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Investigation of ZnO and MgO as activators in the vulcanization of nitrile rubber

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Nitrile rubber (NBR) is a copolymer of butadiene and acrylonitrile resistant to water and non-polar solvents widely used in industry, mainly as sealing devices in the chemical and petrochemical industry. To have the desired elastic property, the rubber product must go through the process of forming three-dimensional bonds between the polymer chains, vulcanization. For the vulcanization process, some additives are needed in addition to rubber and among them are activators, which play an important role in increasing the vulcanization rate and cross-linking efficiency. Zinc oxide (ZnO), whose wide use as an activator in rubber vulcanization, has been criticized. Studies have been carried out with the aim of reducing the ZnO content since when found in specific concentrations it can present toxicity in water and soil, becoming an environmental problem. The objective of the work is to verify the technical feasibility of replacing ZnO with magnesium oxide (MgO) in the activation system of NBR compositions with 33% acrylonitrile and the influence of the substitution on rheometric properties, cross-link density and thermal analysis. The mixtures were made in the Haake RHEOMIX OS closed chamber mixer using the formulation and procedure described in the ASTM D3187 standard. The formulation consists of: NBR: 100phr, S: 1.5phr, and TBBS: 0.7phr. With varying levels of stearic acid: (1-3 phr), MgO: (0, 5 and 10phr) and ZnO: (0, 2.5 and 5phr), where phr is parts per hundred of the rubber. The samples were vulcanized in a TechPro MDPt oscillating cavity rheometer at five different temperatures: 160ºC, 165ºC, 170ºC, 175ºC and 180ºC, for 1 h in accordance with the ASTM D2084 standard. The cross-link density was determined based on swelling measurements in equilibrium solvent by applying the Flory-Rehner equation. The thermogravimetric analysis was carried out on TA Instruments equipment with a temperature range from 25°C to 600°C, in an N2 atmosphere and at a rate of 20°C/min. It was possible to observe that changes in activator levels affected the rubber properties. And in general, depending on the MgO content, it can be a viable substitute for ZnO.