ABSTRACT

Five methods for predicting composite diffusion coefficients of unidirectional composite materials – the resistance analogy of Shen and Springer, the finite element unit cell method of Kondo and Taki, and the three-phase, four-phase and self-consistent models of Gueribiz et al. – were compared to experimental data for multi-directional kenaf fibre composites using three different thermoset resin systems: epoxy, polyester and vinylester, and one thermoplastic matrix: polypropylene.

These five methods were formulated to describe composites with unidirectional fibres, where diffusion occurs perpendicular to the fibre direction. They significantly under-predict the diffusion properties of multidirectional kenaf composite material. A new model, the bidirectional fibre model, was created to account for multidirectional fibre orientation. This model included an empirical fibre direction coefficient, F_D, to account for multidirectional fibre structures. The bidirectional fibre model, using a value of $F_D = 0.0069$ for needle-punched kenaf mat, was found to improve significantly the predicted thermoset composite diffusion coefficients.

None of the prediction methods, however, adequately described behaviour of the polypropylene-kenaf composite. The polypropylene matrix is essentially impermeable and the experimental data indicates that there may be some fibre volume fraction (11% in this case) below which no moisture absorption will occur. Polypropylene-kenaf composite moisture absorption may be better described by different prediction methods, such as percolation theory, rather than diffusion. This was not, however, investigated further in this research.