ABSTRACT

Hydrogenated nitrile butadiene rubber (HNBR) is a special class of nitrile rubber (NBR) that is hydrogenated to increase thermal stability and potentially to alter the thermophysical properties of the material. This elastomer is known for its physical strength and retention of properties after long term exposure to heat, oil and chemicals. However, there are some aggressive applications like radiator hoses where much higher heat resistance is required, and application of nanocomposite would be interesting and is thus chosen in this investigation.

Nanocomposites based on HNBR and five different nanofillers have been prepared and characterized in this thesis. First, the study helped to identify chloroform/methyl ethyl ketone as the best solvent combination to prepare HNBR nanocomposite by a solution process. This explores a correlation between differences in interaction parameters of rubber-solvent and clay-solvent with a few properties of HNBR-filler nanocomposites. Accordingly, the properties of the nanocomposite were the best where the difference in interaction parameters of rubber-solvent and clay-solvent was least. Next, HNBR nanocomposites based on 0, 1 and 2 dimensional nanofillers (nanosilica, Cloisite NA, Cloisite 30B, Cloisite15A and sepiolite) were synthesized. The effects of these nanofillers on the mechanical and dynamic mechanical properties of the elastomer were investigated. It was observed that for the unvulcanized rubber, property improvement was highest for Cloisite 30B and sepiolite filled nanocomposites. The results were explained with the help of XRD, TEM and thermodynamics. The work further explored the effect of varying acrylonitrile content, diene content and Mooney viscosity on the thermal, mechanical and dynamic mechanical properties of the unfilled HNBR and its nanocomposites. It was found that improvement of the above properties was highest for HNBR with 34% acrylonitrile content and 5.5% diene content . The thesis also aimed to correlate the structure of different nanofillers such as montmorillonite, sepiolite and nanosilica with the thermal stability of HNBR nanocomposites. Thermal stability of the silica-filled nanocomposites was higher than the clay-filled nanocomposite at low loading; however, with increase in filler loading, Cloisite 30B and sepiolite filled nanocomposites exhibit higher thermal stability due to better dispersion of the fillers in the rubber matrix. The effect of peroxide vulcanization on dispersion and properties of Cloisite 30B- and sepiolite - HNBR nanocomposites was also investigated and the results were carefully compared with those of the uncured nanocomposites. This thesis further addressed the long term thermo-oxidative stability and useful lifetime of the nanocomposites compared to those of the virgin polymer. This was done by thermal aging in air of the samples, at different time intervals and temperatures, and studying the physico-mechanical properties. It was found that by the addition of nanofillers (Cloisite 30B), the useful service life of the compound was increased from 15 yrs to 45 yrs. Finally, the transport properties (i.e., sorption and diffusion) of HNBR-clay nanocomposites were investigated to understand the extent of resistance to permeability of solvents at different temperatures. It was found that the introduction of even a small quantity of nanofillers leads to a significant decrease in the solvent uptake.

Key words: Hydrogenated nitrile rubber, interaction parameter, nanofillers, nanocomposite, degradation mechanism, aging performance, curing characteristics, solvent resistance.