THE EFFECT ON THE MECHANICAL PROPERTIES OF KENAF FIBRE REINFORCED POLYPROPYLENE RESULTING FROM ALKALI-SILANE SURFACE TREATMENT

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ABSTRACT

Natural fibres have great potential to substitute glass fibre in many applications that do not require high load bearing capabilities [1–4]. Due to the low density of natural fibres the specific properties of composites made using these fibres can match or even exceed those of glass fibre reinforced plastics. To realize the full potential of these materials, it is necessary that they be manufactured at a competitive cost and methods that permit a high degree of automation are beneficial. One possible approach is to fabricate thermoplastic sheets that are impregnated with fibres using the compression moulding technique. These sheets can then be moulded to shape using heat in a final processing step. Polypropylene is well suited to this application since it has low cost, has reasonable mechanical properties and melts at a temperature low enough that the fibres are not damaged. Unfortunately, polypropylene/natural fibre composites still have limitations [3]. A significant problem is the chemical incompatibility between the polar nature of natural fibre molecules and the non–polar nature of polypropylene molecules. This incompatibility leads to difficulties in ensuring proper bonding on the fibre–matrix interfaces, which in turn causes ineffective load transfer between the reinforcing material and matrix [1, 5, 6]. A wide range of chemical treatments of the fibres and compatilizers have been suggested in order to address this issue. Treatment techniques such as alkali, silane, permanganate, benzoylation, acrylation, acetylation and isocyanates have been described [7]. It has also been demonstrated that the mechanical properties of kenaf fibre/polylactic acid composites are improved by chemical treatments of the fibres using alkali treatment followed by silane treatment [8]. No comparable study has been reported for polypropylene/kenaf fibre composites. This study consequently focuses on this topic.

Non-woven kenaf fibre mats of 125 g/m² and 350 g/m² areal density were immersed in NaOH solutions at 45°C for 24h. The concentrations ranged from 1% through to 8% in intervals of 1%. After this alkali treatment, the fibres were immersed in solutions of 5% by fibre weight of three aminopropyltriethoxysilane in a 50% aqueous solution of methanol. The pH of the solution was maintained between 4 and 5 using acetic acid. Four different types of
polypropylene plate were subsequently produced by compression moulding; plates of pure polypropylene, plates reinforced with untreated fibres, plates reinforced with treated fibres and plates reinforced with glass fibres. The fibre volume fraction of the reinforced plates varied from 20% to 35% in intervals of 5%. Tensile and flexural tests were performed in accordance with the ISO 527 and ISO 178 standards, respectively. Electron microscopy studies of the fibres surfaces were also performed.

Results from the tests indicate that alkali-silane treatments improve the mechanical properties of kenaf fibre reinforced polypropylene composites. Increases in tensile strength, tensile modulus and flexural strength are recorded with increasing alkali concentration up to a maximum at around 5-6% concentration, whereafter the mechanical properties reduce markedly. Electron microscopy indicates that for alkali concentrations of less than 4%, surface impurities on the fibres still remain and consequently prevent good adhesion. At the highest alkali concentrations the fibre surface is damaged which also reduces the properties of the composite. At the optimum alkali concentrations, the mechanical properties of the kenaf fibre reinforced polypropylene approach those of glass fibre reinforcement and specific properties exceed those of glass reinforcement.

REFERENCES


