RAMIE/COTTON BLENDED NONWOVEN FOR INDUSTRIAL APPLICATIONS

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The purpose of this study is to investigate the processability of ramie fiber in making nonwoven fabrics and also to see how ramie fibers help to improve the proprieties of cotton and cotton blended nonwovens. The nonwoven layer was obtained in two steps. First step was to open the structure and to blend the cotton and ramie, which was done using a Spinlab 338 fiber opener/blender machine. Each sample was passed through the opener four times. The final structure after this first step was a strip layer of fiber web. The second step was to obtain the needle-punching layer with a stable structure. Each sample was passed four times through a Morison Benkshire needle-punching machine. To evaluate the proprieties of the nonwoven samples obtained, we used a battery of tests. Among findings it was that the structure of nonwoven fabrics with a percentage of ramie in composition is more compact giving a better stability. Potential applications in industry are discussed and recommended.

Introduction

Nonwoven materials present characteristics that they are suitable for diverse end-use applications like insulation, sound deadening, sorbents, geotextiles (paving fabrics, linear geotextile, drainage geotextile, erosion control, slit fence and reinforcement geotextile), and plastic lumber. Cotton and other natural fibers nowadays are increasingly employed for making nonwovens. Recently, we were the witnesses for the increment in accidental oil discharges during production, transportation, and refining. The easiest way to remove quickly and efficient the spilled oil either sea or land is the use of sorbents. Synthetic sorbents are the most used in oil spill cleanup due to their oleophilic and hydrophobic characteristics.

The main deficiency for these synthetic sorbents is that they are often non-biodegradable or only very slowly biodegradable. Biodegradation is an important property for a sorbent in two ways. First, it can provide an alternative method of disposal, versus landfilling or incineration. Secondly, because not all the synthetic sorbent can be recovered, the biodegradable sorbent is preferred to minimize subsequent environmental problems. Natural sorbents such as cotton or cotton blended materials can provide a solution for this problem.

This study is focused on basic mechanical prprieties of cotton and cotton-rich nonwovens. The ultimate objective of this research is to investigate the processability of ramie fiber in making nonwovens fabrics as well as to see how ramie fibers help to improve the proprieties of cotton and cotton-blended nonwoven fabrics.

Rhea, ramie or 'China Grass' has been grown in the Far East for many centuries and its fiber used for making cloth even before the introduction of cotton. Ramie has the look and the feel like linen but is higher in tenacity and lower in price. It is stronger wet than dry, does not shrink, and is mildew and rot resistant. Ramie fiber is exceptionally long and lustrous like silk. Despite its many excellent proprieties and diverse uses, ramie failed to become a highly traded textile because of high labor and other production costs associated with the processing of the fiber. The development of new technologies reduced the cost of production and increased the attractiveness of this fiber. Lowering production costs will extend its end-uses not only in high-value final products, but also in low-value products like nonwovens. Good proprieties of ramie fiber may enhance end-use performance of cotton and other natural fibers in diverse industrial applications.

Methodology

Materials

For the experiment we used cotton (California type) provided by USDA Southern Regional Research Center. Ideally, ramie fiber used for blending with cotton should be short fibers droppings from carding machine. Ramie fibers we used in this study were provided by courtesy of Filter Media Specification in Pittsburgh, PA. Length of ramie fiber was 3 inch.

We used six categories of samples:

-100% Cotton nonwoven simple folded (C1);
-100% Cotton nonwoven double folded (C2);
-100% Ramie nonwoven simple folded (R1);
-100% Ramie nonwoven double folded (R2);
-50/50 Ramie/Cotton nonwoven simple folded (RC1);
-50/50 Ramie/Cotton nonwoven double folded (RC2) ;

Experiment

The nonwoven layer was obtained in two steps. The first step was to open the fiber bundle and to blend cotton and ramie. This was done using a Spinlab 338 fiber opener/blender machine. Each sample was passed through the opener four times. The final product after the first step was a strip layer with a width of 10 in. The second step was to obtain the needle-punched layer with a stable structure. We used Morisson Benkshire needle-punching machine with the speed of 5.4 feet/min corresponding to 228 strokes/min. Each sample was passed through the machine four times.

To evaluate the proprieties of the nonwoven samples obtained, we used a battery of tests. All the tests were performed in the textile testing lab (67F, 60%) at LSU. For bending and compression tests, we used Kawabata System[1] for nonwoven fabrics. Tearing strength was performed under ASTM D 5734-95[3] conditions using a Falling-Pendulum (Elmerdorf) Apparatus. For breaking strength test we used the Instron tensile tester Model 4301 with the following settings crosshead speed 300 mm/min, full-scale load range 0.5 KN, sample rate 10.000. The sample size was 4 x 1 inch.

Results of Analysis

Compression Test (Kawabata System)

The compression was tested using Kawabata Compression Tester. Instrumental parameters obtained were compressive linearity (LC), compressive work (WC) and compressive resilience (RC). During measurements we used five specimens with the dimensions 4 x 4 inch for each of the six groups. For linearity, variance analysis ANOVA indicated that statistic F-value was equal to 19.81 (P-value = 0.0001). Therefore it was concluded that there is a significant difference among the groups analyzed.

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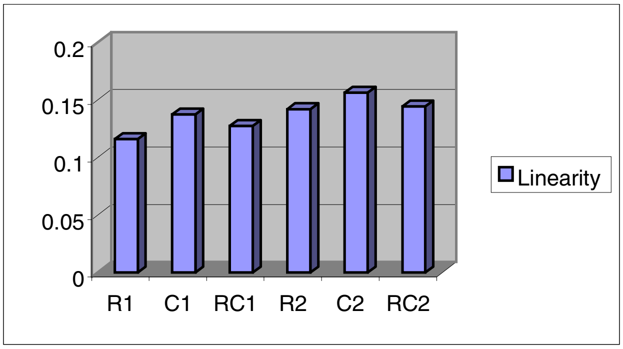

Figure 1.

In order to see differences in means simultaneously we used a Bonferroni[2] procedure with P (I') = 0.1. We observed that 100% Cotton double folded was different from 100% Cotton simple folded, 50/50 Ramie/Cotton simple folded, and 100% Ramie simple folded. 50/50 Ramie/Cotton double folded was different from 50/50 Ramie/Cotton simple folded and 100% Ramie simple folded. 100% Ramie double folded was different from 50/50 Ramie/Cotton simple folded and 100% Ramie simple folded. 100% Cotton simple folded was different from 100% Ramie simple folded.

In fig.2 the parameter compressive work (WC) was analyzed again using ANOVA. The reported F-value is 12.67 and the corresponding P-value = 0.0002. A small P- value indicated us that a significant difference existed among the six groups analyzed. Performing a Bonferroni procedure with P (I') = 0.1, we observed that 100% Cotton simple folded was different from 100% Cotton double folded, 100% Ramie simple folded, 50/50 Ramie/Cotton double folded and 100% Ramie double folded. 50/50 Ramie/Cotton simple folded is different from 100% Ramie simple folded, 50/50 Ramie/cotton double folded and 100% Ramie double folded.

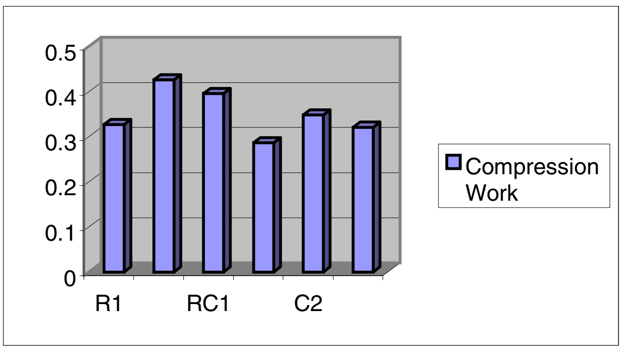

Figure 2.

For the parameter compressive resilience (RC) the F-value resulted was reported to be 5.86 (P-value=0.0058), which again indicated a significant difference among the six groups, analyzed. A Bonferroni with P (I') = 0.1 helped to see where the differences occurred. The simple-folded pure cotton nonwoven is different from 100% Ramie double folded and 100% Cotton double folded. Nonwoven simple folded 50/50 Ramie/Cotton is different from 100% Cotton double folded.

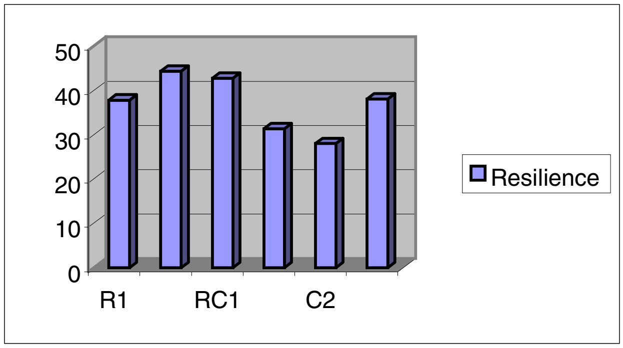

Figure 3.

Bending Test (Kawabata System)

For the bending test we used the Kawabata Bending Tester . Measured parameters were bending rigidity (B), and hysteresis of bending moment (2HB). The sample dimension was 4 x 4 inch. These samples were analyzed in both directions in and across needle punching machine-feeding direction. For analyzing the data we applied an ANOVA statistical analysis. The results of analysis are summarized in Figures 4 and 5. We observed significant differences between the group of double folded samples and the group of simple folded samples for both parameters.

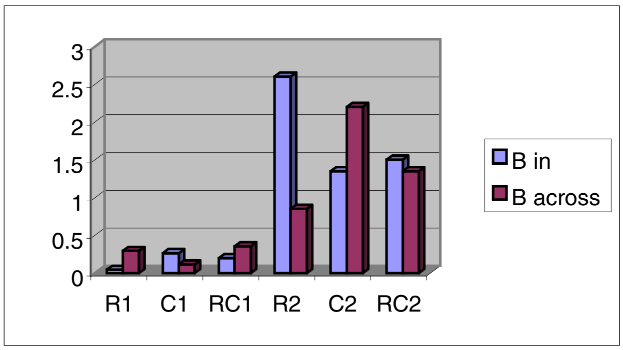

Figure 4.

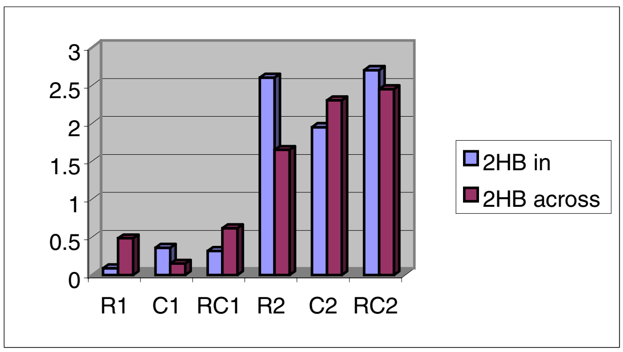

Figure 5.

Tensile Test (Instron)

Strip test was used for evaluating nonwoven breaking strength. Variance analysis (ANOVA) was used for statistical testing for twelve groups, six (I – in machine direction) and six (a- across machine direction). The results were summarized in figure 6. The F-value obtained was 72.07 with a corresponding P-value= 0.0001 which indicated us a significant difference among groups.

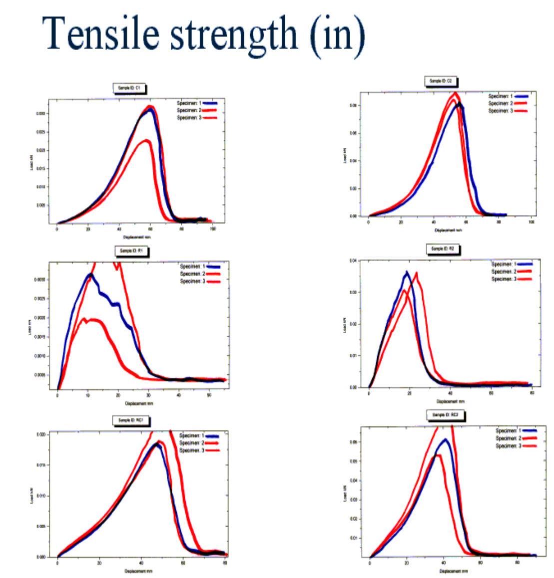

Figure 6.

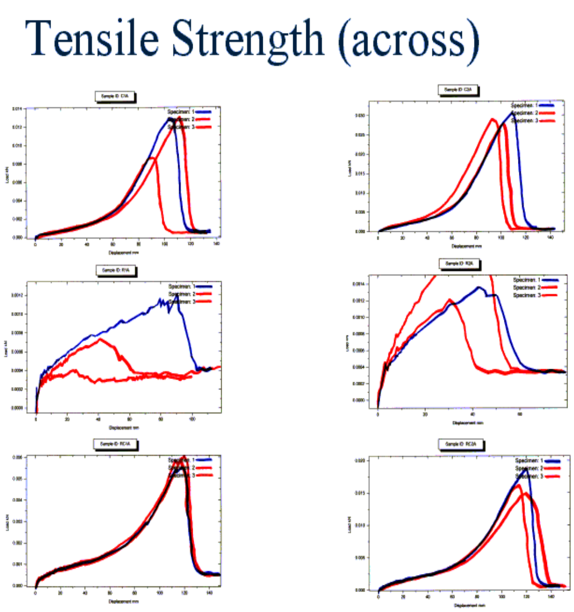

Figure 7.

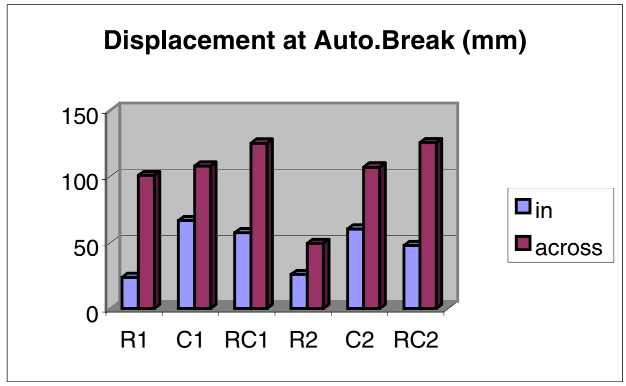

Figure 8.

Tearing Strength for Nonwoven Fabrics by the Falling-Pendullum (Elmerdorf) Apparatus

For the tearing strength we applied an ASTM standard method D 5734 – 95. The results of analysis are presented in the following graph.

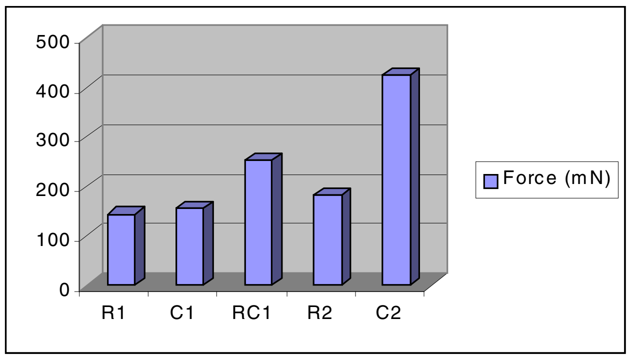

Figure 9.

Conclusions

Compressive Property

Linearity (LC) is increased with the increment of thickness and number of passes trough the needle-punching machine. The structure of the nonwoven multifold fabrics is more compact. 100% Ramie nonwoven fabrics have the lowest linearity parameter.

Compression work (WC) is different for the double folded from the simple folded fabrics. An exception is provided by the 100% Cotton simple folded, which has approximately the same WC value as the double folded one.

Only 100% Cotton double folded presented a difference in resilience (RC), but this is not of great significance, so we can conclude that this is not an important parameter to characterize the pure and blended nonwoven fabrics.

Bending Property

Both bending rigidity (B) and bending hysteresis (2HB), are influenced by the thickness and number of passes and also by the direction of analysis (in or across machine direction). The presence of ramie doesn't help to improve the bending property.

Tensile Strength

Breaking strength is influenced by the direction of nonwoven material (in – across machine direction), by the thickness and number of passes through needle-punching machine, and by the composition of the nonwoven layer.

We obtained a greater displacement at breaking for the 50/50 Ramie/Cotton nonwoven in the direction across machine. This indicates that the presence of ramie enhanced extensibility of the cotton nonwoven.

Tearing Strength

The double folded nonwoven samples provided a significant increase in tearing strength. The presence of cotton produced an increment in the force necessary for tearing.

Carding Property

During the opening and carding process we found a greater loss of material for ramie fiber than for cotton fiber. So, a smaller percentage of ramie fiber should be used for cotton blending.

General Property

The structure of nonwoven fabrics with a percentage of ramie in composition is more compact giving a better stability.

References

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2. Chase, W.,and Bown, F. General Statistics, Third Edition (1996)
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