

STABLE FREE RADICAL ASSISTED MECHANICAL DEVULCANIZATION OF RUBBER: COMPARISON WITH CONTEMPORARY INDUSTRIAL DEVULCANIZATION PROCESSES

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A comparative study of stable free radical, 4-Hydroxy-2, 2, 6, 6-tetramethylpiperidine-N-oxyl free radical (4HT/ 4-hydroxy TEMPO) assisted mechanical devulcanization, with commercial mechano-chemical devulcanization processes based on US Patent 5770632 A and US Patent 6387966 B1 is presented in this paper. The similarity in the mode of action of the chemically dissimilar modifiers used in these patents to accomplish comparable results suggests that, if chemicals which are related in no way can bring about the same result through similar processes, it is the process of shearing and not the chemical *per se* that causes devulcanization. The present paper demonstrated that the efficiency of devulcanization could be substantially increased, if the recombination of free radicals generated by shear scission of crosslinks were blocked by a stable free radical. The stable free radical assisted devulcanization gave higher re-vulcanize properties while devulcanization as per the patents gave results at par with mechanical devulcanization without using any devulcanizing agents. The characterization of devulcanized rubber (DVR) by estimation of residual cross link density, Horikx analysis, chemical probe analysis and re-vulcanize properties suggested that, in the mechano-chemical devulcanization of natural rubber under the influence of shear; (i) devulcanization was effected by the cleavage of crosslinks under the influence of shearing force alone (ii) devulcanizing agents played no role in devulcanization and (iii) efficiency of devulcanization could be significantly improved if the recombination of broken crosslinks could be arrested as in the case of stable free radical assisted devulcanization.

Keywords: Crosslink scission, Crosslink density, Crosslink distribution, Rubber, Devulcanization, Re-vulcanization

INTRODUCTION

Utilization and disposal of used tyres represent an enormous challenge to the world because of the three dimensional-crosslinked-structure of its rubber part. It is

estimated that about 300 million scrap tyres are generated in the US annually, a situation that is mirrored in other countries in various proportions. Devulcanization is a recycling strategy for used rubber products envisaging retrieval of the polymer content