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Devulcanization of waste rubber tyre utilizing deep eutectic solvent and ultrasonic energy

Ricky S[1], Rashmi W[1], Khalid M[2], Kaveh S[3] and **Suganti R[1]**

[1] Taylors University, Malaysia

[2] Sunway University, Malaysia

[3] University of Auckland, New Zealand

This particular study of interest aims to study the effect of coupling ultrasonic treatment with eutectic solvents in devulcanization process of waste rubber tyre. Specifically, three different types of DESs were utilized, namely ChCl:Urea (1:2), ChCl:ZnCl2 (1:2) and ZnCl2:urea (2:7) in which their physicochemical properties were analysed and proven to have permissible water content that is less than 3.0 wt%, degradation temperature below 200oC and freezing point below 60oC. The mass ratio of rubber to DES were varied from 1:20-1:40, sonicated for 1 hour at 37 kHz and heated at variable time of 5-30 min at 180oC. EDX results revealed that the first two DESs give the highest degree of sulphur removal at 74.44 and 76.69 % respectively with optimum heating time at 15 minutes whereby if prolonged, reformation of crosslink network would be experienced. Such is supported by the evidence shown by both FTIR and FESEM results where di-sulphide peak reappear at 30 minutes and morphological structures from 15 to 30 minutes change from smooth with high voidage to rigid with low voidage respectively. Furthermore, TGA curve reveals similar phenomena whereby at 15 minutes thermal decomposition temperature is at the lowest due to the decrease of molecular weight as a result of sulphur removal but increases back at 30 minutes. Type of bond change was also analysed whereby it was found that only di-sulphide bond was cleaved and such indicating partial-devulcanization. Overall, eutectic solvents indeed have a great potential to be used as devulcanizing solvent as proven.

e: rashmi.walvekar@gmail.com