

Devulcanization of Waste Rubber Tyre Utilizing Deep Eutectic Solvents and Ultrasonic Energy

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Abstract : 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 Deep Eutectic Solvents (DES) 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 200°C and freezing point below 60°C. The mass ratio of rubber to DES was varied from 1:20-1:40, sonicated for 1 hour at 37 kHz and heated at variable time of 5-30 min at 180°C. Energy dispersive x-rays (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-sulfide peak reappears 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 which indicates partial-devulcanization. Overall, the results show that DES has a great potential to be used as devulcanizing solvent.

Keywords : crosslink network, devulcanization, eutectic solvents, reformation, ultrasonic

Conference Title : ICEMA 2018 : International Conference on Engineering Materials and Applications

Conference Location : Mumbai, India

Conference Dates : February 22-23, 2018