

**EFFECT OF AIR PRESSURE ON THE COTTON/POLYESTER BLENDED
VORTEX SPUN YARN PROPERTIES IN TERMS OF UNIFORM YARN COUNT****¹Pranay Dutta, ²Mohammad Abu Sufian, ³Iqbal Hossain Imran**¹Instructor¹, Department of Textile Technology, Chittagong Technical College, Chattogram, Bangladesh.²Student², Department of Wet Processing, Textile Engineering College, Zorargonj, Chattogram.³Student³, Department of Mechanical Engineering, Institute of Engineering & Management, West Bengal, India.[¹pranaydutta992@gmail.com](mailto:pranaydutta992@gmail.com), [²sufian.joy33@gmail.com](mailto:sufian.joy33@gmail.com), [³ihimran109@gmail.com](mailto:ihimran109@gmail.com)**ABSTRACT**

Vortex spun yarn is one of the advanced spinning technologies among other conventional spinning technologies. It is yet in intense development and academic work stage as one of the modern technology. This report contains the cotton-polyester spun yarn properties as an additional reference to the vortex spun yarn study. For this reason, we have developed same count yarn such as Ne 30/1 with four different levels of air pressure by using the Murata Vortex Spinning System. After that, the produced yarn specimens are then tested based on their yarn evenness, hairiness, tenacity, elongation %, and CLSP (Count Lea Strength Product). We have seen how the properties of yarn are altered with the change of spindle air pressure. The outcomes of this study have disclosed that the properties of yarn change with increased pressure. After the experiment, we found out the standard spindle air pressure is 0.50 MPa. Although CLSP (Count Lea Strength Product) reaches its maximum point at 0.55 MPa, yet with the increasing pressure twist is also increasing and cost would be high.

Keywords: Vortex yarn, CVC yarn, spindle air pressure, yarn properties, yarn count.

INTRODUCTION

All disparities in yarn properties can be related to the differences in the construction of the yarn resulting from different manufacturing techniques. Four types of yarn manufacturing techniques such as ring, compact, rotor, and vortex spinning, are now generally recognized in short fiber textile spinning [1]. There is a direct relationship between the system of yarn formation, structure, properties, and efficiency. In this sequence of relationships, yarn production technology describes the term yarn formation method in which ring spinning, rotor spinning, vortex spinning, friction spinning, etc. are reported to have different impacts on the formed yarns [2]. For instance, in order to manufacture high-quality yarn and a wide range of yarn styles, the ring spinning method is used. While ring spinning is the global spinning technique, the main disadvantage of this system is its limited spindle speed inducing lower rate of production [3, 4]. On the other hand, to create yarns, 2 nozzle modules produce swirling streams of air in reverse ways in air jet spinning. The air-jet spinning achieves higher yarn output rates compared with the other two techniques [5].

Furthermore, the fibers are drawn into a spiral opening at the entrance to the jet through the air flow which is created following the drafting in the vortex spinning process that has four rollers and an apron drawing system. The front portions of the fibers entering the yarn making zone are twisted by an air flow that develops the central fibers, whilst the back ends of the fibers create a wrapping on all directions of the central fibers during spinning [1]. In addition, the vortex yarn has a unique yarn structure because vortex spun yarn comprises a structure of two segments consisting of core and wrapper fibers that occupy the core of fiber grouping of the body of the yarn [6].

It is believed that vortex yarns and fabrics made by vortex yarn have a number of distinct properties, particularly excellent pilling and abrasion resistance, high moisture absorption and diffusion properties, quick drying characteristics, low hairiness, good color fastness, and improved durability that maintain functionality for a long period. [7].

Prior works of literature have shown that vortex spun yarns' structure and efficiency have been affected by the impacts of the angle of the nozzle, the diameter of the spindle, the speed of delivery of the yarn, the linear density of the yarn, the space from the spindle to the front roller and the fiber composition. Additionally, spindle air pressure is described as one of the most key factors because it has a major impact on the yarn characteristics. Murata Machinery Ltd. claimed that the air pressure of the spindle had a substantial influence on the properties of the yarn. That is why with respect to the uniform yarn count, the impact of the air pressure of the spindle on the CVC (Chief Value Cotton) vortex spun yarn properties were studied in this work. This paper mainly aims to examine the influences of the air pressure of the spindle on the properties of CVC vortex spun yarns, particularly yarn irregularity, hairiness, tenacity, elongation %, and CLSP (Count Lea Strength Product). Besides, the focus of the study's analysis was to identify the appropriate pressure for CVC vortex yarn production.

EXPERIMENTAL PART

Preparing the Yarn Specimens

With a view to analyzing the effect of air pressure of the spindle on the properties of vortex yarns, samples of Ne 30/1 CVC vortex yarn with a blend ratio of 60/40 were made on the MVS 861 spinning machine. For vortex spinning, the appropriate choice of cotton and polyester fibers is imperative. Table 1 and Table 2 illustrate the properties of the cotton and polyester fibers utilized in this analysis. Table 2 shows the properties of cotton fibers.

Table 1: Properties of polyester fiber used during vortex spinning process

<i>Fiber</i>	<i>Fiber Profile</i>	<i>Breaking Extension (%)</i>	<i>Tenacity (g/d)</i>	<i>Linear Density (denier)</i>	<i>Fiber Length (mm)</i>
Polyester	Circular semi dull	20 ± 5	6.7 ± 0.5	1.0	32.0

Table 2: Properties of cotton fiber used during vortex spinning process

<i>Fiber</i>	<i>Elongation (%)</i>	<i>Length (mm)</i>	<i>Strength (G/tex)</i>	<i>Fiber Fineness (micronaire)</i>
Cotton	3.2	30.9	39.4	4.3

Before entering the vortex spinning system, the combed cotton and polyester fibers were blended with a mixing ratio of 60/40 and treated via the blow room section, carding section, and 3 continuous drawing sections. The finisher drawing slivers were formed by the Reiter Auto Leveler drawing frame at a distribution speed of

500 meters/min. By using the Murata vortex spinning unit, the drawn slivers were spun using various air pressure combinations with a view to making CVC (Chief Value Cotton) yarns with count Ne 30.

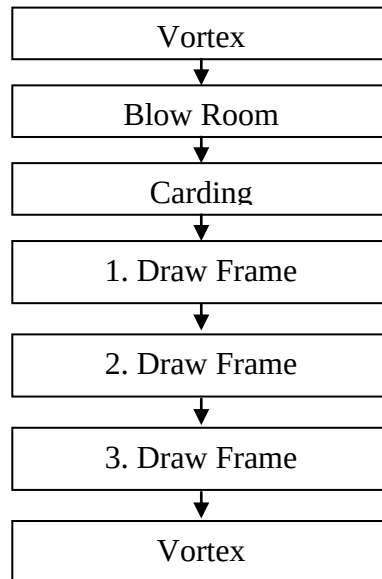


Figure 1: Production phases to spinning for Murata Vortex Spinning System

Methods of Testing

The yarn test specimens that were formed by changing the air pressure of the spindle were evaluated on the USTER TESTER 6 at the speed of 400 m/min for Hairiness Index and yarn evenness. By using the USTER TENSORAPID test machine, the tenacity and elongation properties were calculated. The average yarn irregularity and hairiness values for each yarn specimen were assessed at 10 measurements, and the average tensile properties for each yarn specimen were taken at 120 readings. For the length of 100 meters per specimen, the protruding hairs of yarn were calibrated with various lengths by using the ZWEIGLE G567 hairiness tester. All tests were carried out in standard lab conditions, where the relative humidity of the lab was $65 \pm 2\%$ and the temperature of the lab was $20 \pm 2^\circ\text{C}$. The evaluation of all tests using single-way ANOVA was done to identify the important differences between the averages of yarns spun on the vortex spinning system in this experiment, too.

RESULTS AND DISCUSSIONS

The results of all test have been shown in the table following.

Yarn Unevenness

Figure 2 indicates observation of yarn irregularity effects. It has been found that the yarn uniformity has deteriorated for all test specimens because the air pressure of the spindle has risen. The maximum irregularity yield was achieved from the Ne 30 vortex yarn Spun with 0.60 MPa air pressure of the spindle, whereas the highest evenness outcome was reported for the Ne 30 vortex yarn, spun with 0.40 MPa air pressure of the spindle. This is because the high-speed airflow removes the separate fibers from the fiber bundle when the air

Table 3: CVC vortex spun yarn properties with various spindle air pressure

Spindle Air Pressure (MPa)	0.40	0.50	0.55	0.60
Actual Count (Ne)	30	30	30	30
Yarn Unevenness, U %	11.04	11.38	11.72	11.98
Average Time Of Breakage	2.6 s	3 s	3.3 s	2.6 s
Tenacity (cN/tex)	1417.817	1652.957	1795.926	1399.882
Elongation At Break %	6.720	7.636	8.382	6.637
CLSP (Count Lea Strength Product)	1882.308	2194.483	2384.290	1858.498
Hairiness Index, H	3.69	3.48	3.45	3.41

of the spindle is too high; as a result, this produces more wild fibers and raises fiber degradation. The yarn evenness of vortex yarn is eventually degraded.

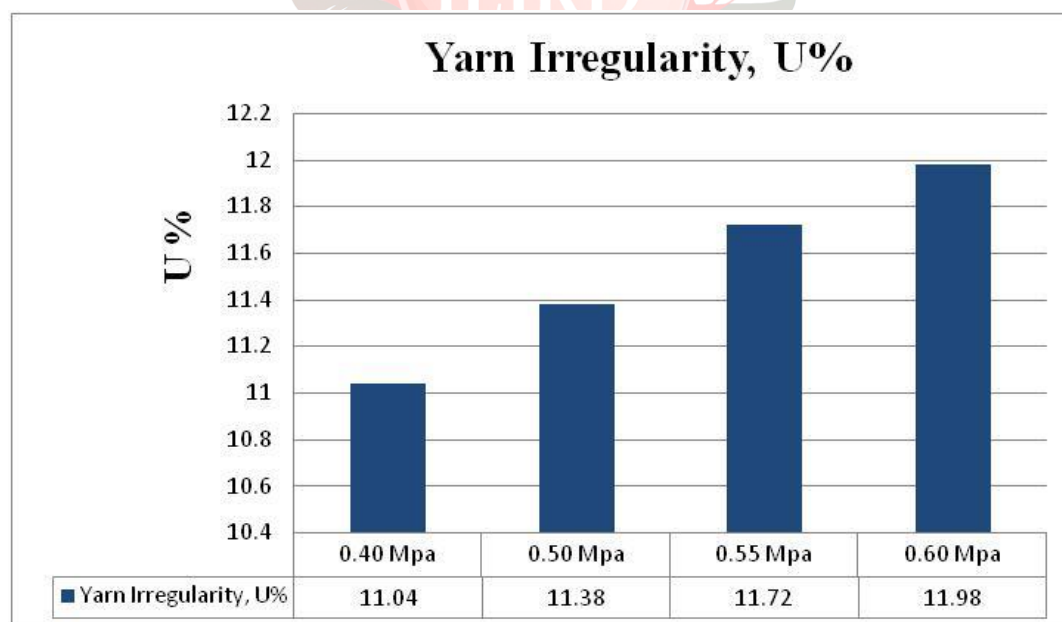


Figure 2: The result of air pressure of the spindle on the yarn irregularity of CVC vortex spun yarns.

Tenacity

Vortex yarns' tenacity is affected by the air pressure of the spindle seen from the table 3. Vortex yarns' tenacity is determined by the ratio of both the wrapper and core fiber. Also, it relies on the sheath fibers' wrapping length. In determining the tightness of the twist, the wrapper to core proportion performs the more significant role. Analysis of experimental results revealed that when the air pressure of the spindle was 0.55

MPa, the highest tenacity was noticed. In other words, increased spindle air pressure resulted in substantial tenacity growth of the vortex yarn. This is because finer yarns have more wrapper fibers, meaning that there are fewer amounts of core fibers remain within the yarn.

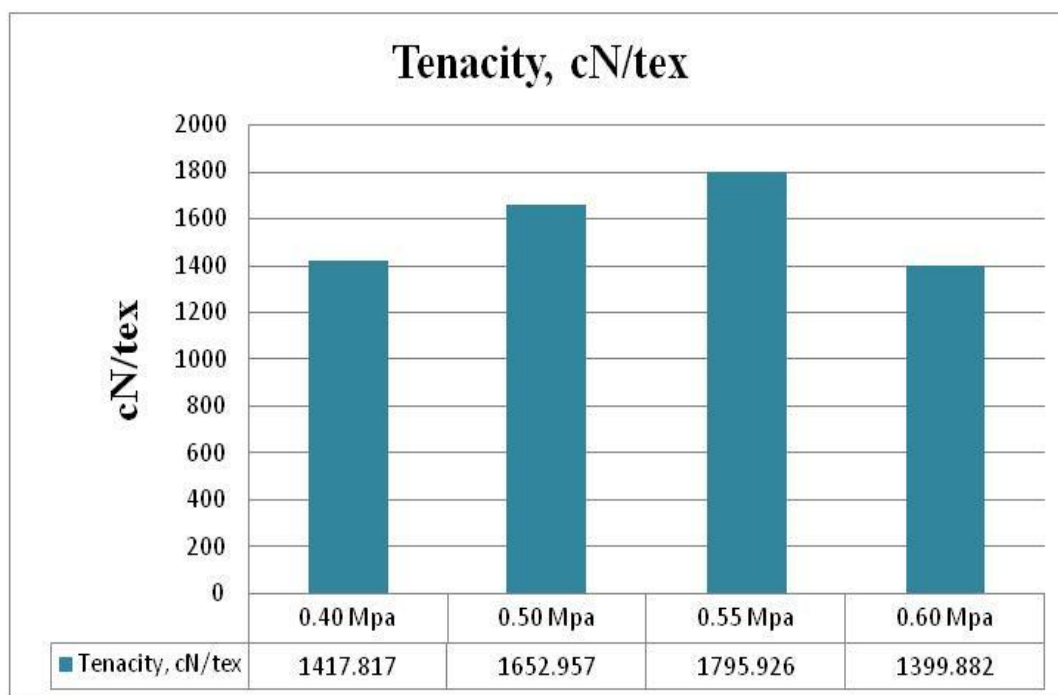


Figure 3: The result of air pressure of the spindle on the tenacity of CVC vortex spun yarns.

Elongation %

The elongation% even changed with the use of the air pressure of the spindle. In figure, the effects of the air pressure of the spindle on the breaking elongation of vortex yarns have been shown..

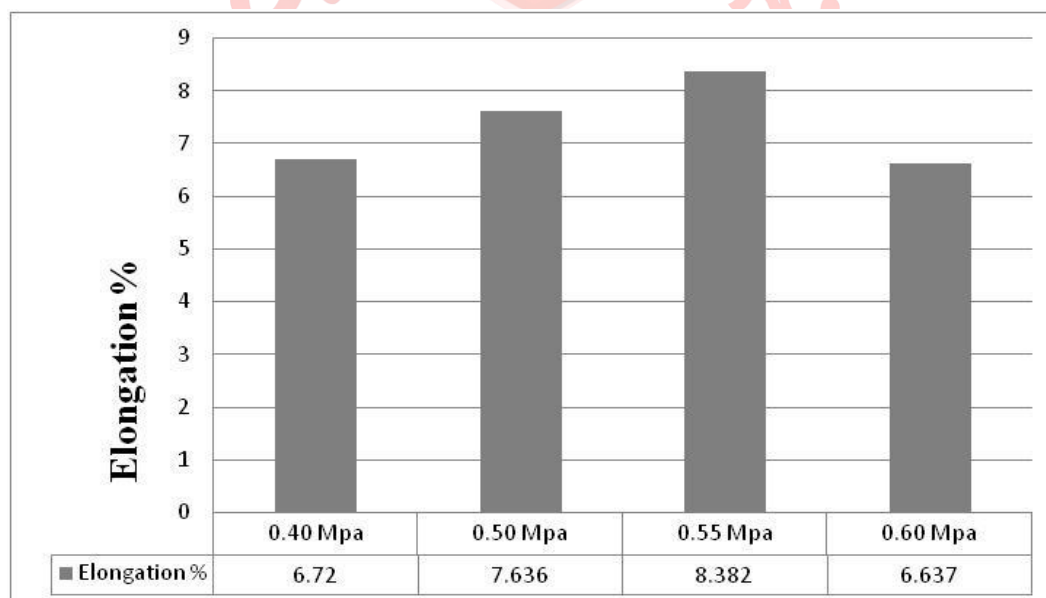


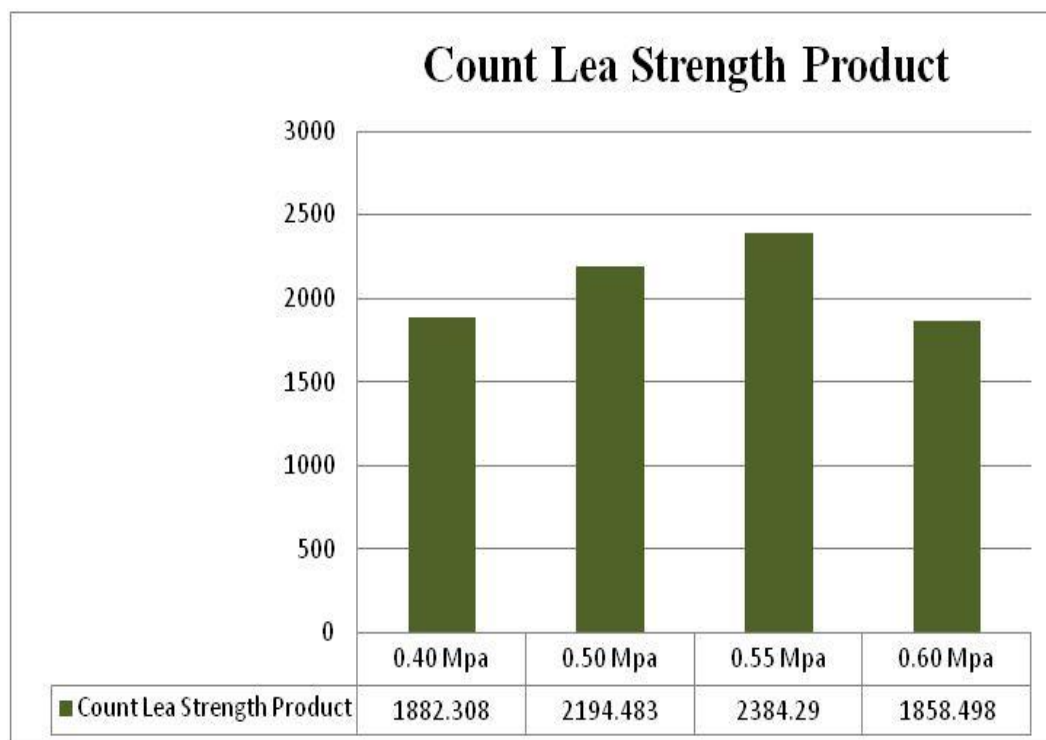
Figure 4: The result of air pressure of the spindle on the breaking elongation of CVC vortex spun yarns.

Statistical research has shown that for all vortex spun yarn specimens, the rise of the air pressure of the spindle also raises the breaking elongation value. The Ne 30 yarn spun under the spindle air pressure of 0.55MPa was the highest value. Because of too many wrapper fibers, Yarn elongation raises as the air pressure from the

spindle raises. The air pressure of the spindle shifts the direction of the core fibers as well as the wrapping length for the sheath fibers; as a consequence, the air pressure of the spindle significantly raises the vortex yarns' elongation characteristics.

Count Lea Strength Product (CLSP)

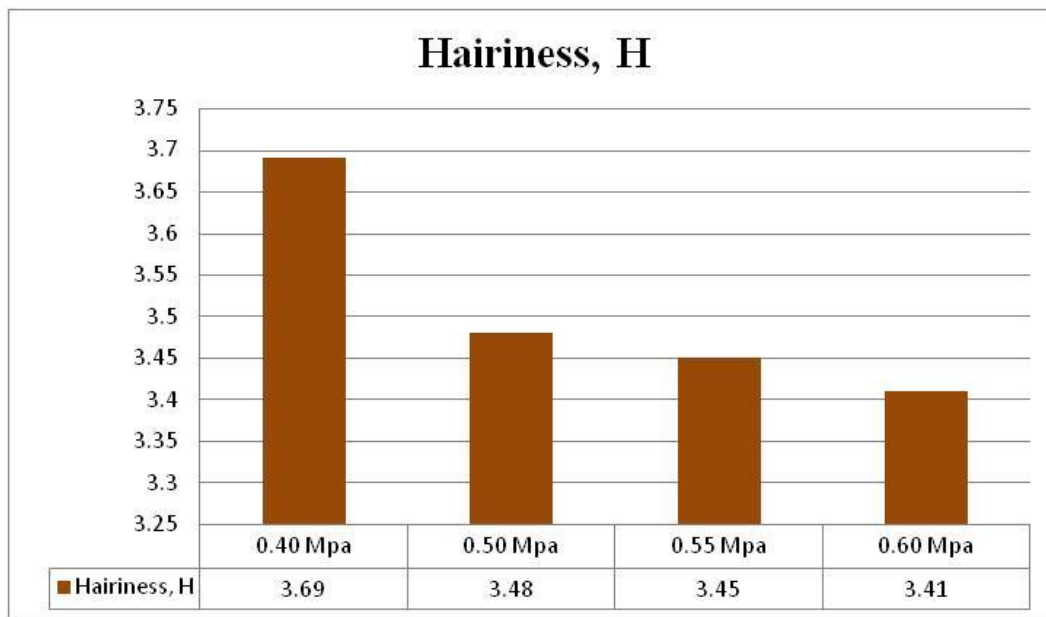
It was shown from table 3 that the value of CLSP elevates with the raise of spindle air pressure. Increased spindle air pressure improves the yarn strength, caused by a tightening fiber wrapping because of supplementary spindle air pressure. In comparison, the highest CLSP value comes when the air pressure of the spindle is 0.55 MPa; on the other hand, CLSP continues to lower at the spindle air pressure of 0.60 MPa.



Hairiness

Hairiness properties of yarn samples were evaluated using the Hairiness Module which was connected to the USTER TESTER 4 testing systems. The findings of the experiments have been shown in the above table. The value of the "H" Index refers to the cumulative number of hairy ends with a 1 cm yarn surface. 400 meters of yarn from every bobbin were examined during the experiments. It is clearly evident from figure 5 that spindle air pressure is an essential factor that influences the hairiness of the yarn. In Table 3, the results of the test disclosed that yarn hairiness ebbs with increased pressure of the spindle. The reduced hairiness at higher spindle air pressure has been ascribed as the whirling force of the spindle air stream, increasing the spindle air pressure, increased the wrapping fibers quantity, and the wrapping evenness.

While high air pressure greatly decreases hairiness, these pressures from the work point of view are not preferable. The air recirculation zone is increased by too much pressure and thus affects the wrap operation. To minimize hairiness, air pressure of 0.50 MPa is appropriate.



CONCLUSIONS

In this research, the influence of the air pressure on vortex spun yarn properties has been investigated with regard to the uniform yarn count. Spindle air pressure has a major influence on yarn unevenness, hairiness, tenacity, elongation %, and CLSP (Count Lea Strength Product) test results in terms of performance tests and ANOVA results. Test findings and works of the statistical analysis demonstrate that the spindle air pressure is the vital criterion, affecting the hairiness of the yarn. Yarn hairiness dwindles as the air pressure of the spindle is gone up since the whirling force of the spindle air stream, increasing the spindle air pressure, increased the wrapping fibers quantity and the wrapping evenness. Even though high air pressure reduces hairiness considerably, this pressure is not favorable from the working viewpoint. The air recirculation zone is developed by too much pressure and thus influences the wrap operation. Air pressure of 0.50 MPa is suitable for a reduction of hairiness.

Moreover, the yarn elongation rises with the increased air pressure of the spindle was noticed probably because of too many wrapper fibers. Additionally, increased spindle air pressure resulted in substantial tenacity growth, whereas the spindle air pressure has a noticeable impact on yarn evenness. Since the air pressure of the spindle was enhanced, the yarn uniformity has deteriorated for all test specimens.

According to the above experiment it is seen that yarn properties are changing with increased pressure. After the experiment, we found out the standard spindle air pressure is 0.50 MPa. Even though CLSP reaches its maximum point at 0.55MPa, with the increasing pressure twist is also increasing and cost would be high.

This research is an effort in this area to lead to findings as cotton-polyester fibers are widely used on MVS (Murata Vortex Spinning System). Anyway, to assess the impact of overall spinning parameters during the production of CVC vortex yarn properties, comprehensive analysis is required. Furthermore, in order to determine the impact on the end result of manufacturing parameters, a comprehensive study of fabrics made of such yarns is essential.

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