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The influence of nozzle pressure and yarn count on vortex spun yarn properties produced by MVS machine

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REZUMAT – ABSTRACT

Influența presiunii duzelor și a finețiifirelor asupra proprietăților firelor filate Vortex produse cu ajutorul mașinii MVS

Pe lângă alte tehnologii de filare tradiționale și moderne, firul filat Vortex reprezintă una dintre cele mai înfloritoare tehnologii de filare. Fiind o tehnologie nouă, aceasta este încă în faza de îmbunătățire tehnologică intensivă și a lucrărilor academice. Ca o contribuție suplimentară la studiile despre firele filate Vortex, această lucrare abordează proprietățile firelor filate Vortex din bumbac 100%. În cadrul studiului experimental, au fost produse trei tipuri de fire cu diferite finețiți (Ne 20, Ne 30 și Ne 40), cu trei niveluri diferite de presiune a duzelor (4 kgf/cm^2, 4.5 kgf/cm^2, 5 kgf/cm^2). Probele de fire produse sunt apoi evaluate, luând în considerare caracteristicile lor de aspect, pilozitate, uniformitate, imperfecțiuni și rezistență la rupere. Se constată că rezultatele obținute sunt în conformitate cu lucrările experimentale anterioare.

Cuvinte-cheie: filare vortex Murata, bumbac, proprietățile firelor

The influence of nozzle pressure and yarn count on vortex spun yarn properties produced by MVS machine

Vortex spun yarn is one of the flourishing spinning technology among other traditional and non traditional spinning technologies. As one of the new technology, it is still on the phase of intensive technological improvement and academic works. As one additional contribution to the vortex spun yarn studies this paper involves with the 100% cotton vortex spun yarn properties. In the content of the experimental study three different number of yarns (Ne 20, Ne 30 and Ne 40) produced with three different levels of (4 kgf/cm^2, 4.5 kgf/cm^2 , 5 kgf/cm^2) nozzle pressure. The manufactured yarn samples are then evaluated considering their visual aspect, hairiness, evenness, imperfections, and tensile properties. Obtained results are found attributable to the previous experimental works.

Keywords: Murata vortex spinning, cotton, yarn properties.

In general, three main spinning methods are used for cotton yarn production in industrial scale; ring spinning, open-end spinning and air-jet spinning. In the case of ring spinning, the twist is inserted into yarn by a circulating traveler, and winding action is realized by a rotating spindle. Open-end spinning method has different working principle that an opening roller and an air stream separates the fiber bundles into individual ones first, and then the fibers are collected again in the form of continuous yarn strand. In air jet spinning, there are two nozzle systems generate swirling air currents in opposite directions to form the yarn. Compared with the other two techniques, air-jet spinning achieves greatest yarn production speeds [1].

In Murata vortex spinning, compressed air is transferred into the twisting chamber through the jet orifices, thereby; the high-speed whirled air current is created. This generates the negative pressure effect at the inlet of the nozzle block. The drafted fibers are drawn into the spiral fiber passage under the negative pressure; subsequently the preceding parts of those fibers are drawn into the vortex spun yarn trail along the guide needle. When the trailing ends of the drafted fibers are departed from the front roller nip point and have passed through the spiral fiber passage, the trailing portions of those fibers are inverted at the inlet of the hollow spindle and form the open-end trailing fibers because of the whirling force of the high-speed air stream. The high-speed whirled air current enables the open-end trailing fibers rotate around the core fibers, and finally the fiber bundles are twisted into the vortex spun yarn [2]. Vortex yarn has different yarn structure comparing the conventional yarn structures. Vortex spun yarn consists in two-segmented structure which includes core and wrapper fibers which covers the core part of the fiber grouping the yarn body [3].

It is known that vortex yarn and fabrics produced using vortex yarn possess several unique properties including low hairiness, outstanding pilling and abrasion resistance, high moisture absorption and diffusion properties, fast drying characteristics, high color fastness and better durability that maintains functionality over a long time [5].

Previous studies proved that the structure and performance of vortex spun yarns were influenced by the effects of nozzle angle, nozzle pressure, spindle

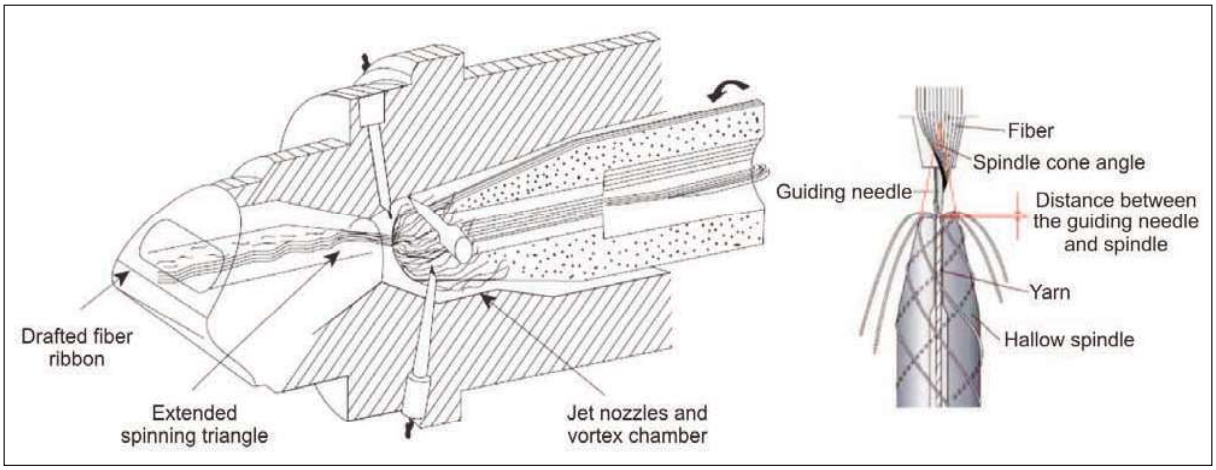


Fig. 1. Shematic diagram of the nozzle block of vortex spinning machine [4]

diameter, yarn delivery speed, yarn linear density, fiber composition and the distance between the front roller and the spindle. Nozzle pressure was defined as one of the most effective parameters. The theoretical and practical works, based on the impacts of nozzle pressure on vortex spun yarns, presented that the nozzle pressure directly influences the fiber configuration and consequently the yarn structure [6–8]. Tyagi et. al. reported that the changes in nozzle pressure influenced the tightness of wrapping fibers along the yarn strand, as well as the amount of wrapping and the proportion of unwrapped sections [8]. Moreover, it was stated that the alterations in nozzle pressure change the number of core-fibers that affect the flexural rigidity and tensile properties of the vortex spun yarns. Some authors strongly claimed that yarn evenness and imperfections are also significantly affected by the nozzle pressure [9,10]. Yarn count is also another dominant factor on the structural properties of vortex spun yarn. Yarn evenness, the number of imperfections and tensile properties are greatly influenced by the yarn count as well [9–12].

Machine producers claimed that the range of yarn count spinnable on vortex system is between Ne 15 – Ne 60 [13]. Ortlek and Ulku explored the influences of nozzle pressure and delivery speed on 100% carded cotton vortex spun yarns of Ne 20/1, Ne 30/1 and Ne 40/1. They produced vortex spun yarns on MVS 851, and from the slivers that were drafted in various ratios [14]. According to their findings, nozzle pressure and yarn count were highly influent factors for the vortex yarn properties. Decreases in the nozzle pressure resulted in improved evenness and imperfection; on the other hand, increases in the nozzle pressure resulted in highly improved hairiness and tensile properties of MVS yarns because of the better wrapping. In the case of yarn count, it was concluded that better yarn properties regarding evenness, imperfection values, hairiness and tensile properties were obtained for coarser yarns.

Our experimental studies were performed on MVS 861, and the drafting ratios and delivery speed of slivers fed to the machine were 90/26, 130/40, 173/54, and 330 m/min, respectively. Yarn numbers were ranged between Ne 20 and Ne 40 for carded cotton (100%) yarns. The optimum ones were chosen for the measurements. The main purpose of this research is to examine the effects of two important parameters, nozzle pressure and yarn count, on the properties of Vortex spun yarns, including structure, tensile strength, elongation, evenness and hairiness.

EXPERİMENTAL PART

Materials

In order to analyze the influence of nozzle pressure and yarn count on the properties of vortex yarns, 9 different types of cotton carded sample yarns were produced on the MVS 861 spinning machine. Processing cotton (100%) fibers on the systems based on jet spinning principle is still a major matter. For this reason, the proper selection of cotton fibers for the vortex spinning is vital. The properties of used cotton fibers for the experimental studies are illustrated in table 1.

Table 1

PROPERTIES OF COTTON FIBER USED IN VORTEX SPINNING PROCESS

Fiber	Fineness (micronaire)	Elongation (%)	Length (mm)	Strength (g/tex)
Cotton	4.3	5.4	30.14	33.2

Yarn preparation

In the first place, cotton fibers were opened and carded, then, they were subjected to drawing process. For the sliver preparation, three passages of drawing were applied by utilizing Rieter SB-D15 type draw machines. Good fiber alignment and sliver evenness are prime parameters in order to gain satisfactory production results, hence special care was required

for the preparation of slivers. After three passages of drawing, the slivers with a linear density of approximately Ne 0,20 were transferred to vortex spinning machine. Delivery speed of the slivers was remained the same. The list of yarn samples and corresponding test conditions are presented in table 2.

Two process parameters, which were considered to influence the properties and structure of vortex yarns, were chosen for the investigation. These were: nozzle pressure and yarn count. Therefore, three different nozzle pressures (4.0 kgf/cm^2, 4.5 kgf/cm^2, 5.0 kgf/cm^2) were determined for vortex spinning and three different yarn counts Ne 20, Ne 30 and Ne 40 were optimally produced with a constant delivery speed of 330 m/min (table 2). All the sample yarns were produced with the following spinning conditions; 70° nozzle discharge angle, **2**p130d L7 -9.3 type needle holder, 1.2 mm spindle inner diameter on MVS-861 vortex spinner.

Measurements of yarn properties

For the observation of yarn structures, a stereo microscope (Olympus SZ61) with a software analysis system (BABSOFT) was used to investigate side visual assessment of the yarn structures. Fiber arrangements were carefully observed by using this set-up. Uster Tester 4 was utilized to explore the evenness and hairiness properties of the sample yarns. Vortex yarn samples were compared in terms of structures, yarn evenness, imperfections, hairiness, tenacity, elongation and work-to break values (B-work) by using measurement data of Uster Tensojet 4. Ten bobbins were chosen for the efficient assessment of each yarn sample and ten different yarn pieces were taken from each bobbin. All the measurements were conducted under standard test conditions, 65 ± 2% relative humidity and 20 ± 2°C. Test results were analyzed for significance in differences using two way repeated measures analysis of variance (ANOVA) and Tukey HSD tests at the 0.05 level in the SPSS statistical package.

RESULTS AND DISCUSSIONS

Yarn structure

Optical images of nine different vortex yarn samples spun in various counts and nozzle pressures are shown in figure 2. Tyagi et. al. [8] used fiber tracing technique to analyze the structural properties of spun yarns and they classified the structure of vortex spun yarns into three main categories as core fibers, wrapper fibers and wild fibers. Core fibers were defined as straight or inclined fibers that constitute the most part of the yarn. Wrapper fibers are wrapped around the core fibers along the yarn central axis. Wild fibers protrude from the yarn strand in various directions and sometimes they were observed in loop formation. Our visual analysis presented that all sample yarns had these three fiber types in different amounts.

Table 2

NOMINAL YARNS AND PROCESS PARAMETERS				
Samples No.	**Yarn Count**	**Nozzle pressure (kgf/cm²)**	**Delivery Speed (m/min)**	**Total Draft/Main Draft**
1	20	4	330	90/26
2	20	4.5	330	90/26
3	20	5	330	90/26
4	30	4	330	130/40
5	30	4.5	330	130/40
6	30	5	330	130/40
7	40	4	330	173/54
8	40	4.5	330	173/54
9	40	5	330	173/54

As can be clearly seen from the images that as the yarns get finer, the amount of wrapper fibers increases. This situation was also previously reported by Erdumlu et. al. [15]. During the vortex spinning process fiber bundle are drawn into the hollow spindle where yarn formation occurs. Trailing ends of some fibers are separated from fiber bundle, because of the swirling air current, and form the wrapper fibers as well as wild fibers. When more fibers in the fiber bundle fed into the vortex system, higher inter-fiber cohesion takes place which retards the separation of trailing ends of the fibers, and less wrapper and wild fibers form in coarse counts. On the other hand, in finer counts fewer fibers are located on the yarn strand means that fibers exposed more to the swirling force of air current. Consequently, greater amount of wrapper fibers form along the yarn axis. The influence of nozzle pressure can also be seen clearly from the images. Amount of wrapper fibers increases as the nozzle pressure gets greater. Zou et.al. analyzed the flow field characteristics inside the nozzle block. They mentioned that increasing nozzle pressure generates an increase in the velocity of the air flow at the exit of the jet orifice as well as an increase in axial, radial and tangential velocities inside the nozzle block that enhance the number of open trail end fibers and therefore wrapper fibers [16]. It is also visually validated in the frame of our experimental work that yarn samples which are spun with high nozzle pressure have intense number of wrapper fiber in the yarn body.

Yarn hairiness

Comparing with other spinning techniques, one of the most spectacular characteristics of vortex spun is claimed as the low hairiness [12]. Basal and Oxenham also specifically stated that the vortex spun yarns possess lower hairiness than air jet spun yarns [17]. The reason for low hairiness was attributed to the uniformly distributed layer of wrapper fibers [18]. Hairiness properties of vortex spun yarns were measured with the help of hairiness module attached on

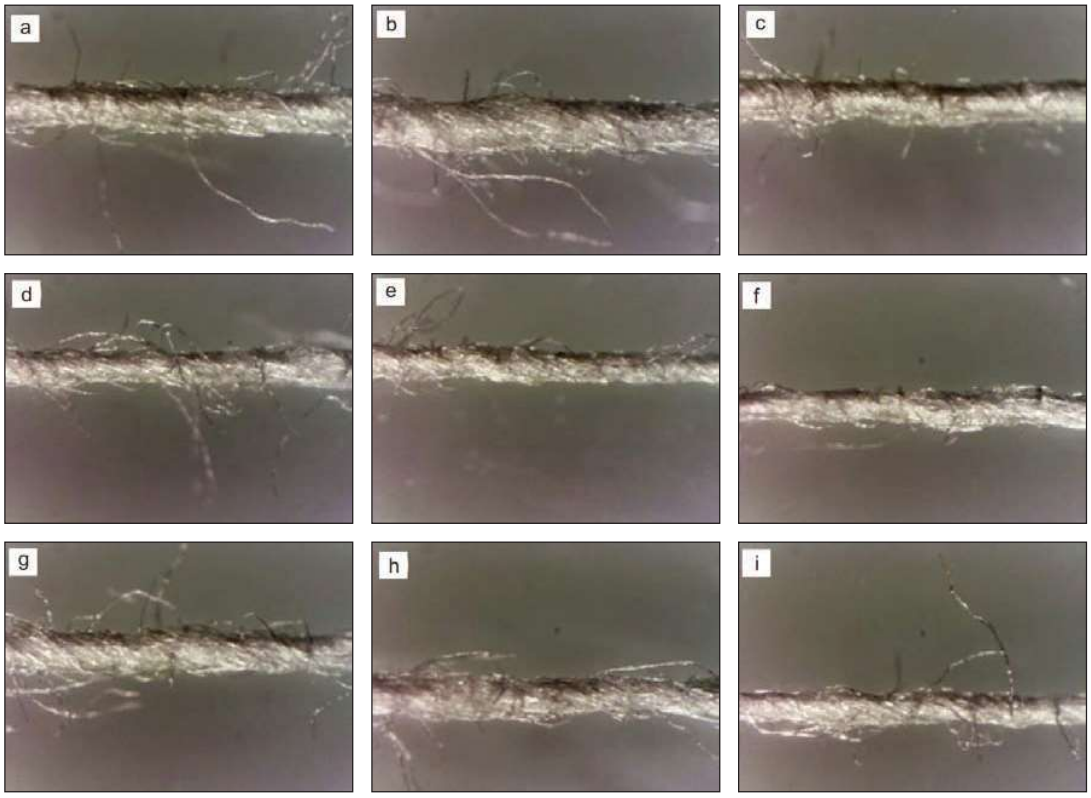


Fig. 2. Yarn samples spun in different counts and nozzle pressures; (a) Ne 20, 4 kgf/cm^2; (b) Ne 20, 4.5 kgf/cm^2; (c) Ne 20, 5 kgf/cm^2; (d) Ne 30, 4 kgf/cm^2; (e) Ne 30, 4.5 kgf/cm^2; (f) Ne 30, 5 kgf/cm^2; (g) Ne 40, 4 kgf/cm^2; (h) Ne 40, 4.5 kgf/cm^2; (i) Ne 40, 5 kgf/cm^2

Uster Tester 4 laboratory equipment. Test results are exhibited in table 3. "H" Index value stands for the total number of hairy ends on 1 cm length of yarn surface. During the experiments, 400 meters of yarn from each bobbin was tested. According to Tukey HSD test results and ANNOVA data, it was found that nozzle pressure and yarn count are important parameters that affect yarn hairiness.

The Tukey HSD test results from table 3 revealed that yarn hairiness decrease with increased nozzle pressure. The decreased hairiness at higher nozzle pressures was attributed to the fact that the whirling force of the nozzle air stream which increases with the nozzle pressure, therefore, the amount of wrapping fiber and the uniformity of wrapping are enhanced [14]. Table 3 results also indicate that as the vortex spun yarns get finer, lower hairiness values are obtained. This may be explained by the fiber packing density of vortex spun yarns [19]. Coarser yarns have higher fiber packing density that extends the probability of increasing amount of hairy ends on the yarn surface.

Table 3

EFFECTS OF NOZZLE PRESSURE AND YARN COUNT ON MVS YARN HAİRİNESS PROPERTİES, TUKEY HSD TEST RESULTS	
H (USTER INDEX)	
Nozzle Pressure	
4 kgf/cm^2	13.9737 ^{b}
4.5 kgf/cm^2	14.0890^a
5 kgf/cm^2	14.1077^a
Yarn Count	
Ne 20	12.3373^c
Ne 30	14.3260^b
Ne 40	15.5070^a

Note: a,b,c indicates the groups of data that are not different from each other at 0.95 significancy level.

Yarn evenness and imperfection properties

We compared the vortex yarn samples on the basis of yarn evenness and imperfections including thin places, thick places and neps. Table 4 presents the evenness and imperfection test results of vortex spun yarns samples produced with various nozzle pressures and yarn counts. ANOVA analysis and Tukey HSD test results proved that both air pressure and yarn count were significant factors for yarn evenness and imperfection properties.

It was noticed that as the yarn gets finer, it becomes more uneven and the amount of thin places, thick places and neps increases markedly. This was explained by the deterioration of fiber arrangement within the yarn. The decline in number of fibers in the yarn cross section makes the uniform arrangement of

Table 4

EFFECTS OF NOZZLE PRESSURE AND YARN COUNT ON MVS YARN EVENNESS AND IMPERFECTION PROPERTIES, TUKEY HSD TEST RESULTS

	CVm (%)	Thin Places (–50%)	Thick Places (+50%)	Neps (+200%)
Nozzle Pressure				
4 kgf/cm^2	13.9737 ^{b}	13.9737 ^{b}	58.0000 ^{b}	95.8333 ^{b}
4.5 kgf/cm^2	14.0890 ^{a}	31.5833 $^{a\,b}$	63.4167 $^{a\,b}$	98.8333 ^{b}
5 kgf/cm^2	14.1077 ^{a}	36.4167 ^{a}	67.1667 ^{a}	111.3333 ^{a}
Yarn Count				
Ne 20	12.3373 ^{c}	.7500 ^{c}	11.7500 ^{c}	23.9167 ^{c}
Ne 30	14.3260 ^{b}	15.8333 ^{b}	55.4167 ^{b}	109.6667 ^{b}
Ne 40	15.5070 ^{a}	78.2500 ^{a}	121.4167 ^{a}	172.4167 ^{a}

Note: a,b,c indicates the groups of data that are not different from each other at 0.95 significancy level.

the fibers more difficult. This result is consistent with the findings of the previous studies [9–14].

Figure 3 shows the measurement results of yarn evenness. It was observed that yarn evenness became worse for all sample yarns as the nozzle pressure and yarn count are increased. The highest unevenness rate was obtained from the Ne 40 vortex yarn that was spun with the nozzle pressure of 5 kgf/cm^2. The best evenness result was recorded for Ne 20 vortex yarn that was spun with the nozzle pressure of 4 kgf/cm^2. Zou et.al. reported that when the nozzle pressure is too high, the high speed air flow takes the separated fibers out of the fiber bundle. This generates the more amounts of wild fibers and increases the fiber loss. At the end, the uniformity of vortex spun yarn is deteriorated [16, 20].

Figure 4 shows the impact of yarn count and nozzle pressure on the occurrence of thin places along the yarns. According to the graph, the number of thin places increased enormously on Ne 40 yarn compared with the Ne 20 and Ne 30 yarns. The greatest number of thin places was obtained from Ne 40 yarn that was spun with the nozzle pressure of 5 kgf/cm^2. The least amount of thin places was observed on Ne 20 yarn that was spun with the nozzle pressure of 4 kgf/cm^2. As it can be clearly seen from the graph that the amount of thin places increase, as the yarn becomes finer and as the nozzle pressure gets greater. This situation was explained by the increase in whirling force of air current inside the nozzle that causes more amount of fiber lost. This effect becomes more influent for finer yarns due to the low number of fibers located in the yarn cross section [8, 10].

Figure 5 presents the impact of yarn count and nozzle pressure on the occurrence of thick places along the yarns. According to the graph, it can be stated that there was not a regular trend among the test results; however, number of thick places was greater on finer yarns. The lowest amount of thick places was recorded for Ne 20 yarn that was spun with the nozzle pressure of 4.5 kgf/cm^2, on the other hand, the highest number was observed for Ne 40 yarn that was spun with the nozzle pressure of 4.5 kgf/cm^2. This irregular data distribution was also observed by Ortlek and Ulku for vortex spinning of carded cotton (100%) [14, 15]. Undesired alterations in efficiency of nozzle air pressure during the spinning process may cause such irregularities.

Figure 6 illustrates the influence of yarn count and nozzle pressure on the neps formation along the yarns. According to the graph, the number of neps

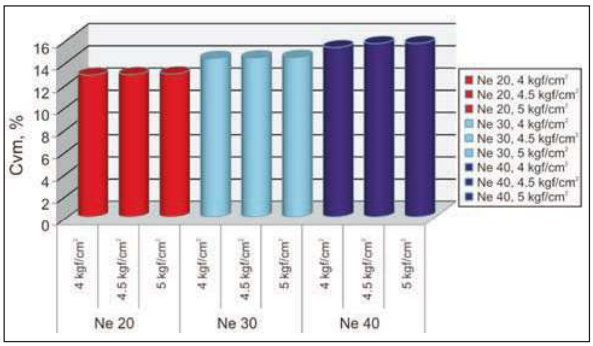


Fig. 3. The impact of nozzle pressure and yarn count on yarn evenness (CVm%, per km)

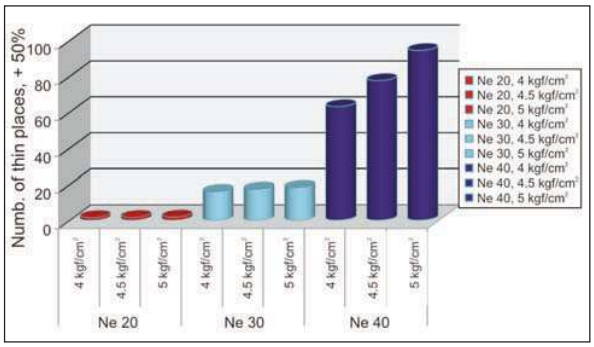


Fig. 4. The impact of yarn count and nozzle pressure on the occurrence of thin places (per km) along the yarns

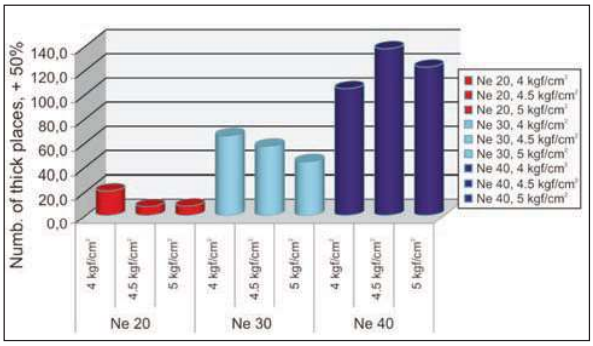


Fig. 5. The impact of yarn count and nozzle pressure on the occurrence of thick places (per km) along the yarns

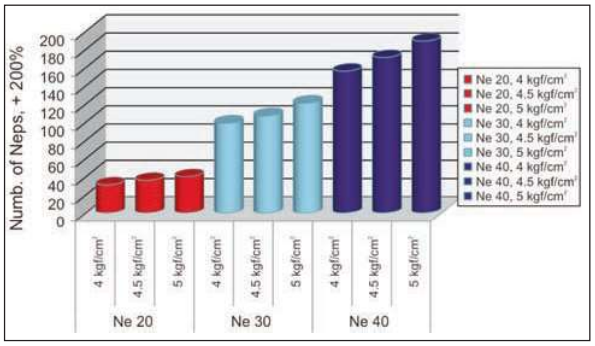


Fig. 6. The influence of yarn count and nozzle pressure on the neps formation (per km) along the yarns

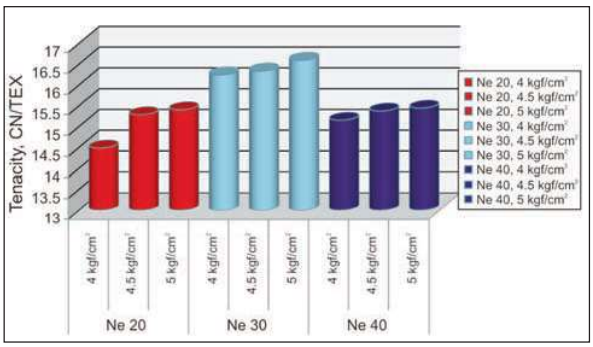


Fig. 7. The results of tenacity measurements of 100% cotton vortex spun yarns

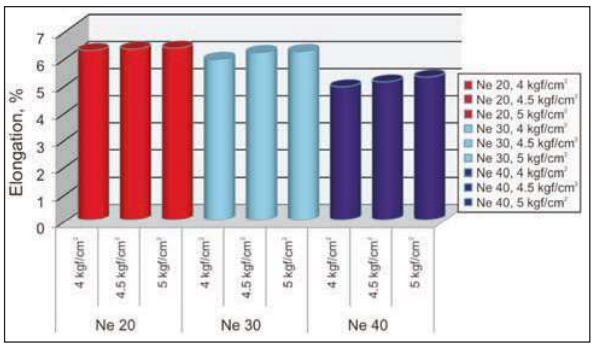


Fig. 8. The impact of nozzle pressure and yarn count on the breaking elongation of vortex spun yarns

formation increased as the nozzle pressure increased. In addition, more amounts of neps were observed on finer yarns. The highest amount was measured for Ne 40 yarn that was spun with the air pressure of 5 kgf/cm^2, whereas, the lowest amount was observed on Ne 20 yarn that was spun with the air pressure of 4 kgf/cm^2.

Tensile properties of vortex spun yarns

In terms of tenacity properties of vortex spun yarns, there are various opinions mentioned by different researchers. Tyagi et.al and Ortlek and Ulku claimed that compared with the finer yarns, coarser yarns performed better in terms of tenacity, breaking elongation and work-to break values. On the other hand, Murata Machinery Ltd. stated that the yarn tenacity increases as the yarn becomes finer [9–11]. Leitner et.al. also confirmed that coarser yarns possess higher tenacity and breaking elongation [12].

In figure 7, the results of tenacity measurements of 100% cotton vortex spun yarns are shown. It was observed that the tenacity of Ne 30 yarns achieved the greatest value with the applied nozzle pressure of 5 kgf/cm^2. On the other hand, the lowest value was obtained for Ne 20 yarns produced with the nozzle pressure of 4 kgf/cm^2. In general, increasing nozzle pressure caused a noticeable growth in tenacity. Analysis of experimental results revealed that tenacity values follow a decreasing trend as the yarn becomes too much finer or too much coarser. This could be explained by the wrapping length of the edge fibers and the ratio of wrapper and core fibers. Generally, vortex spun yarns contain 50–60 % of core fibers and the rest of them are wrapper fibers, respectively. Finer yarns have more amounts of wrapper fibers which means less amount of load bearing core fibers exist within the yarn. Consequently, tenacity and breaking elongation values decline in too much finer yarns. In too much coarser yarns, wrapping length of the edge fibers in the fiber bundle gets smaller and hence the tenacity declines [11].

The impact of nozzle pressure and yarn count on the breaking elongation of vortex spun yarns is illustrated in figure 8. Statistical analysis revealed that increase in nozzle pressure also increases the breaking elongation value for all vortex spun yarn samples. The highest value was obtained from the Ne 20 yarn that was spun under the nozzle pressure of 5 kgf/cm^2, whereas, the lowest value noted for Ne 40 yarn produced with nozzle pressure of 4 kgf/cm^2. It was also noticed that coarser yarns had greater breaking elongation values compared with finer yarns (figure 8). Alterations in breaking elongation values may be explained by the amount of wrapper fibers and wrapping length of the edge fibers on the yarn.

The effect of nozzle pressure and yarn count to the work-to break values of vortex spun yarns is illustrated in figure 9. According to the statistical analysis, it can be expressed that similar trend was observed for breaking elongation ratios and work-to break values of vortex yarn samples. As the yarn becomes coars-

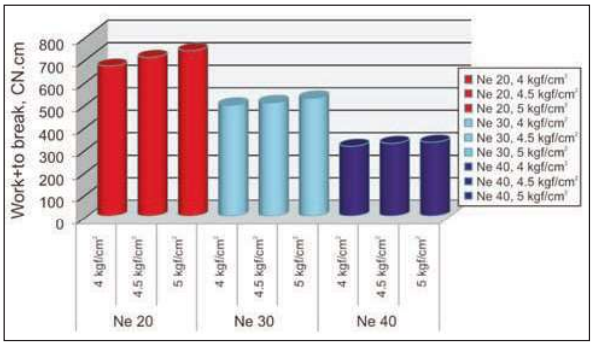


Fig. 9. The effect of nozzle pressure and yarn count to the work-to break values of vortex spun yarns

er, work-to break value rises up. Nozzle pressure also affected the work-to break values of yarns markedly. Work-to break values were triggered when the nozzle pressure was enhanced.

CONCLUSIONS

Vortex spun technology is a flourishing spinning technology among other traditional spinning technologies. Even the expansion speed of the technology settlement is going well all over the world; there are still some abstainable approaches about the vortex spun yarn production technology. This study is conducted aiming to better understand vortex spun technology, to support steady implementation of the technology among the textile world, and experimenting the influence of the nozzle pressure on the yarn properties for the cotton carded yarn production.

As result of the experimental work that has been carried out in the frame of the paper below listed conclusions can be drawn out;

1. Produced vortex spun yarn samples have three basic parts of a typical vortex yarn, core fibers, wrapper fibers and wild fibers. Experienced visual evaluation proved that amount of wrapper fibers increases with the increasing nozzle pressure. On the other hand, a decline in the amount of wrapper fibers was observed in coarser yarns.
2. Measured results and statistical analysis work prove that nozzle pressure and yarn count are important parameters that affect yarn hairiness. Yarn hairiness decrease with increased nozzle pressure as result of the fact that the whirling force of the nozzle air stream increases with the nozzle pressure, causes raised amount of uniform wrapping fiber. Finer yarn number of vortex spun yarn results lower hairiness values comparing the coarser vortex spun yarns.
3. Measured results and statistical analysis work prove that both air pressure and yarn count were significant factors for yarn evenness and imperfection properties. It was noticed that as the yarn gets finer, it becomes more uneven and the number of imperfections increases markedly.
4. Measured results show that the highest tenacity belongs to the Ne 30 yarns spun with the nozzle pressure of 5 kgf/cm^2; the lowest tenacity belongs to Ne 20 yarns spun with the nozzle pressure of 4 kgf/cm^2. In general, increasing nozzle pressure caused a noticeable growth in tenacity. Analysis of experimental results and previous literature studies revealed that tenacity values follow a decreasing trend as the yarn becomes too much finer or too much coarser. This could be explained by the rate of core and wrapper fibers of yarn body. Finer yarns have more amounts of wrapper fibers which mean less amount of load bearing core fibers resulting lower tenacity and breaking elongation.
5. Calculated work-to break values and statistical analysis work show that as the vortex spun yarn becomes coarser, work-to break value rises up. Increasing nozzle pressure also causes the higher value of the work-to break results.

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BIBLIOGRAPHY

[1] Soe, A.K., Takahashi, M., and Nakajima, M. *Structures and properties of MVS yarns in comparison with ring yarns and open-end rotor spun yarns.* In: Textile Research Journal, 2004, vol. 74, issue 9, pp. 819-826.

[2] Zou, Z.Y., Yu, J.Y., Xue, W.L., Zhu, Y.D., Wu, J.M., Cheng, L.D. *Analysis of the fiber spatial trajectory in vortex spun yarn*. In: Textile Research Journal, vol. 79, issue 10, pp. 924-929.

[3] Altas, S.; Kadoglu, H.. *Comparison of the evenness, faults and hairiness of compact and conventional spun ring yarns*. In: Industria Textila, 2013, vol. 64, issue 3, pp. 65-69.

[4] Pei, Z., Yu, C. *Prediction of the vortex yarn tenacity from some process and nozzle parameters based on numerical simulation and artificial neural network*. In: Textile Research Journal, 2011, vol. 81, issue 17, pp. 1796-1807.

[5] Ortlek, H. G.; Kilic, G.; Bilgin, S., *Comparative study on the properties of yarns produced by modified ring spinning methods*. In: Industria Textila, 2011, vol. 62, issue 3, pp. 129-133.

[6] Basal,G. The Structure and Properties of Vortex and Compact Spun Yarns, PhD Thesis, 2003, North Carolina State University.

[7] Basal, G., Oxenham, W. *Effects Of some process parameters on the structure and properties of vortex spun yarn.* T In: Textile Research Journal, 2006, vol. 76, issue 6, pp. 492-499.

[8] Tyagi, G.K., Sharma, D., Salhotra, K.R. *Process-structure-property relationship of polyester-cotton MVS yarns: Part I-Influence of processing variables on the yarn structural parameters.* In: Indian Journal of Fiber & Textile Research, 2004, vol. 29, pp. 419-428.

[9] Tyagi, G.K., Sharma, D., Salhotra, K.R. *Process-structure-property relationship of polyester-cotton MVS yarns: Part II-Influence of processing variables on the yarn structural parameters.* In: Indian Journal of Fiber & Textile Research, 2004, vol. 29, pp. 429-435.

[10] Ortlek, H.G., Ulku S. *Effect Of some variables on properties of 100% cotton vortex spun yarn.* In: Textile Research Journal, 2005, vol. 75, issue 6, pp. 458-461.

[11] Oxenham,W. *Fasciated Yarns-A Revolutionary Development?*. In: Journal of TATM, 2001, vol. 1, issue 2, pp. 1-7.

[12] Leitner, H., Schwippl, H., Baldischwieler, O. *Air-jet spinning – yarns&fabrics compared to established spinning systems.* XIIth International Izmir Textile &Apparel Symposium, October 28-30 October 2010, Izmir, Turkey.

[13] Nazan Erdumlu, Bulent Ozipek, William Oxenham. *The structure and properties of carded cotton vortex yarns.* In: Textile Research Journal, 2012, vol. 82, issue 7, pp. 708-718.

[14] Ortlek, H. G., Ulku, S. *Effect of some variables on properties of 100% cotton vortex spun yarn.* In: Textile Research Journal, 2005, vol. 75, issue 6, pp. 458-461.

[15] Erdumlu, N. *An approach to investigate the Spinnability of fine count yarns on vortex spinning system.* İstanbul Technical University, Institute Of Science And Technology, Phd Thesis, p. 154, İstanbul (2011).

[16] Zou, Z., Liu, S., Zheng, S., Cheng, L. *Numerical computation of a flow field affected by the process parameters of murata vortex spinning.* In: Fibres and Textiles in Eastern Europe, 2010, vol.18, issue 2, pp. 35-39.

[17] Basal, G., Oxenham,W. *Vortex spun yarn vs. air-jet spun yarn*. In: Autex Research Journal, 2003, vol. 3, issue 3, pp. 96-101.

[18] Kılıc, M., Okur, A. *The properties of cotton-Tencel and cotton-Promodal blended yarns spun in different spinning systems.* In: Textile Research Journal, 2010, vol. 81, issue 2, pp. 156-172.

[19] Zheng, S., Zou, Z., Shen, W., Cheng, LD. *A Study of the fiber distribution in yarn cross section for vortex spun yarn.* In: Textile Research Journal, 2012, vol. 82, issue 15, pp. 1579–1586.

[20] Zou, Z., Cheng,L., Xue,W., Yu, J. A. *Study of the twisted strength of the whirled airflow in murata vortex spinning.* In: Textile Research Journal, 2008, vol. 78, issue 8, pp. 682-687.

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