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DEVELOPMENT OF LIGHTWEIGHT VALUE-ADDED COTTON NONWOVENS: H1 TECHNOLOGY

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Introduction

H1 needlepunching technology is one of the modern developments in dry laid nonwoven technologies. The needle zone in the H1 technology is not flat as in the case of conventional needle loom. The contoured zone needlepunching results in oblique angled needle penetration. H1 needlepunching technology has higher efficiency and high productivity. Texas Tech University is the first academic facility in the US to house the modern needle loom. This technology has been effectively used to develop cotton blended nonwoven webs. This paper elaborates the results from the cotton needlepunching study.

Materials Used

The details of the cotton used in the study are given in Tables 1 and 2. Cotton fiber characteristics were measured using the HVI 900A. AFIS data are given in Table II. Cotton fibers are fed in to the hopper feeder, which leads to the initial opening of fiber tufts. The double-cylinder cards individualize fibers. There are ten carding zones between the worker and stripper rollers resulting in individualization of fiber tufts. Carded webs are then layered into multilayer webs by the cross-lapper. The cross lapper then feeds the web to the H1 needlepunching machine. The H1 technology machine is capable of running at a maximum speed of 1300 strokes/min. In this study the needle loom was operated at 750 strokes/min.

H1 Needlepunched Cotton and Cotton Blended Webs

The details of the samples developed are given in Table 3. Cotton and Cotton-Polypropylene composites are developed at two different weights and all the samples are single punched by passing the carded web with only one pass in the needle zone.

Experimental Results

Important physical and mechanical properties of the webs were evaluated based on ASTM standards. Thickness values of the nonwoven webs are given in Table 4. Instron constant rate of elongation tensile tester was used to evaluate the tensile properties of the nonwoven webs. Tensile characteristics were evaluated in both machine and cross directions. Tenacity values are given in Tables 5-8. Figures 1-4 delineate the tenacity values. As is evident from the results, tenacity values are higher in the cross direction than those in the machine direction. Similarly extension at break values are higher in the cross direction than those in the machine direction. Furthermore, as the weight of nonwoven webs increases, breaking strength increases.

Structural Arrangement

The structural arrangement of cotton fibers in the web was studied using scanning electron microscopy. From Figure 5, it is clearly evident that the fibers are integrated in the web by interlocking. Also the surface damage to the fibers is minimum since the interlocking is uniformly carried out by keeping the stitch density constant.

Conclusions

Results presented in the paper prove that 100% cotton lightweight nonwoven can be successfully needlepunched on the H1 technology needlepunching machine. The nonwoven webs are developed were found to have adequate strength and elongation. Furthermore tenacity values were higher in the cross direction.

Acknowledgements

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Table 1. Cotton HVI Data. The physical properties of cotton were evaluated using high volume instrument, HVI 9000, using the ASTM standard D-5867.

Micronaire	Length	Uniformity	Strength	Elongation
4.9	1.03	79.8	27.6	3.9

Table 2. Cotton AFIS Data.

Nep size (μm)	Nep Gm (cnt/g)	Length (weight)	Length (weight) (% cv)	SFC (number)	SFC (weight)
690.8	592.8	0.516	56.3	78.02	57.36

Table 3. Samples Developed.

Sample	Material	(% Composition)	Punching	Weight [gm/sq.m]
A1	Cotton	100	Single punched	60
A2	Cotton	100	Single punched	80
B1	Cotton/Polypropylene	80/20	Single punched	65
B3	Cotton/Polypropylene	80/20	Single punched	80

Table 4. Thickness Results.

Sample	Average thickness (mm)	Standard Deviation
A1	0.70	0.01
A2	1.07	0.05
B1	0.79	0.04
B3	1.06	0.04

Table 5. Breaking Strength – Machine Direction.

Sample	Material	(% Composition)	Weight (gm/sq.m)	Breaking load (N)	[SD]
A1	Cotton	100	60	6.43	[0.61]
A2	Cotton	100	80	14.93	[1.56]
B1	Cotton/PP	80/20	65	10.54	[2.05]
B3	Cotton/PP	80/20	80	14.12	[1.46]

Table 6. Breaking Strength – Cross Direction.

Sample	Material	(% Composition)	Weight (gm/sq.m)	Breaking load (N)	[SD]
A1	Cotton	100	60	8.38	[0.74]
A2	Cotton	100	80	21.88	[0.45]
B1	Cotton/PP	80/20	68	29.73	[3.5]
B3	Cotton/PP	80/20	82	34.35	[1.91]

Table 7. Tensile Extension – Machine Direction.

Sample	Material	(% Composition)	Weight (gm/sq.m)	Tensile Extension (mm)	[SD]
A1	Cotton	100	60	124.07	[6.82]
A2	Cotton	100	80	112.22	[5.19]
B1	Cotton/PP	80/20	65	151.76	[7.15]
B3	Cotton/PP	80/20	80	149.20	[5.25]

Table 8. Tensile Extension – Cross Direction.

Sample	Material	(% Composition)	Weight (gm/sq.m)	Tensile Extension (mm)	[SD]
A1	Cotton	100	60	136.15	[9.52]
A2	Cotton	100	80	112.70	[6.74]
B1	Cotton/PP	80/20	65	147.43	[8.00]
B3	Cotton/PP	80/20	80	157.21	[9.73]

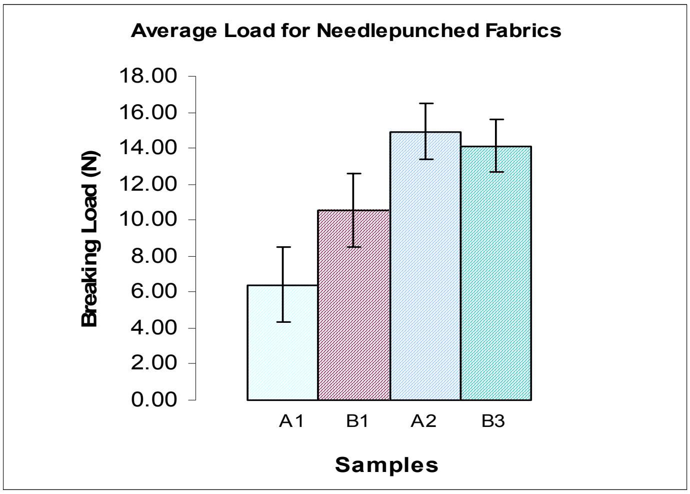

Figure 1. Breaking Strength in Machine Direction.

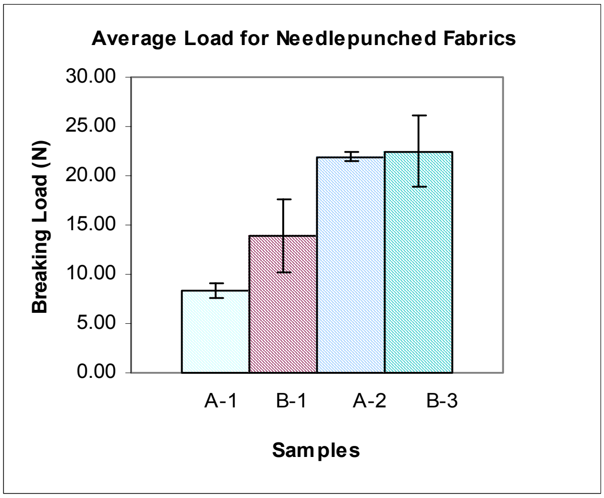

Figure 2. Breaking Strength in Cross Direction.

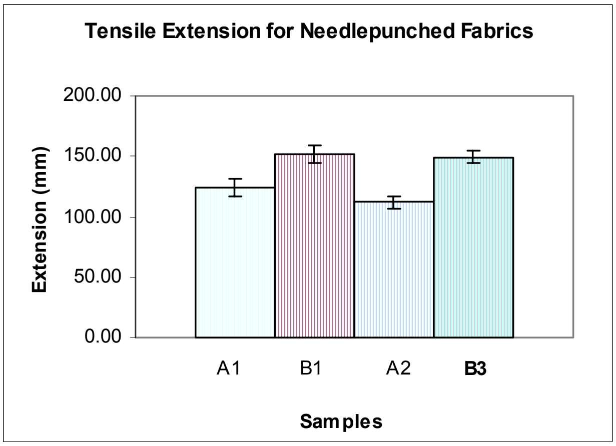

Figure 3. Tensile Extension in Machine Direction.

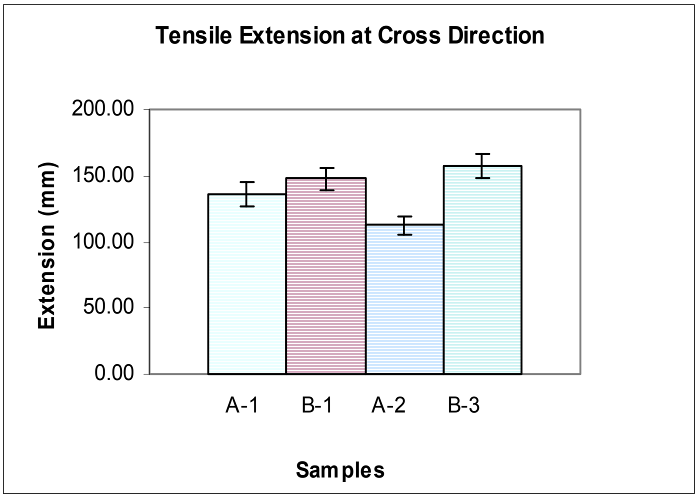

Figure 4. Tensile Extension in Cross Direction.

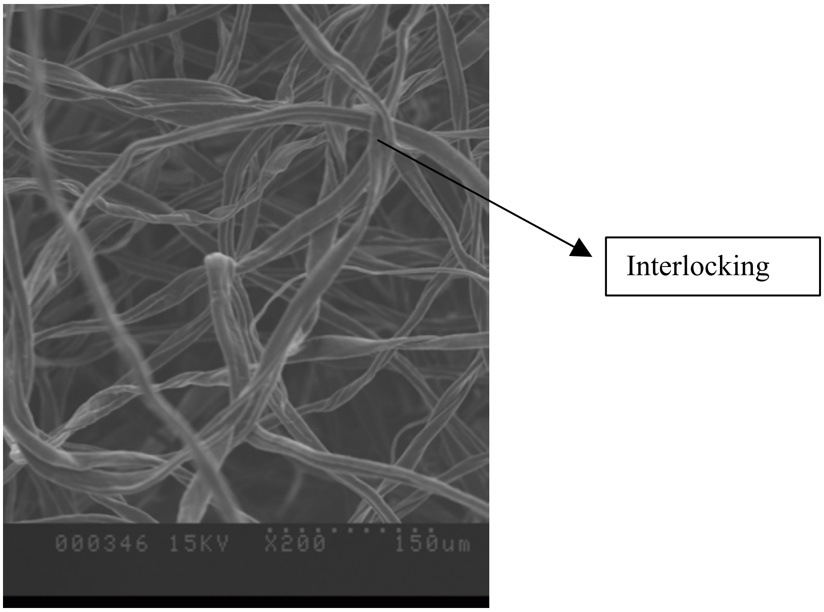

Figure 5. SEM Image of Fiber Interlocking.