Modelling of Chemical Ageing and Fatigue in Rubber and Identification of Parameters

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Abstract

Rubber parts are often subjected to combined thermal and mechanical loading and to chemically active environment. This exposure may lead to significant changes in their mechanical properties due to effects such as formation of microcracks or changes in chemical structure. Numerical modelling of such changes is of great importance when designing mechanical systems and their operation (e.g. maintenance schedule).

A model that captures both the chemical changes caused by ageing and the fatigue damage, as well as the coupling between the two, was proposed in [1]. It is a combination of the dynamic network model by Naumann and Ihlemann [2] and the model of fatigue damage based on the approach by Ayoub et al. [3], which uses continuum damage mechanics. Estimation of parameters related to chemical ageing was described in detail by Naumann [4] and it is based on precise measurements of oxygen consumption rates. In our work, however, we investigate the possibility of obtaining similar results by indirect measurements of the changes in mechanical properties and validity range of such results.

The discussed material model is well suited for the finite element implementation and thus for simulations of rubber components within a broad range of operating conditions. The results regarding parameter estimation are of crucial importance to calibration of the model and, consequently, to practical usability of the model in real-world applications.

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