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ABSTRACT:

Physical Ageing of Filled Elastomers at Room Temperature: Experiments and Modelling

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Physical ageing is a process of equilibration that occurs following a temperature change, during which the material's properties require additional time to transition from their initial state to their ultimate value at the new temperature. While earlier studies suggested that physical ageing occurs exclusively at temperatures below the glass transition temperature, recent experimental findings suggest that the physical ageing process may also occur at room temperature in the case of filled elastomers. Initially, experimental tests were carried out to analyze the impact of the physical ageing process on the mechanical properties. This involved subjecting a series of carbon black-filled samples to a temperature change at room temperature. Subsequently, the mechanical properties of the samples were observed, revealing that a period of up to four days was required to achieve equilibrium at the final temperature. The concluding phase centered on creating a model capable of capturing the diverse physical ageing processes occurring in filled rubber. Two factors were taken into account as contributions to represent the influence of physical ageing on mechanical properties: free volume and configurational changes. The results obtained from the experiments, coupled with the presented physical ageing model, enhance the ability to predict the mechanical properties of the material. This has the potential to improve predictions of the material's service life, ultimately reducing rubber waste, the frequency of replacements, and overall material consumption.