MODIFICATION AND FABRICATION OF SELECTED NATURAL FIBRES INTO THERMAL BONDED STRUCTURES FOR HYBRID POLYMER COMPOSITES

Abstract

Nature has abundance of natural fibres that are also renewable. Natural fibres are very essential to meet the environmental challenges that are growing every day in the field of technical textiles. Environmental friendly materials have come under consideration as a result of rising awareness, public interest, new environmental regulations, and unsustainable petroleum use. Synthetic fibres destroy the environment due to their non-biodegradable and polluting nature, which leads to the utilization of natural fibre-based materials. In the last few years, natural resources have been considered as alternatives to synthetic fibres in several engineering applications. Acoustic materials assist in preventing undesirable sounds from affecting the human ear, and these have major potential in build tech, mobile tech, and home tech applications. A survey was conducted among the builders and persons involved in the civil field to obtain information regarding the potentiality of natural fibres in civil applications. From the survey, it was understood that green building concepts could be initiated as there was a problem of waste disposal. The locally available plant sources, namely *Abutilon indicum, Agave americana,* and *Areca catechu,* were selected, which were from different parts of the plants. These fibres were given chemical treatments namely Alkalization, Benzoylation, Acetylation and enzyme treatments with cellulase, pectinase and their combination for fibre surface modification. Then the fibres were assessed for visual evaluation, spectrophotometric analysis, chemical constituents, moisture content, regain, water absorption, density, tensile strength, elongation, thermogravimetric analysis (TGA), scanning electron microscopic analyses (SEM), fourier transform infrared and spectroscopic analysis (FTIR).

The treatment and the fibres that exhibited favorable properties were selected, blended, and converted into nonwoven material. This nonwoven fabric was analyzed for different properties namely thickness, weight, bulk density, tensile strength and elongation, abrasion resistance, moisture regain, air permeability, water absorption, thermal conductivity, thermogravimetric analysis (TGA), scanning electron microscopic analyses (SEM), Sound Absorption Coefficient (SAC) and the best samples were selected for composite fabrication. The brightness index was higher on enzyme treatments than chemical treatments, with the highest brightness in Agave americana fibre sample treated with combination of enzymes.

In *A. americana*, the **cellulose content** decreased on chemical treatments namely Benzoylation and Acetylation but increased on enzyme treatments in all the three samples. This increase may assist in improving the strength and stiffness of the composites by reinforcing such fibres. Water absorption reduced in all the chemical treated samples of which it was the highest in the *Areca catechu* fibre sample which underwent benzoylation treatment (143.64 per cent) and in the *Areca catechu* fibre sample treated with combination of enzymes. The treatments have improved the thermal stability of the *Agave americana* fibres. The thermal stability of the alkali treated *Areca catechu* fibres was good which could assist in composite making when used as reinforcement.

The highest **bulk density** was observed in the sample enzyme treated *Areca catechu* and *Abutilon indicum* blended nonwoven structure with 854 g/cc over other samples. Among all these samples the chemical treated *Areca catechu/Agave americana* and enzyme treated *Abutilon indicum /Agave americana* nonwoven structures exhibited the highest strength among their respective treatments. The least abrasion resistance was exhibited by the sample chemical treated *Abutilon indicum*/*A.Americana* blended nonwoven structure with 4.34 percent.

The composites were characterized for various essential properties, and based on the results, the composite samples were selected for further study. Among the functional properties assessed for selected reinforced composites, the best acoustic property was exhibited by the sample from *Abutilon indicum* and *Agave americana* blended nonwoven

material-reinforced polymer composites. At the maximum frequency (4000 Hz), the same sample showed the best result (0.838832 dB), and the average Sound Absorption Coefficient (SAC) value was also the highest in the sample of *Abutilon indicum* and *Agave americana* blended fabric reinforced composite material. A material with a Noise Reduction Coefficient (NRC) value greater than 0.20 is an absorption material. The nonwoven fabric samples, namely *Areca catechu*, *Agave americana* blend, and *Abutilon indicum*, *Agave americana* blend, showed NRC values of 0.219655 and 0.24197, respectively, which were improved by the conversion into composites to 0.247512 and 0.496911. The Noise Reduction Coefficient (NRC) of the composite sample prepared from *Abutilon indicum and Agave americana* showed the greatest value, representing 49 per cent of the sound absorbency rate. This hybrid polymer composite slab with novelty would serve as an acoustic material for building components.