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ORIGINAL PAPER

Optimization study of ammonia and glutaraldehyde contents on vulcanization of natural rubber latex

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Abstract This manuscript presents a continuation work on a simple system to vulcanize natural rubber using glutaraldehyde as a cross-linking agent. Natural rubber latex consists of protein which is allergenic to human body. The protein immobilization behavior of glutaraldehyde is of greatest interest to conduct this study. A study to determine the optimum condition for the vulcanization of the newly introduced system was carried out using glutaraldehyde as a cross-linking agent. Efforts were made to find out the best combination of glutaraldehyde and ammonia to vulcanize natural rubber latex with superior physical properties. Direct vulcanization method was employed to prepare natural rubber vulcanizates from natural rubber latex. The mechanical performance of the vulcanized natural rubber was determined for various combinations of ammonia and glutaraldehyde. Superior tensile properties were observed for the vulcanized rubber prepared from a very high ammonia natural rubber latex. The activation energy of the degradation of the vulcanizates was determined from thermogravimetric analysis. The cross-link density of the vulcanized rubber was determined from swelling experiments in toluene. The very high ammonia natural rubber latex (0.9 wt% ammonia) with 15 mL of 10 wt% glutaraldehyde solution was found to be the effective combination to vulcanize natural rubber latex with excellent properties. Advantage of this technique is the possibility of directly vulcanizing natural rubber latex at low temperature.

Keywords Natural rubber · Vulcanization · Glutaraldehyde · Cross-link density · Transport properties

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Introduction

Natural rubber is extracted as a latex or 'milk', viz., an aqueous emulsion or dispersion of the natural polymer (~96 wt% of solids) and other substances, such as proteins (~1 %), lipids (~3 %) and traces of potassium, magnesium and copper [1]. It is one of the most important materials since it gives various properties (i.e., excellent tensile strength, elongation at break and outstanding elasticity) together with an advantage of its renewable recourse materials [2]. However, uncured natural rubber cannot be used to make articles with a good level of elasticity because it is sticky and can easily deform when warms, and becomes brittle when colds [3]. Thus, vulcanization is an important process to gain all better physical properties. The cross-link density plays a key role in achieving higher strength [4–6].

In general, there are three main types of curing agents for rubber namely, sulphur, peroxide and phenolic compounds. Sulphur vulcanization is the most popular system for general purpose rubbers because it provides excellent properties together with low cost. However, this system