STUDY OF CHARACTERISTICS OF NATURAL FIBRES BASED NONWOVEN FABRICS

A THESIS

Submitted by

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ABSTRACT

Many varieties of plant fibres such as sisal, coir, banana, and kenaf exist. The availability of these fibres in large quantities and the pressures on them to use evermore “green” technologies have made this area of research worldwide interest. The vision of India as mentioned often by the Prime minister is to put up hygienic items in several places for which the doors made of composite from natural fibres would be more suitable. After reviewing the past work, it was thought that there are many areas which need to be taken up on natural fibers. Accordingly they have been taken up in the current study and this work is the culmination of them.

Four natural fibers, namely sisal, kenaf, banana and coir were selected as they differed widely in cost, properties and their physical properties were studied. They were characterised by Scanning Election Microscopy (SEM), X-Ray Diffraction (XRD). They were also tested for cellulose content, ash content, wax content, density diameter, tenacity, elongation, longitudinal section, cellulose content, lignin content, moisture content, absorbency.

The variability or scatter in tenacity, elongation and energy was studied by Weibull modulus. Weibull modulus is a measure of variability and high values of it indicate low variability. There are three methods for computing Weibull modulus, namely, linear regression, maximum likelihood method and a simple method which uses CV%. In the current study, Weibull modulus of fibres was computed by maximum likelihood method by writing software. The fibres were converted into nonwoven fabrics by using needle punching technology namely with Sisal 100%, Sisal: Coir 70%:30%, Sisal:

Coir 30%:70%, Sisal: Banana 50%:50%, Sisal: Banana: Kenaf 50%:25%:25% and Sisal: Kenaf 50%:50% combination.

They were tested for air permeability, GSM, thickness, flexural rigidity, tensile properties, bursting strength, water absorbency, pore size, thermal conductivity, compression, thermal resistance, wicking, stiffness and sound absorption. The results showed that while sisal fiber was characterised by higher strength, coir had lower strength. Coir had exceptionally good elongation in comparison with other fibers.

With regard to Weibull modulus, it was found that the values determined by the three methods were found to be similar. Weibull modulus is an important parameter for representing the variability in strength of natural fibres and without it any work carried out on the properties of natural fibres is incomplete. Coir had shown the lowest Weibull modulus which is a manifestation of large scatter in strength. Both in untreated and treated fibres, the agreement between values obtained by the three methods namely; linear regression, maximum like hood method and methods of moments were found to be excellent. Comparative data on Weibull modulus following plasma treatment shows that scatter in strength has decreased. The improvement with oxygen treated plasma is quite significant. The same trend is noticeable in elongation also. In coir fibres, a significant improvement in tenacity is noticed in coir fibres treated with argon type of plasma.

There is a decrease in Weibull modulus in respect of elongation following plasma treatments. Kenaf fibres shows an improvement following treatment with argon type of plasma while with oxygen, there is a deterioration. In terms of elongation, oxygen treated kenaf fibers show an improvement in Weibull modulus. Untreated fibres appear more disordered than those of the treated fibres in all the cases. Some etching also was noticed and the surface more uneven.

Alkali treatment led to a deterioration in tenacity accompanied by a drop in elongation. With increase in alkali concentration a drop in tenacity was noticed. Elongation was found to increase with an increase in alkali concentration. The relation between experimental values and characteristic values has been pointed out for both untreated and treated fibres.

With regard to the physical properties of nonwoven fabrics, excellent correlation between thickness and air permeability, pore size and bundle strength thickness with compression, pore size and sound absorption and pore size with bursting strength and pore bubble point and thermal conductivity was noticed.

A blend consisting of 70% sisal of coir 30% of is recommended for composites to be produced. Sisal is found to be more compressible and may be more appropriate for certain end uses. The important industrial implication was fully discussed.

The most used statistical tool that deals with inhomogeneities and variability in properties is Weibull modulus which can be used to evaluate the fibres homogeneity in terms of their properties and it has been found to be a good quality control parameter during processing.