinsic molecular mobility can often be very different. Through so-called relaxation processes, the materials undergo a reduction in the applied



1 Creep recovery tests of elastomeric sealing materials at room temperature

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stress at different speeds. The stress level that had been reached and the period of time that had elapsed before arriving at this "quasi-stationary" state provides information about the long-term behavior and enables assessment of the property profile in real applications. In this case, the stress reaches an almost constant value of 5.5 MPa.

In a second step, the static force is abruptly removed and a contact force of 2 N is applied to hold the specimen tight. This stress reduction is accompanied by a spontaneous reverse deformation, which lasts for a relatively short time in the this case. The sample creeps or expands and after just one hour, it reaches its full recovery state, which is only 94% (100% - 6% = 94%) of its original length. The permanent compression of 6% is based on the non-linear, viscoelastic behavior of the material tested here and indicates an irreversible state.

Conclusion

Creep recovery tests record the change in length of elastomer seals as a function of load, holding time and temperature. They are an indispensable means of checking and verifying the requirements for elastomer seals.

The examined sample showed a permanent compression of 6% after a loading and unloading phase and could not return to its original shape.

Decisive factors for successful measurement include an instrument's maximum force available, the machine-specific deformation range and, of course, stable temperature control, which should cover the largest possible temperature range. A high-load DMA of the GABO EPLEXOR 2000 N type or, even better, a high-load DMA of the GABO EPLEXOR 4000 N type is the first choice.

Literature

[1] https://de.wikipedia.org › wiki › Seal (mechanical)

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