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Effect of air-jet texturing conditions on the physical properties of split-type ultrafine P/N filaments

이은주, 복진선*, 주창환
*충남대학교 섬유공학과, *한국섬유기술개발원*

1. INTRODUCTION

Characteristics of air-jet textured yarns are determined by linear density, strength, and instability together with structural properties. Such characteristics are affected by various processing parameters and supply yarn properties. In this paper, specially, we have studied on the effect of air jet texturing conditions not only on texturing characteristics but also on splitting behavior using split-type ultrafine P/N filaments and their draw textured yarns as raw materials. Textured microfiber polyester yarns are given a rich bulk and soft handle due to the entanglement and loop of splitted fine multi-filaments. The effect of texturing conditions on the final yarn properties such as instability, linear density and strength has been investigated. Also, visual assessment of the yarn structure and splitting behavior are carried out using the SEM photographs.

2. EXPERIMENTAL

Split type ultrafine P/N filaments and their draw textured yarns producing with pin twisting method(2.3% overfeed, 170℃ heating temperature, 2300T/M) were used in this study. The general properties of supply yarns used are given in Table Ⅰ. Heberlein T110 HemaJet texturing nozzle was used and samples were produced with 10% to 20% overfeed by increments of 5%, different air pressure from 4bar to 8bar by increments of 1bar, 214RPM texturing speed, a one liter/hour water application to the supply yarn and 5% stabilizing extension. In addition, we applied 10% to 30% NaOH solution by increments of 10% to each supply yarn, meanwhile other parameters are constant(15% overfeed and 6bar air pressure).

Table 1. The general properties of the supply yarns

Property / supply yarn	Linear density(denier)	No. of filament	Filament fineness(denier)	Tenacity (g/denier)	Extension at break(%)	Modulus (g/denier)
P/N filament	75	24	3.125 (after split 0.195)	4.539	18.46	86.45
P/N DTY	75	24	3.125 (after split 0.195)	4.228	28.31	25.59

3. RESULTS AND DISSCUSSIONS

3.1 Surface and cross-section structure

The yarns produced air-jet texturing process are similar to spun yarns in terms of their appearance and physical characteristics. This similarity arises from the unique air-jet texturing process in which a flat multifilament yarn is given a spun like structure with a compact core and surface loops occuring at irregular intervals along its length. Figure 1 shows when the overfeed is as low as 10%, the excess length of filament available to form loops are indeed small. Consequently, texturing efficiency is poor. As the overfeed is increased, loops and entanglement are also enhanced due to more excess length of filament. Figure 1 also depicts that loops and entanglement of textured yarns have increased as the pressure increases. It can be considered that filament texture is increased due to increasing flow velocity.

From the comparison of surface characteristics of two yarns textured, we see that P/N DTY air-jet textured yarns have more compact yarn core and a greater number of loops than P/N filament air-jet textured yarn. It can be considered low initial modulus and bulk of P/N DTY lead to form loops and entanglement easily.

Figure 2 and 3 reveal split characteristics of two yarns textured at the different overfeed, air pressure and NaOH solution application. In case of NaOH solution application, other parameters keep constant at 15% overfeed and 6bar air pressure. A partial split began to occur at 15% overfeed and 6bar air pressure and almost complete split was made at 20% overfeed and 8bar air pressure in both textured yarns. We also could see that all textured yarns applied NaOH solution were structurally damaged and did not splitted with regardless of the concentration of NaOH solution.

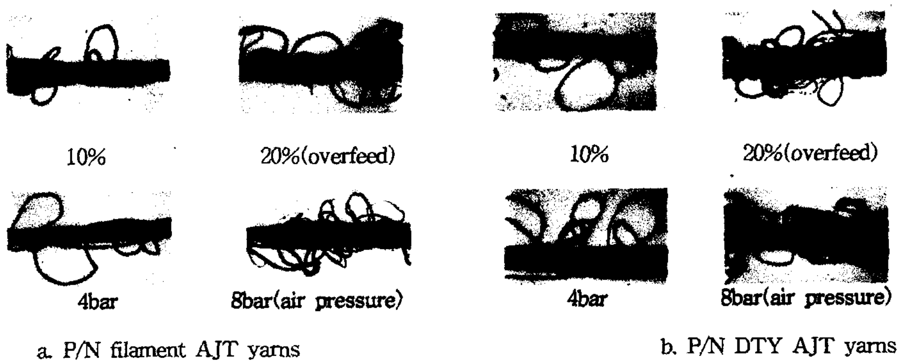

Figure 1. Surface structure with different overfeed and air pressure

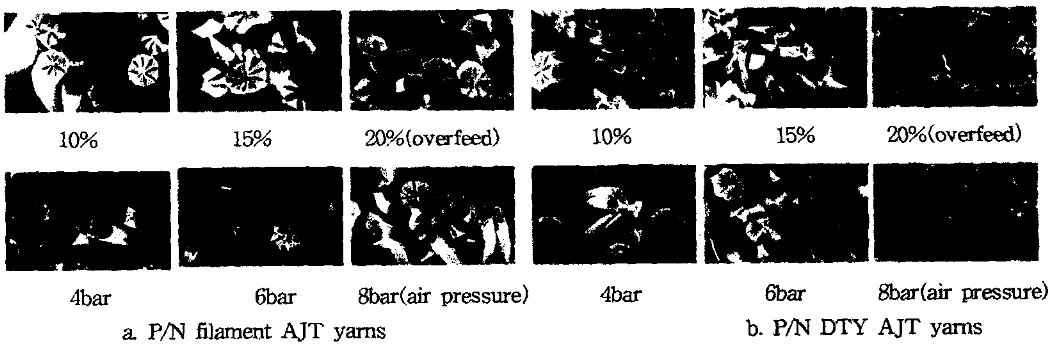

Figure 2. Split behavior with different overfeed and air pressure

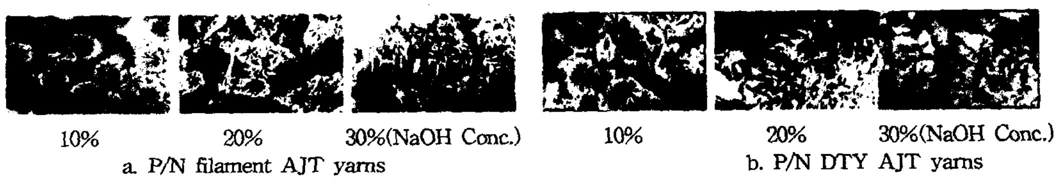

Figure 3. Split behavior with different concentration of NaOH solution

3.2 Linear density

Figure 4 shows that, with increasing overfeed and air pressure, linear density has increased. As the overfeed is increased, more excess lengths of filament are available to form loops, which tend to cover the yarn surface. And as the air pressure has increased, the flow velocity, which is the main driving force that opens up the filament to enable them to entangle and texture, has increased. Figure 4 indicates that the linear density of P/N DTY is higher than that of P/N filament as overfeed and air pressure are increased. The center-to-center distance between two neighboring filaments due to bulk increases due to the velocity differential between filaments. Both of these acting together enhance the opening of the filaments. The P/N DTY with having lower initial modulus is easily to bend and form higher loops, resulting in higher bulk in textured yarns.

3.3 Strength and breaking extension

Figure 5 and 6 show that, when overfeed and air pressure have increased, tenacity and breaking strain decreased correspondingly. This reduction in yarn strength is caused by the increased number of loops, as depicted by the SEM photographs, which in turn, reduces the number of load-bearing filaments.

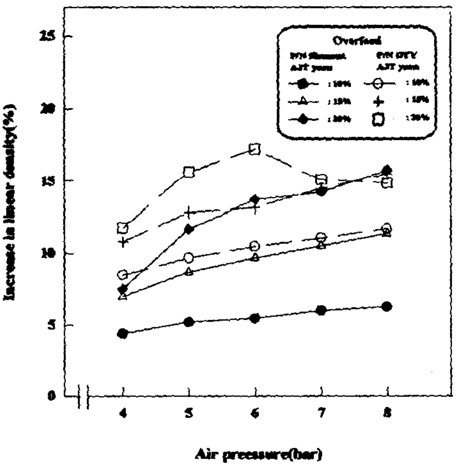

Figure 4. Effect of air pressure and overfeed on linear density of P/N filament AJT yarns and P/N DTY AJT yarns

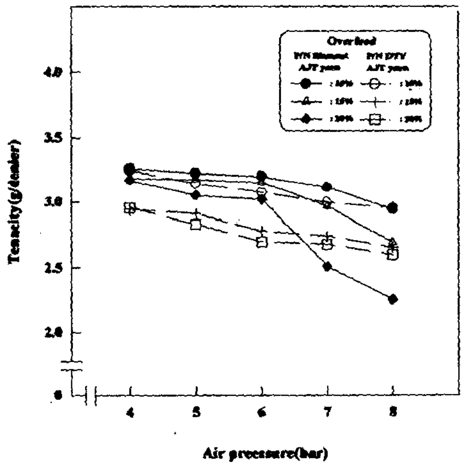

Figure 5. Effect of air pressure and overfeed on tenacity of P/N filament AJT yarns and P/N DTY AJT yarns

3.4 Instability

Figure 7 shows the trend that the instability of air-jet textured yarns has decreased with increasing overfeed and air pressure, because excess length of filament available to form loops increased by increasing overfeed. Non-uniformity and turbulence of the air flow enhanced by increasing air pressure and then the yarn made greater number of loops and entanglement. It is considered that yarn instability has increased since these formed loops and entanglement have the more likelihood of loop removal by applied load.

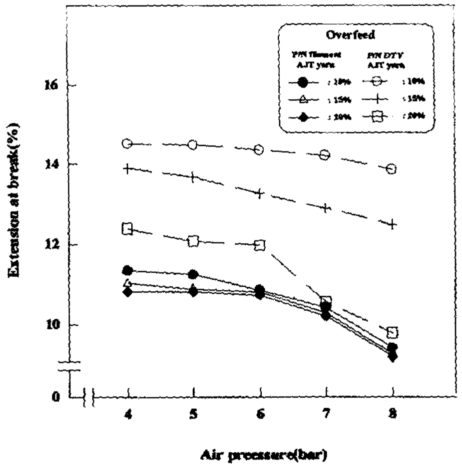

Figure 6. Effect of air pressure and overfeed on breaking extension of P/N filament AJY yarns and P/N DTY AJT yarns

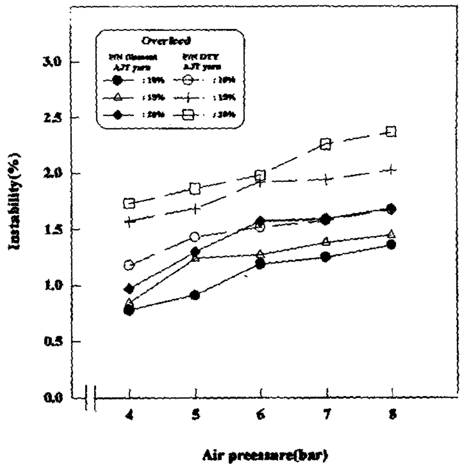

Figure 7. Effect of air pressure and overfeed on instability of P/N filament AJY yarns and P/N DTY AJT yarns

4. CONCLUSION

We have investigated the effect of air-jet yarn texturing process on the properties of split-type ultrafine P/N filament. The results obtained in this study are as follows :

1. The surface characteristics of P/N filament and P/N DTY air jet textured yarns have more loops and entanglement with increasing overfeed and air pressure, and a almost complete split occurs at 20% overfeed and 8bar air pressure in both textured yarns. In case of NaOH solution application, all textured yarns were not splitted only but damaged by NaOH solution.
2. The linear densities of both P/N filament and P/N DTY air-jet textured yarn are increased with increasing the overfeed and air pressure. But the linear density of P/N DTY air-jet textured yarn is higher than that of P/N filament air-jet textured yarn.
3. The strength and breaking strain of two textured yarns are generally reduced as compared with that of supply yarns with increasing the overfeed and air pressure. But the strength of P/N filament air jet textured yarn is higher than that of P/N DTY air-jet textured yarn, while the breaking strain is lower than that of P/N DTY air-jet textured yarn as the overfeed and air pressure have increased.
4. The instabilities of P/N filament and P/N DTY air jet textured yarns have increased with increasing the overfeed and air pressure. But the instability of P/N DTY air-jet textured yarns is higher than that of P/N filament air-jet textured yarn.

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