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EXPLORATORY STUDY OF THE DEVELOPMENT OF NONWOVEN CELLULOSIC BLENDS USING H1 TECHNOLOGY

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Introduction

A generous funding from the US Department of Defense through the Admiral Zumwalt, Jr. Program at Texas Tech University has resulted in the initiation of a new nonwovens research program. A manufacturing scale "state of the art" H1 technology needle punching machinery has been most recently installed at Texas Tech University.

The nonwovens laboratory at Texas Tech University is the *first and only facility* in the US to have the H1 technology needleloom. The needle loom is served by a full feeding line from William Tatham Ltd, England. The feed unit consists of a hopper feeder, a two cylinder card and a crosslapper. The card is clothed with aluminum base wire and can handle a variety of fibers with linear densities ranging from 1.5 - 6 denier. The cross-lapper feeds the H1 technology needle-loom. The needle-loom is 1.2 meters wide and is capable of needling up to 1300 strokes/min. This paper will endeavor to report on the progress of nonwovens research program. The report will discuss about the development of natural fiber nonwoven substrates. The use of thermal bonding machine to develop multiplayer composite structure will also be discussed briefly.

Needle Mat Formation

H1 technology needleloom has a contoured needle zone resulting in oblique angled needle penetration. The oblique angled penetration results in improved quality webs with enhanced needling efficiency. Figure 1 shows the image of fibers being fed to the contoured needle zone. The thickness and the weight of the web can be varied by adjusting the cross-lapper lattice and the relative speed between the cross-lapper and the conveyor belt of the needle loom. The fiber mats are punched by the needles at very high speeds. The speed of punching that is used on a regular basis at TTU for product development is 800 needle strokes/min. The needle webs produced from the H1 technology needlelooms are found to be structurally well integrated. Based on visual examinations on several occasions, the webs developed by the H1 technology needleloom have been found to be uniform. However this observation has to be substantiated objectively with the help of SEM images. Figure 2 shows machinery setup at the nonwovens laboratory at TTU.

Fibers are manually blended to the required blend level and then fed to the hopper feeder as a normal practice. A minimum of 15-20 lbs of fiber is required for product development. The uniformity of the product depends on the uniform feed of the material. Uniform feed is achieved with the help of feed monitors and measuring mechanism in the hopper feeder known as micro feed. Fibers in suitable blend composition levels are then carded with the help of double cylinder cards. The carding drums are equipped with rotating worker and stripper rollers. Carding of fibers take place due to the combined actions of the carding drums, stripper and worker rollers. In total there are 10 carding zones in the two carding machines.

The clothing on the carding machine determines the type of fibers that can be processed through the system. The carding machine available at TTU is capable of handling synthetics and natural fiber blends. The machine is capable of handling 1.5 – 6 denier fibers. Blends of cotton, wool, mohair and synthetics were successfully carded and needlepunched into nonwoven substrates of different weights.

Development of Different Needlepunched Substrates

The H1 technology needle loom was successfully used to develop a variety of nonwoven substrates. Different nonwoven substrates developed are given in Table 1.

The web weights achieved are given in Table 2.

Processing of Cotton on H1 Technology Needleloom

Cotton fibers have to be specially cleaned before being fed to the hopper feeder. A typical short staple processing line was used to open and clean the cotton. Opened cotton was intimately blended with synthetics in the hopper feeder of the needleloom feed unit. The outline of mechanical processes used for cleaning cotton fibers is shown in Figure 3.

Initial experiments were focused on developing cotton blended nonwoven substrates. Pima cotton was processed and was used to develop cotton based nonwoven substrates. The characteristics of the cotton used in the study are given in Table 3. As of today 50/ 50 needlepunched. Efforts are currently underway to explore different cotton blend levels. Mechanical property such as bursting strength and air permeability characteristics are currently being evaluated on the nonwoven substrate.

Conclusion

The "state-of-the-art" H1 technology needlepunching nonwoven machinery has been successful in developing a variety of natural fiber based nonwoven substrates. Nonwoven substrates from upland cotton varieties are currently developed. The overall goal is to develop one hundred percent cotton nonwoven substrates that will have variety of applications such as filter bags, oil spill absorbents, high loft wadding etc. The program will effectively needling and thermal bonding capabilities to develop high-tech products. Development of Composite Nonwoven Substrates Needlepunching and thermal bonding technologies will be employed to develop composite substrates. A flat bed through flow thermal oven from Phoenix Dryers, Ltd. Will be used in the development of nonwoven composites. The thermal bonding machine's width will match with that of the needleloom. Natural fiber based composite substrates such as lightweight waddings, high loft bats, compressed waddings, etc. will be developed.

Acknowledgement

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References

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Table 1. Different Nonwoven Substrates Developed.

Substrate ID	Fiber in the Mix	Composition
1.	Cotton (1.06")	30
	Lyocell (1.5 denier, 1.5")	70
2.	Lyocell	25
	Wool	25
	Polyester (all fibers: 1.5 denier)	50
3.	Nylon (6 denier, 3")	70
	Mohair (34 micron)	30
4.	Kevlar	60
	Nylon	20
	Mohair	20
5.	Nylon (6 denier, 3")	50
	Wool	50
6.	Lyocell (1.5 denier)	100

Table 2. Different Web Weights Achieved.

Substrate ID	Fibers in the Blend	Web weight (g/m^2)	Percentage
1.	Cotton (1.06”)	81	30
	Lyocell (1.5 denier, 1.5”)		70
2.	Lyocell	45	25
	Wool		25
	Polyester (all fibers: 1.5 denier)		50
3.	Nylon (6 denier, 3”)	223	70
	Mohair (34 micron)		30
4.	Kevlar	51	60
	Nylon		20
	Mohair		20
5.	Nylon (6 denier, 3”)	106	50
	Wool		50
6.	Lyocell (1.5 denier)	45	100

Table 3. Cotton Characteristics.

Property	Value
Length	1.30 inches
Uniformity	86%
Micronaire	4
Strength	43.6 g/tex
Elongation	6.9 %

Figure 1. Nonwoven Mat Formation.

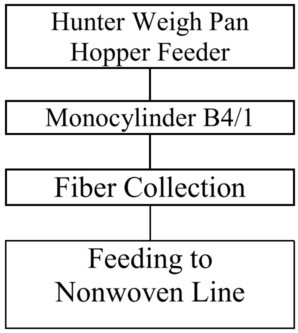

Figure 2. H1 technology needlepunching line.

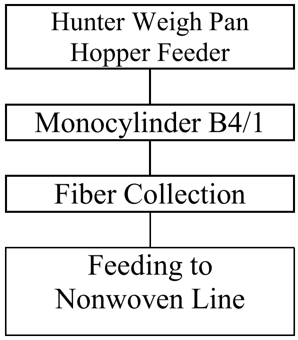

Figure 3.