Validation of a generic tool of kinetic simulation of cable ageing

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Since the early 2000s, the EDF R&D team of polymers is interested in the study of the multiscale analysis aging of polymers (at the molecular, macromolecular and macroscopic levels) used in nuclear power plants, such as cables, pipes or paintings [1-4]. This understanding of the mechanisms of aging allows, among others, to develop a universal approach for life time prediction or monitoring the aging of these materials on-site. The establishment of structure/property relationships remains the major problematic in any non-empirical approach for lifetime prediction.

The objective of the present work is to present the first step of this approach which is the development of a generic tool of simulation of aging kinetics and its validation on different ethylenic polymers (EPDM and PE) used in cables.

The approach taken to establish the physical model validation of polymer aging consists in: First, the integration of a system of non-linear differential equations derived from an established mechanistic scheme for describing the polymer ageing process in the simulation code. Then, the comparison of chemical experimental results [1,5] (obtained by FTIR spectrophotometry in a transmission mode to deduce changes in concentration of thermal degradation products) and numerical resolution (obtained both with Matlab software and the new simulation tool) (Fig.1).

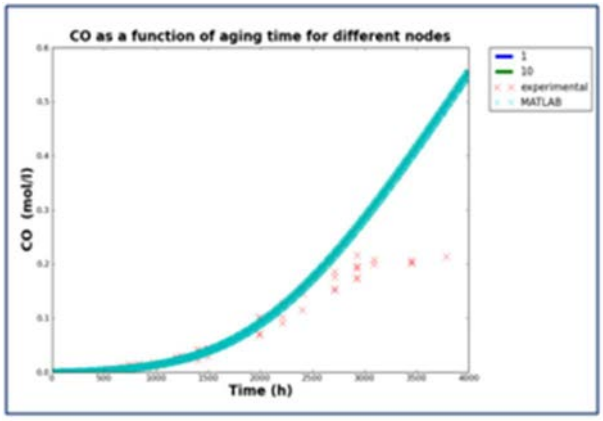

Fig. 1: Comparison of carbonyl evolution results obtained both with Matlab software and the new simulation tool.

The results show a satisfactory agreement between theory and experiment in a wide temperature range. Thus, this new developed simulation tool is validated on well-controlled tests and allows us to take with confidence the next step of our approach for lifetime prediction, i.e. the prediction of macromolecular and macroscopic changes of polymer and the proposed methodology is conceptually applicable to other types of polymer.

References

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