

A COMPARISON OF THE SELECTIVITY FOR CROSSLINK CLEAVAGE OF THREE DEVULCANISATION PROCESSES

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ABSTRACT

The network structure of vulcanised rubber makes these compounds difficult to recycle in comparison to thermoplastic polymers. Devulcanisation processes aim to recycle rubber by selectively cleaving sulfur crosslinks, although in practice these processes typically break the carbon-carbon bonds of the polymer chains as well, thereby reducing the mechanical properties of the recycled product. Thus, higher selectivity for sulfur crosslink cleavage will improve the mechanical properties of the product of devulcanisation.

Horikx's theory is a useful tool for analysing the mechanism of network breakdown in a vulcanised rubber network.¹ Horikx's theory shows that the rate of increase of the soluble (sol) fraction of the rubber as a function of the measured crosslink density of the remaining insoluble (gel) fraction is different for cleavage of crosslinks and carbon-carbon bonds. Thus, sol fraction and crosslink density measurements of devulcanised rubber samples can be analysed to give an indication of the dominant mechanism of network breakdown.

This study aims to use Horikx's theory to determine the selectivity for crosslink cleavage of three extrusion-based devulcanisation processes: mechanical, mechanochemical and ultrasonic devulcanisation.^{2,3,4} The variation of operating parameters in each process will allow investigation of the effect of these parameters on the selectivity within each process. This will be followed by a comparison of the selectivity between the three processes. The operating parameters that will be investigated include barrel temperature (all processes), screw speed (mechanical process), diphenyl disulphide (DPDS) concentration (mechanochemical process) and ultrasonic amplitude (ultrasonic process).

The novelty of this work lies in the definition, quantification and interpretation of a selectivity parameter (K). Furthermore, using the same crumb rubber source and analytical methods for all experiments ensures comparability of data between the three devulcanisation processes.

References

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