Development of Acrylonitrile Butadiene Rubber Composite with Improved Physico-Mechanical and Oil Resistant Properties by Incorporating Waste Egg Shell Powder as a Filler

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The present study attempted to develop a high-performance oil-resistant rubber material based on acrylonitrile butadiene rubber (NBR) by incorporating waste eggshell powder (ESP) as a filler to be utilized in automobiles industry while reducing the commercial Carbon Black (CB) content. Since CB is obtained from petroleum resources, its manufacturing process is hazardous and cause environmental pollution. Thus, the use of calcium carbonate ($CaCO_3$) is found as a remarkable way to replace the CB in the rubber compounds due to its non-toxic and environmentally friendly nature. Value addition to waste eggshells was one of the main aspects of this research. The effect of surface modified $CaCO_3$ filler on the cure, mechanical and swelling properties of NBR composites with respect to CB was studied. Filler amount was kept constant at 45 phr. Only the ratio of CB: ESP was changed. Ten ratios of samples were prepared by varying filler amounts by 5 phr. The surface modification of $CaCO_3$ was confirmed using Fourier transform infrared spectroscopy. Particle size having 3.05 μm $CaCO_3$ was successfully obtained from eggshell powder. X-ray diffraction patterns proved that raw eggshell powder was chemically similar to commercial $CaCO_3$. The vulcanizates were evaluated by rheological, physical, and mechanical characteristics. The cure times and scorch times were at an acceptable level. NBR composites with ESP loadings of 0, 5, 10, 15, 20 phr showed tensile strengths of 7-14 MPa, compression sets of 2.38- 5.49 %, hardness of 61 - 72 IRHD. Therefore, it can be deduced that NBR filled with surface modified eggshell powder has competed favorably with the standard CB. Replacing CB from ESP loadings of 5, 10, 15, 20 phr did not show a significant difference in physico-mechanical properties. Hence eggshell $CaCO_3$ can be considered as one of the best conventional fillers suited for automotive applications with a high oil-resistant sealing material.

Keywords: Calcium carbonate, Carbon black, Egg shell powder, Filler, Oil resistance