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An investigation to ascertain the suitability of using coconut shell powder as a filler in natural rubber compounds using dry rubber

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Coconut shell powder (CSP) for this study was sourced from Silver Mills Pvt Ltd, and the particle size was reduced by ball milling for 72 hours, followed by evaporating the dispersion to obtain the dry powder. The CSP powder was characterized using laser diffraction and FTIR along with its pH determination. A base dry rubber compound consisting of natural rubber 100, ZnO 5, stearic acid 3, sulphur 2, cyclohexyl benzthiazyl sulphenamide 1.5, diphenyl guanidine 0.1, Flectol H 1, N-isopropyl-N'-phenyl-p-phenylene diamine1, and process oil 3, was used to add CSP in varying amounts ranging from 10 – 50 phr. Compound batches were mixed using a Brabender type plasticorder with a rotor speed of 60 rpm at 120 ^{0}C and sulphuring was done on a two roll open mill. Three series of compounds were made. The first series was made, adding CSP only to the base compound formulation at amounts ranging from 10 – 50 phr. The second series of compounds carried 40 phr of CSP and a well known coupling agent, bis(triethoxy silyl propyl)tetrasulphide (Si-69) added at varying levels from 0.8 – 4.8 phr. In the third series instead of Si-69, hexamethylene tetramine (HMTA) was added in amounts ranging from 1.6 – 4.8 phr. The cure characteristics of all compounds were studied using an Alfa Rheometer and in addition a few selected vulcanizate properties such as hardness, resilience and abrasion resistance were studied. In the first series there was a reduction in scorch time of about 40% in adding 10 phr of CSP, and it remained flat even up to 50 phr of CSP. In compounds carrying 40 phr of CSP and varying amounts of Si-69, the scorch time was remarkably stable with an improvement. This could be attributed to the surface adsorption of Si-69 on the CSP particles thereby minimizing the frictional heat buildup during mixing at high speed. HMTA is seen to reduce scorch time progressively and significantly, probably due to the release of ammonia by thermal decomposition of HMTA and ammonia acting as an accelerator. The effects of CSP on cure rate and reversion resistance were also studied. Increased amounts of CSP were found to increase the hardness with a strongly positive correlation. However, in the presence of both Si-69 and HMTA, the hardness not only increased with the amount of both Si-69 and HMTA added, but interestingly the resilience too kept increasing significantly when compared to the compounds with only filler. This no doubt is an outcome of a much more cohesive filler polymer composite that has resulted. However, abrasion resistance decreased progressively with filler loading probably due to the large particle size.

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