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EFFECT OF POLIESTER POY FIBRE CROSS-SECTION ON THE YARN PROPERTIES OF AIRJET TEXTURING

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Abstract: *POY yarns are well know and commercialized since 1970s. On the other hand, air-jet textured yarns are very common due to their unique structure which looks like natural spun-staple yarns. In the air-jet texturing process, the yarn is textured by overfeeding into a high-pressure of air to create a looped and more natural yarn appearance and also the bulkiness level of the yarn is controlled by input speed and jet-take out speed. This process reassigns flat, continous synthetic yarns into entangled, convoluted, bulky, spun like structured yarns. They are of higher bulk, exhibits increased covering power, have a more subdued lustre and are warmer in hand. Therefore, air-jet textured yarns possess some unique properties that require investigation. Hence, in this study, first the texturing process is introduced briefly and its principle of manufacturing is illustrated, later four different types of yarns were produced with two different fibre cross-sections at the three different nozzle types and three different core yarn feeding. The produced yarn production details are given and their breaking strength, elongation and work of rupture are studied along with their morphological structures by using light microscope and SEM. The aim of this study is to investigate the effect of POY fibre cross-section on air-jet textured yarn mechanical properties. The overall results showed that coarser air-jet textured yarns with a round shape have higher breaking strength, elongation and work of rupture than the trilobal shaped yarns. On the other hand, half matted yarn which was applied* TiO_2 *has also presented better breaking strength and elongation.*

Key words: *Poliester, Air-jet, Textured yarn, Mechanical properties, Cross-section*

1. INTRODUCTION

Partially oriented yarn known as POY spinning technique was initially investigated in the early 1950s and was commercialized in 1970s. Today is generally are produced by spinning at speeds of 2500 to 4000m/min. On the other hand, the term “texture” defines and describes those attributes of an object that can be recognized by the human sight (visual characteristics) or touch (tactile characteristics) [1]. These attributes of an object features bulk, hand and warmth as the tactile properties, for appearance and lustre as the visual properties. Because of the growing world demand on textile goods and an alternative production methods for the natural resources, the first commercial air jet texturing machine was displayed at ITMA in 1979. The air jet texturing process transforms flat multi-filament yarns into yarns with a spun like formation.

As is already known that, warmth, handle, natural texture and appearance are considered to be enviable properties of most textile yarns. On the contrary, synthetic filament yarns do not have such qualities; however they are usually stronger and much more uniform than the natural fibre yarns. So, textile technologists tried to produce textile yarns from synthetic filaments, i.e. polyester and polyamide, to combine the desired properties of both natural and synthetic fibres. Although this task is not very easy, however certain aspects of natural textiles can be imitated by the synthetic filaments with the method of texturing which can be described as a modification process of regular structure of synthetic filaments into rather random structures. Another explanation for texturing is given by Denton[2] and that which " texturing is the means whereby permanent fine distortions, crimps, loops, coils or crinkles are introduced into the original straight filaments of synthetic yarns without destroying the continuity of the original filaments". Most of the texturing processes introduced on the yarns which are heat sensitive (thermoplastic property) however air-jet texturing process is not heat sensitive; it is a mechanical process. On the other hand, the air-jet texturing process is by far the most versatile of all the yarn texturing technique (such as thermomechanical texturing techniques and other texturing techniques i.e. bicomponent) which it can produce yarn by means of mechanics. In this method, the yarn is textured by overfeeding into a high-pressure of air to create a looped and more natural yarn appearance and also the bulkiness level of the yarn is controlled by input speed and jet-take out speed [3]. On the air-jet texturing process, any filament yarn (POY, FDY etc.), not necessarily thermoplastic, is fed through a special designed nozzle that creates highly turbulent air at a higher speed than is taken up as entanglement in the yarn core and loops/ arcs at the surface of the yarn (Figure 1). These air-jet textured yarns have a structure which is uniquely unstretchable just the same as spun-staple yarns made of natural and man-made fibres. The surface loops are firmly fixed into the well-entangled core of the yarn and produce a voluminous bulky structure which gives natural warmth to the material.

Thus, the air-jet texturing process re-assigns flat, continuous synthetic yarns into entangled, convoluted, bulky, spun-like structured yarns. And this is achieved by the multi filament feeding of the core/effect yarn which has a higher speed inside the nozzle and hence principally can be overfed. (Figures 2-3). Additionally, a slight intermingling can be given to the flat yarn after spinning and drawing processes and also as an alternative for the twisting intermingling can be done at the texturing process (IMG)[4] as seen in Figure 4.

The aim of this research is to study the effects of POY cross-section on the breaking strength and elongation of some air-jet textured yarns.

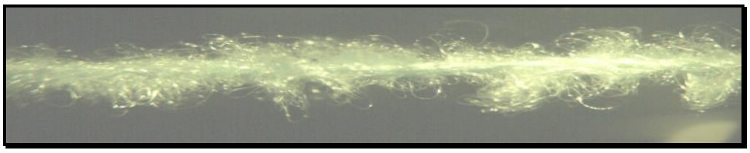

Fig.1: *Air-jet yarn*

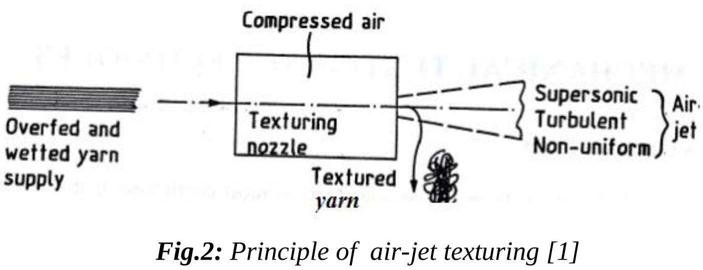

Fig.2: *Principle of air-jet texturing [1]*

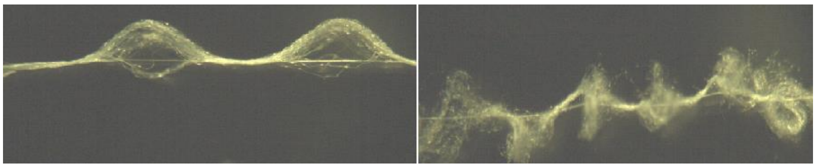

Fig.3: *Intermingled yarn (IMG) (yarn nips)*

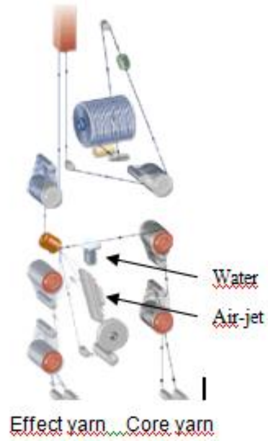

Fig.4: *Schematic diagram of air-jet textured yarn manufacturing*

2. MATERIAL AND METHOD

The aim of the work is, to study some of the effects of air-jet textured yarn production parameters on the yarn properties. Also, the cross-section of POY will be correlated on the yarn breaking strength and elongation.

2.1 Materials

In the study, to be able to observe the effect of POY cross-section on the yarn breaking strength and elongation, polyester POY yarns were produced in four different parameters: 150 f 72 dtex half matt, 150 f 72 dtex shiny, 167 f 72x2 dtex shiny and 167 f 72x2 dtex half matt appearance textured yarns.

2.2 Machinery and Instruments

The machinery and the test instruments used in the study are presented in Table 1**.**

Table 1: *Machines and the instruments used in the study*

Machines and Instruments	Purpose of the use
SSM AT01 Air-jet texturing machine	Air-jet textured yarn production
TEKTECHNO STATIMAT ME	Breaking strength and elongation
JEOL JSM-5910 LV Scanning Electron Microscope (SEM)	Surface and cross-section of yarn images
PROJECTINA 4002 microscope	Surface and cross-section of yarn images

2.3 Yarn Production Details and Yarn Properties

Yarn production details and the produced yarn properties are given in Table 2 and 3.

Table 2: *Yarn production details*

Materials and production details	Codes for yarn types			
	Yarn (A)	Yarn (B)	Yarn (C)	Yarn (D)
Material	PET	PET	PET	PET
Core yarn (dtex)	150/72 dtex half matt appearance	150/72 dtex coloured appearance	167/72x2 shiny appearance	167/72x2 half matt appearance
Effect yarn (dtex)	-	-	167/72x2 shiny	167/72x2 half matt
Nozzle type	LBO2 S3 15K2	T351	EO52-V220 K144	EO52-V220 K144
Core yarn feeding (%)	30	25	14	14
Effect yarn feeding (%)	-	-	150	150
Yarn linear density (dtex)	200	195	1310	1285
Cross-section	Round shape	Trilobal shape	Trilobal shape	Trilobal shape

Table 3: *Yarn properties*

Yarn types	Yarn linear density (dtex)	Breaking strength (cN)	Breaking elongation (%)	Work of rupture (cN.cm)	Breaking time (s)
A	200	569.23	30.88	6213.20	17.67
B	195	524.61	28.99	5055.20	15.51
C	1310	1229.18	22.45	10244.50	14.20
D	1285	1280.87	26.44	11904.15	15.64

2.4 Images of Produced Yarns

PROJECTINA 4002 light microscope and JEOL JSM- 5910 LV scanning electron microscope was used to observe the cross-section of the produced yarns and their surface morphologies with regarding to highlight their breaking strengths and elongations. The morphology images of the produced samples are given in Figures 5-8.

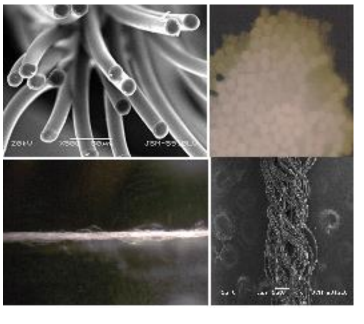

Fig. 5: *Morphology of A coded yarn (200 dtex, round shape cross-section)*

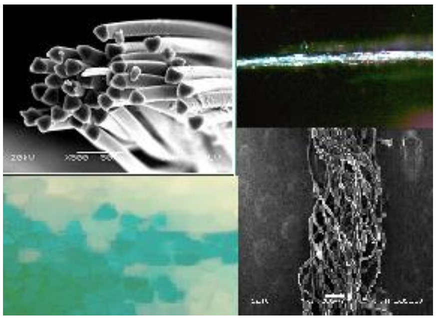

Fig. 6: *Morphology of B coded yarn (195 dtex, trilobal shape cross-section)*

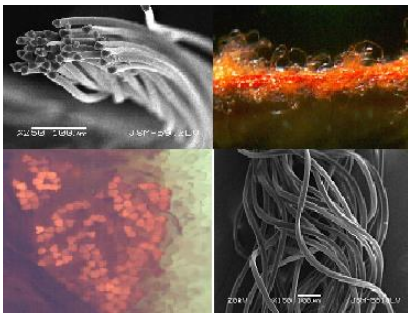

Fig. 7: *Morphology of C coded yarn (1310 dtex, trilobal shape cross-section)*

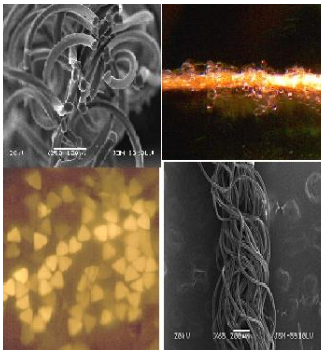

Fig. 8: *Morphology of D coded yarn (1285 dtex, trilobal shape cross-section)*

3. RESULTS AND DISCUSSION

1. In the study, although core yarn feeding ratio and its final yarn linear density of the A coded yarn (200 dtex, round shape cross-section) is coarser than the B coded yarn (195 dtex, trilobal shape cross-section); it confered higher breaking strength and elongation than the B coded air-jet textured yarn. In fact, the expectation for the A coded air-jet textured yarn was low breaking strength and elongation values, because of the A coded samples' core yarn feeding ratio is higher than the B coded sample. This is because of the increment in feeding ratio of a yarn causes more loosely and disordered fibre placement and hence resulting less parallel fibres at the yarn structure. As it is mentioned already, an opposite outcome occurred rather than the expected one: the reason for this might be that much more parallel fibre placements of the round shaped fibres within POY yarns (as seen in Figure 5) taken place at the nozzle of an air-jet textured machine; consequently it is thought that this may helped to improve breaking strength of the yarns.

2. Trilobal cross-section yarns, which are C and D coded samples, have same effect and core yarn linear densities beside same feeding ratios to the machine. However, the D coded yarn has shown higher breaking strength and elongation than the C coded yarn. This may be due to the TiO_2 which is used as a delustrant on the D coded yarns.

4. CONCLUSION

This study reveals the effect of the polyester POY yarn cross-section of the air-jet textured yarn on its mechanical properties i.e. breaking strength, elongation and work of rupture. The comparison is accomplished by using tenacity instrument and morphological appearances (e.g. by using light microscope and SEM) of the produced yarns. The following conclusions can be drawn on the basis of the study:

- Coarser air-jet textured yarn, which is also a round shaped, has shown higher breaking strength, elongation and work of rupture than the trilobal shaped yarn.
- D coded half matt yarn, although it has same cross section with C coded sample, has presented higher breaking strength and elongation than the shiny trilobal cross-sectioned yarn.
- Generally it can be said that, rather than over feeding of the core yarn (A and B codded yarns), the fibre cross-section has much more effect on the air-jet textured yarn mechanical properties.

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