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Performance of Elastomer Seals in Transport and Storage Casks

Elastomer seals are widely used as barrier seals in containers for low and intermediate level radioactive waste and for spent fuel transportation casks. In addition, they are also used for spent fuel storage and transportation casks (dual purpose casks (DPC)) as auxiliary seals to allow leakage rate measurements of metal barrier seals for demonstration of their proper assembling conditions. Depending on the area of use, the rubber materials have to demonstrate proper sealing performance with regard to mechanical, thermal and environmental conditions as well as irradiation during the entire operation period. Concerning DPC, degradation effects should be limited in a way that, for example, effects from potentially released decomposition elements may not harm e. g. metal barrier seals. Leakage rate measurements should be possible also after long interim storage periods prior to subsequent transportation.

Because of the complex requirements resulting from the various applications of containers for radioactive waste and spent nuclear fuel, BAM has initiated several test programs for investigating the behaviour of elastomer seals. Experiments concerning the low temperature performance down to -40°C and the influence of gamma irradiation have been started first. Currently also the thermal aging behaviour of elastomer seals is examined. The applied methods are e.g. Dynamic Mechanical Analysis, measurement of hardness, Compression Set and Compression Stress Relaxation. Exemplary test results are shown for selected rubber materials. Their major relevance concerning safety aspects is discussed in this paper.
Furthermore, materials testing is accompanied by the development of finite element (FE) models to simulate the seal behaviour by using the FE code ABAQUS®. At first this shall enable the simulation of specific laboratory test configurations containing elastomer seals and finally the simulation of complete lid closure systems under specific operation or accident conditions. In a first step, basic compression and tension tests were carried out. Test data were used to identify the constitutive behaviour and find parameters for material models already implemented in the computer code. Basically, the investigated rubber-like materials show hyperelastic behaviour with additional effects.

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