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〈연구논문(학술)〉

Knitting Parameters on Lint Pollution during Knitting Process

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니팅공정오염에 대한 니팅요소 분석

구영석

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Abstract— 니팅 공정상의 니팅 요소들 중 편침번수, 실의 공급 각도, 실의 공급 속도 등을 변화시키면서 새로 고안된 실험기구를 이용하여 니팅 존에서의 린트 발생현상을 조사하였다. 편침 번수와 실의 공급 각도는 실의 장력과 린트 발생량에 영향을 미쳤으며 이는 실과 편침 형태에 의한 마찰에 기인한 것으로 사료된다. 그러나 실의 공급 속도는 린트 발생에 큰 영향을 미치지 않았다. 본 실험을 기초로 하여 보다 더 심도 있는 연구를 위해서 좀더 정교한 실험기구의 개발이 필요하며 니팅요소들의 화학적, 기계적 변경에 의해 니팅공정상의 린트 문제를 개선시킬 수 있을 것으로 사료된다.(Knitting parameters specially related to lint generation in the knitting zone such as knitting needles, yarn feed angle and yarn feed speed were investigated with a developed test rig, which simulated the knitting area on the knitting machine. Three different types of needle counts and feeding angles affected tension and the amount of lint that was caused by frictional forces between the yarn and the morphological structure of the needle. However, the yarn feed speed did not affect the lint generation. The results implied that a more advanced test rig was necessary for further study. Also, chemical and mechanical modifications of the knitting elements may be necessary to improve the lint problem.)

Keywords: *Knitting elements, Knitting process, Lint, Tension, Friction*

1. Introduction

Recently, advanced textile machinery has allowed high speed manufacturing in the knitting industry. However, even with highly efficient manufacturing process, machine suitability is an important concern in the textile industry because yarn is a basic material in the process[1]. In the knitting industry, knitting parameters are the principal factors for producing high quality fabric. Of these parameters, knitting needles are one of the more important factors for the knitting process and are largely influenced by knitting conditions and yarn type. Knitting needles are always subjected to consistent friction with other knitting elements on the machine, which results in needle wearing and breakage. Knitting needles are subject to the most stress of all of the knitting elements due to the constant pressure from the yarn tension, which is needed for feed yarn into the process and proper movement of the knitting elements. This stress depends on the loop, loop length and the quality of the final products. Yarn tension is the source of friction between the yarn and other elements. The take-up movement after stitch formation is

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also a source of stress on the knitting needle[2-3].

Another factor affecting the knitting needle is the knitted structure. When a long knitted structure is produced, the contact force between the yarn and needle increases. When a tight stitch is necessary even more force is placed on the needle causing needle fatigue.

The problems of knitting needle directly impinge on the knitting process with respect to efficiency, manufacturing and the quality of knitted products.

When knitting a circular knitted fabric, the yarn arrived at the knitting zone from several courses. The yarn from creel parts has much bending force via feeding equipment and guides and creates friction with knitting elements which also increases the yarn tension, and thus the tension on the knitting needle.

Knitting speed is also a critical factor, which leads high tension and influences needle durability. As the feed speed increases, the shear force between the needle and contact area with the needle increases. Shear force indirectly causes needle wearing.

Another problem related to the knitting needle is lint generation during the knitting process[4-8]. Lint consists of short fibers in the yarn composition, which are not strongly anchored to the yarn body, and broken into pieces of fiber by the frictional force of yarn movement in the knitting process. Spun yarn is generally made of natural or synthetic fibers. The spinning or manufacturing process largely influences the condition of the needle because impurities in the natural fiber or the chemical components of the synthetic fiber impinge lint generation.

Lint accumulation around the knitting area increases proportionally with the yarn feed tension. Yarn feed tension is affected by two factors: the contact area and pressure between the yarn and needle. As the yarn feed speed increases, the pressure between the yarn and needle increases and there is a flat segment of yarn on the needle hook. Due to the flattening of the yarn, the shear force on the yarn increases. The increased shear force causes staple fibers that are mostly short and weakly bonded to separate from the yarn body and accumulates on the knitting elements. This accumulated lint prevents the knitting elements from moving smoothly, and then causes mistakes in the operation, which lead to problem in the process and a low quality of knitted products.

The impurities on the spun yarn worsen the lint accumulation and are a factor influencing the knitting elements. These impurities such as soil dust which is not completely removed during the spinning process causes wear on the knitting needle, carrier, cylinder, cam, sinker and other elements. The location of the impurity on yarn is also considered because it affects the extent of wear on the knitting element. Therefore, it is important to select good quality yarn without impurities, which should have been removed during the spinning process.

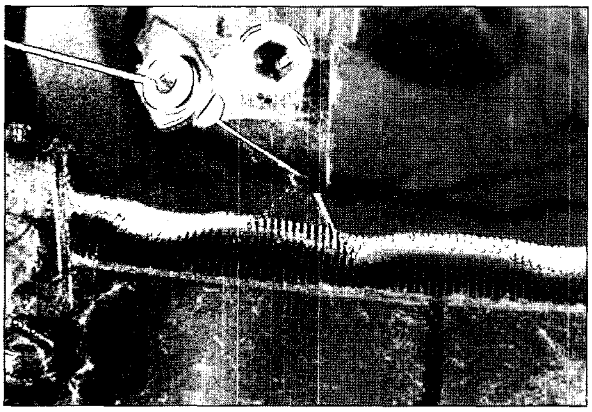

Fig. 1. Lint generation around knitting zone.

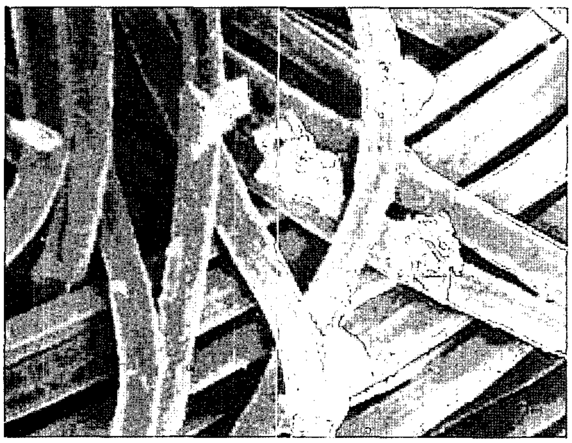

Fig. 2. Impurities in natural fiber.

Due to the structural complexity of the knitting zone in a knitting machine, it is difficult to investigate the exact location of lint generation with the mentioned parameters. In this study, knitting parameters specially related to the lint generation on the knitting zone were investigated with a test rig, which simulated the knitting zone on the knitting machine.

2. Experimental

3 shows the developed test rig, which can measure tension variation and the amount of lint. The test rig consisted of two yarn feeding rollers, yarn guides, a support to hold different types of needle gauge and tension sensors on the yarn path. The tension sensor has a range of 0~100 cN and three yarn guides on the measuring heads. The yarn guides were placed on the test rig to facilitate changing the yarn feed angle to the needle hook. Three feeding angles (F.A.) of 30°, 60° and 90° were used for this study as shown in Fig. 4.

The test yarn was threaded through the needle hook under pre-set tension of 10 cN and the two pairs of rollers varied the tension of the yarn. Yarn feed speed was in the range of 100 ~ 400 m/min.

Needle (latch needle, Groz-Beckert Co.) is a factor in lint contamination on the knitting machine and a main parameter in this study. Three different needle gauges(E10, E18 and E28)were used to investigate lint generation with respect to needle morphology. Gauge is defined as needle density in a reference unit, which also means the density in the knitted fabric. Needle gauge should be properly matched to the type and count of knitting yarn. Differences in needle gauge implied differences in contact points between needle and yarn in the structure.

Lint generated from the point of friction between the yarn and needle was collected in an enclosed area in the test rig. Lower atmospheric pressure was created in the enclosed area by a simple suction motor under the base of the lint collection box in order to collect generated lint at the point of contact with the needle hook and yarn. The weight percent of lint was measured by weighing the filter paper installed under the

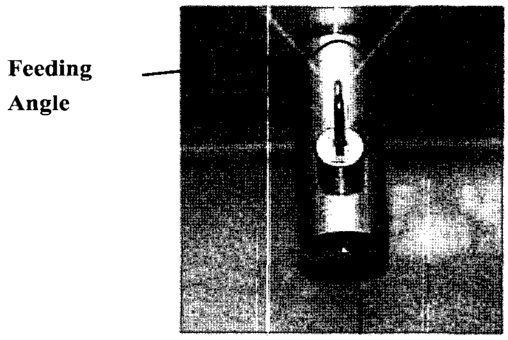

Fig. 4. Needle and yarn feeding.

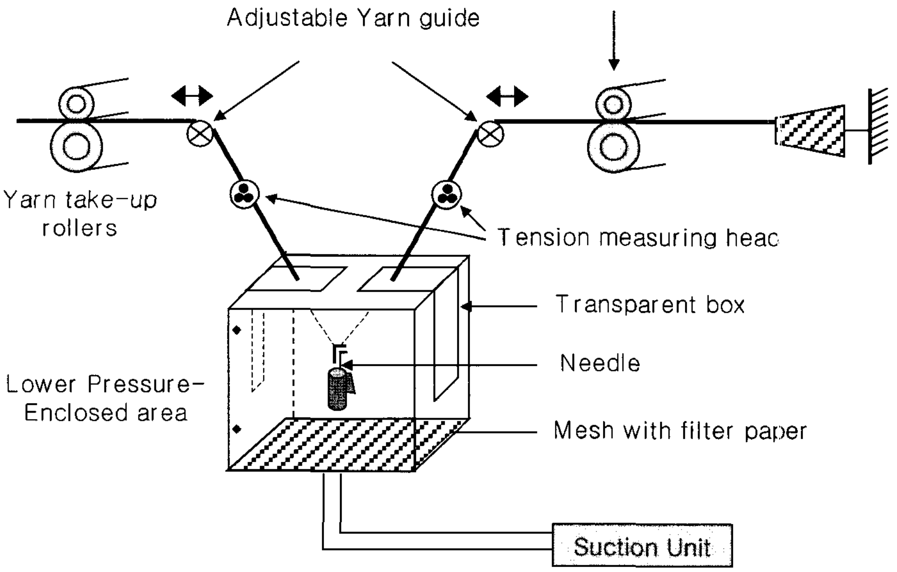

Fig. 3. Schematic diagram of the test rig.

box before and after testing. The lint accumulated on the filter paper was kept in a standard atmosphere room for one day before the measurement. Yarn count of 20 tex and ring-spun carded cotton yarn was used for the study.

3. Results and Discussion

Fig. 5 shows the results of tension variations by needle gauge, yarn feed angle and yarn feed speed. Yarn tension was differentiated from intervals of the needle gauge and yarn feed angle but not yarn feed speed.

As can be seen from the results of the yarn feed angle, the narrow angle increased the tension rather than the wide angle in each needle gauge. Similar results were found with higher needle counts.

Slight differences in tension caused by the yarn feed speed did not seem to be important factor. However, the result is against the general theory of yarn speed and tension as well as it seems to be caused by the wide range of yarn feeding speed, which is necessary to carefully concern for the further study.

The amount of generated lint was differed slightly from knitting parameters as shown in Fig. 6. With respect to needle gauge, E10 and E18 did not produce any differences in the amount of lint but E28 did. In addition, feeding angles of 90° and 60° did not show obvious tendency with low amount in the accumulation but 30° produced a higher amount of lint along with needle gauge and yarn feed speed.

The curvature of the needle hook is considered one of the main causes of these results.

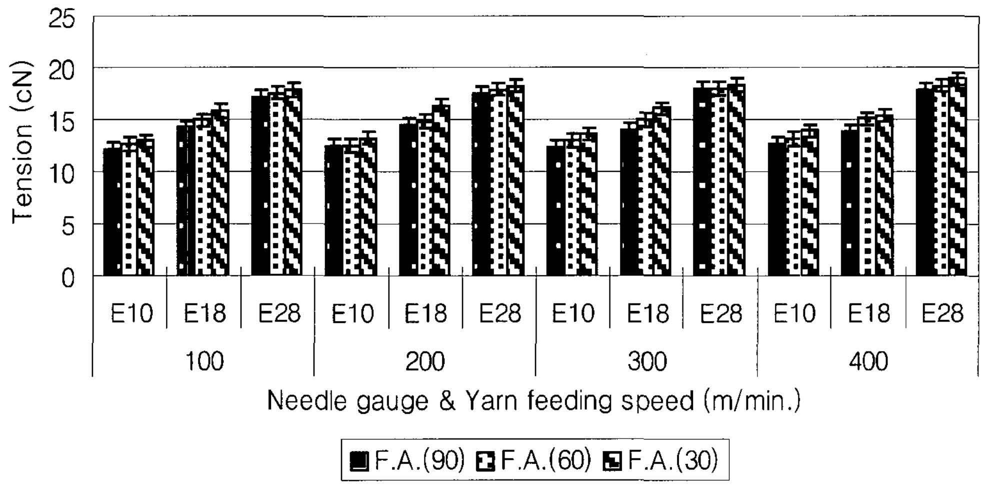

Fig. 5. Tension change according to testing parameters.

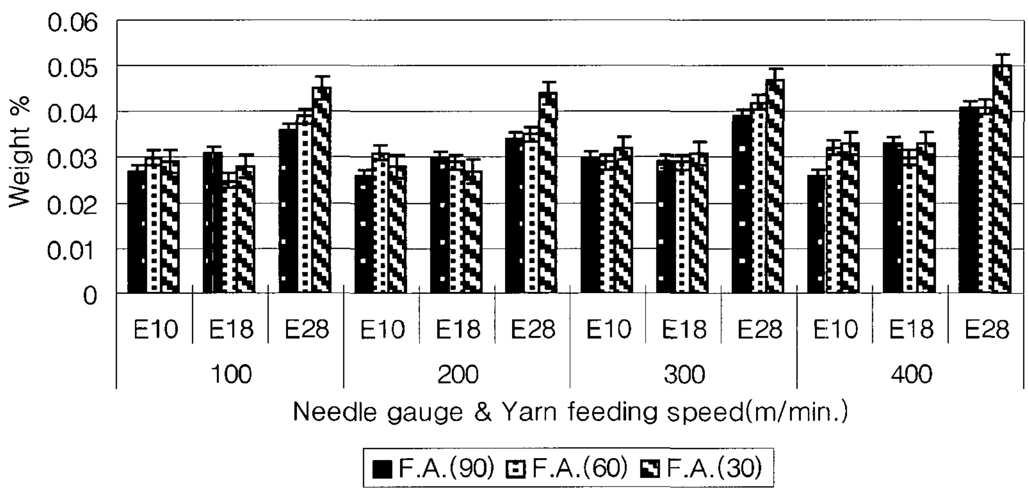

Fig. 6. Weight percentage of lint according to testing parameters.

Table 1. ANOVA Analysis

Sources	DF	F	P <	Remark
Speed	3	4.029	0.05	N.S
Angle	2	6.483	0.01	N.S
Needle	2	74.796	0.01	S
Total	7			

The hook structure of needle mainly contributes to the contact area with yarn. The curvature of the needle hook varies according to the needle count thus the curvature of the needle hook decreases as the needle count increases. The needle gauge of E28 has a more jamming structure at the contact point between hook and yarn than that of an E10 or E18. Therefore, the higher tension in E28 as shown in the figure 5 could be explained by the more jamming point of the needle hook, which resulted in the higher amount of friction between the yarn and needle hook. Accordingly, it was believed that the high friction seemed to affect higher amounts of lint.

The yarn feed angle can be another cause of tension. With respect to the amount of lint, a narrow feed angle was in more contact with the curvature of needle hook. In addition, it is also believed that the yarn contacts the inside of hook more tightly on a small gauge needle with narrow feeding angle. This implies that the increased tension between the yarn and needle hook produces high friction. This could also be explained by that smaller hook radius on the E28 needle produces a higher frictional force and thus a higher amount of lint. However, the Table 1 as ANOVA table shows that the count of needle affected with the occurred lint amount but not else. Therefore, it is believed that the knitting elements such as yarn feeding speed and angle partly affect the lint generation.

4. Conclusions

It is important for the knitting elements such as a needle structure and yarn guide to have consistent and proper movement in order to produce improvements in the quality of knitted products and a high degree of efficiency in the knitting process. In order to achieve these objectives, the factors related to knitting needles are major factors in the knitting process. In this study, we investigated process parameters, which particularly affects lint contamination during the process. Knitting conditions such as needle count, yarn feed angle and speed are critical in the knitting process. In these result, the needle count and feed angle affected the variation in tension and amounts of lint that were caused by friction forces between the yarn and the morphological structure of the needle. However, yarn feed speed did not result in any critical changes in lint generation with the other factor. This was thought to be a result of the simplicity of the developed test rig, which did not produce yarn feed condition exactly like those in industrial machines. A more advanced test rig is needed to conduct tests under conditions more like those in the knitting industry.

It is important to develop a system to prevent the mentioned problems during the knitting process, which should be continuously studied in the future. The system should include the development of new material for knitting elements as well as chemical and physical modifications of the knitting elements and yarn in order to reduce the friction force.

However, regular and efficient inspection of the knitting elements in the manufacturing process could reduce the process faults to some extent for optimum conditions in the knitting process.

Acknowledgement

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