Effect of Punching Conditions on Physical Properties and Evenness of Needle Punching Nonwovens

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1. Introduction

Needle punching nonwovens are made from compactness and interlock of fibers in the web structure. During the needle punching, the function of needles forms interfiber entanglement by interlocking due to frictional force and then webs take up fabric strength. Therefore, the processing parameters such as punching density and needle depth have a great effect on evenness and physical properties of needle punching nonwovens.(1-5)

In this study, we consider the effect of punching density and needle penetration depth on the evenness and physical properties of needle punching nonwovens. we have examined the evenness of the nonwovens by measuring thickness and basic weight at the various position with two directions, i.e., machine direction(MD) and cross direction (CD) and also made a experiment in physical properties of nonwovens through tensile and tearing tests.

2. Experimental

2.1 Sample manufacture

Fig. 1 shows a schematic diagram of needle punching processing for manufacturing samples. Manufacturing processing consists of 1 passage of preneedling and 4 passages of main needling machines. The manufacturing conditions of each needling part are described in Table I. The winding speed of sample 1 and 2 is same, but the punching density and penetration depth of needles are different levels.

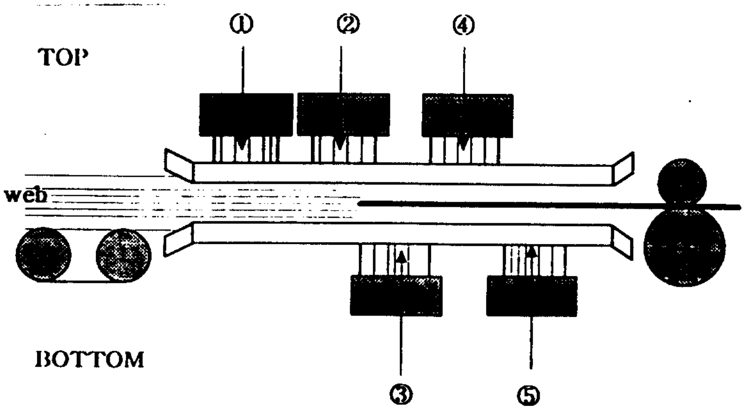

Fig. 1 Schematic diagram of the needle punching processing
①Preneedle M/C ②Main needle(1)M/C ③Main needle(2)M/C
④Main needle(3)M/C ⑤Main needle(4)M/C

2.2 Thickness and basic weight

Fig. 2. describes the method of preparing sample to measure basic weight and thickness of the samples. On the base of center in width direction, the 20cm×20cm fabrics were produced in MD and CD. Basic weight and thickness were measured according to ASTM methods (D-1910 and D-1777), respectively.

		Needle Machine					
factor	sample number	Feed	Preneedle	Main needle(1)	Main needle(2)	Main needle(3)	Main needle(4)
speed	1, 2	2.5	3.1	3.6	4.1	4.4	4.6
needle density(개/cm²)	1		78	156	240	245	248
	2		78	243	263	240	245
needle depth(mm)	1		9	8	7	6	2
	2		9	8	7	4	5

2.3 Tearing and tensile properties

An Instron machine(Shimadra AGS-500B) was used to study tensile properties at the strain rate of 30mm/min(Cut strip method, ASTM D 461). Tearing strength was measured by ASTM D1117 with trapezoid tearing method.

MD

CD ← → CD

1(L-3-5)	1(L-3-4)	1(L-3-3)	1(L-3-2)	1(L-3-1)	1(R-3-1)	1(R-3-2)	1(R-3-3)	1(R-3-4)	1(R-3-5)
1(L-2-5)	1(L-2-4)	1(L-2-3)	1(L-2-2)	1(L-2-1)	1(R-2-1)	1(R-2-2)	1(R-2-3)	1(R-2-4)	1(R-2-5)
1(L-1-5)	1(L-1-4)	1(L-1-3)	1(L-1-2)	1(L-1-1)	1(R-1-1)	1(R-1-2)	1(R-1-3)	1(R-1-4)	1(R-1-5)

Center

Fig. 2. specimen preparation for experiment
L=Left, R=Right, MD=Machine Direction, CD=Cross Direction

3. Results and discussion

From Fig. 3 and 4, we observed that the basic weight of the sample 1 in cross direction was larger than the weight of center, because the fibers of the web in the center were pushed toward the side of nonwoven during the needling punching. In comparing Fig. 3 and Fig. 4, the basic weight of sample 2 made by the larger punching density was much more even than the sample 1 made by the lower needle density. Because the nonwoven evenness has a great effect on the physical properties of nonwovens.

Fig. 5 and 6 show the thickness distribution of Sample 1 and 2, respectively. The thickness distribution has general pattern which is locally different thickness values without the kind of samples. i.e., both edge sides have higher values compared to the center portion. This has indicated that the evenness of needle punch nonwovens has increased and the quality of product has decreased.

Fig. 7 and 8 show the breaking strength and strain of the samples. The sample 2 in breaking stress and strain without tensile directions have higher than those of the sample 1. This indicated that the increase of punching density has improved the tensile properties of needle punching nonwovens.

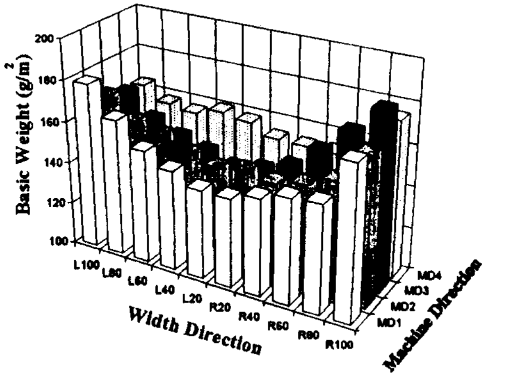

Fig. 3. Basic weight distribution of sample1

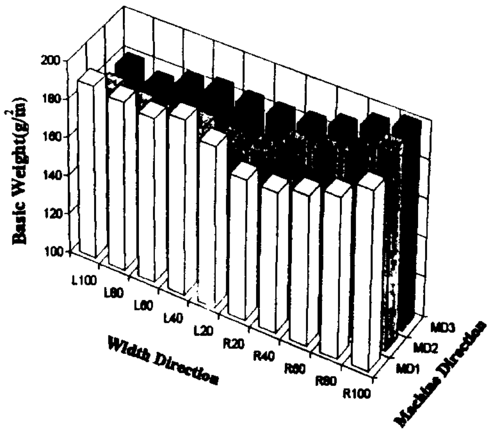

Fig. 4 . Basic weight distribution of sample2

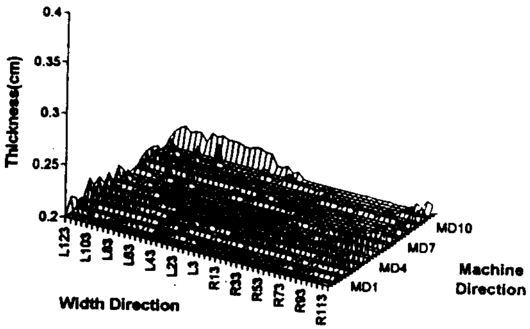

Fig. 5 Thickness distribution of sample1

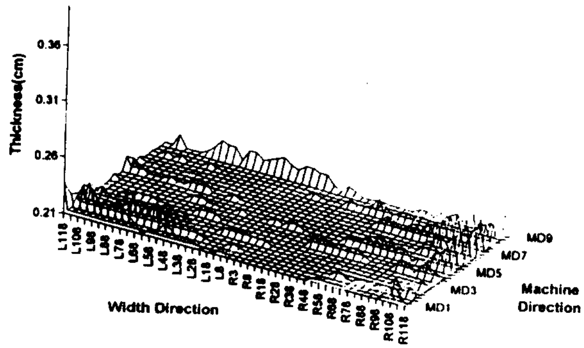

Fig. 6. Thickness distribution of sample2

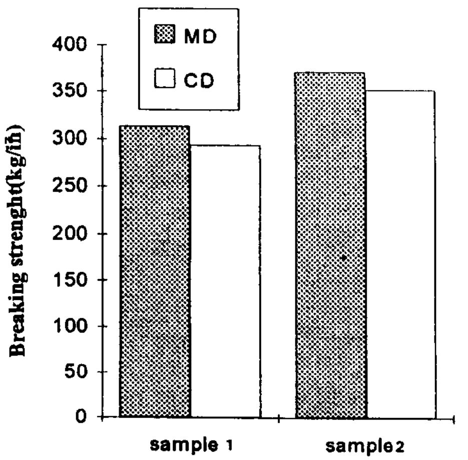

Fig. 7. Effect of punching density and needle detph on the breaking strenght of nonwoven

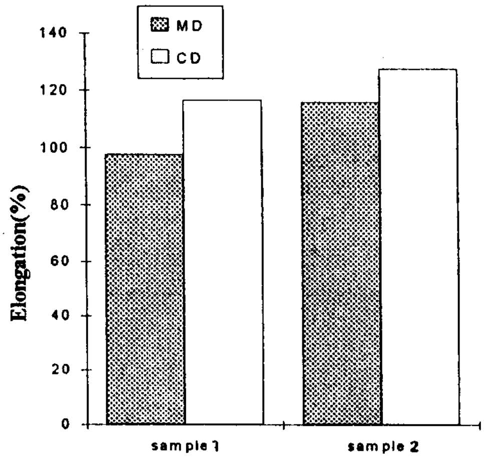

Fig. 8. Effect of punching density and needle depth on the elongation of nonwoven

4. Conclusion

We have studied effect of needle punching and needle depth on the evenness and physical properties of needle punching nonwovens and also considered the effect of tensile directions on physical properties of the sample. The conclusions obtained in this experiment are as follows.

1) The basic weight distribution of nonwoven made by large punching density has more even than by low punching density. The basic weight of nonwovens has increased toward edge side and has the lowest value in the center portion,
2) Thickness of nonwovens also has the same tendency as basic weight distribution,
3) Tearing strength and tensile properties have higher values in larger punching density than in low punching density, and
4) Tearing and breaking strength are larger in machine direction than in cross direction while elongation is larger in cross direction than in machine direction.

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