

EFFECT OF ROTOR VARIABLES ON THE TENSILE AND EVENNESS PROPERTIES OF JUTE-VISCOSE BLENDED YARN

MD. ABDUS SHAHID¹, A.K.M. MAHABUBUZAMAN², FARID AHMED³ & MD. ABU SAYED⁴

^{1,4}Department of Textile Engineering, Dhaka University of Engineering and Technology (DUET),
Gazipur-1700, Bangladesh.

²Mechanical Processing Division, Bangladesh Jute Research Institute (BJRI), Manik Mia Avenue,
Dhaka-1207, Bangladesh

³Department of Physics, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.

ABSTRACT

Physical properties are very important for post-spinning operations as well as for determining some final fabric characteristics. This paper is concerned with the investigation of physical properties such as tensile strength, tenacity, elongation% at break and yarn evenness of jute-viscose blended rotor spun yarn changing the processing parameters. The processing parameters included opening roller speed, rotor speed and yarn linear density. This work reports the successful outcome of attempt to manufacture 30, 40, 50, 60, 80 tex rotor spun yarn using viscose and jute fibers blending at 80:20 ratio. The results show that opening roller speed, rotor speed and yarn linear density have considerable influence on tensile properties and yarn evenness. Yarn tenacity and breaking elongation % increases with the increase in opening roller speed up to 8500 rpm and then start reducing.

KEYWORDS: Jute, Viscose, Blending, Rotor spinning and Tenacity.

INTRODUCTION

Jute is one of the world's most important fibrous crops, being exceeded in quantity only by cotton. It has long been known to people and known as golden fiber [1]. Jute fiber is a bast fiber obtained from the bark of jute plant containing three main categories of chemical compounds namely cellulose (58~63%), hemicellulose (20-24%) and lignin (12~15%), and some other small quantities of constituents like fats, pectin, aqueous extract, etc. Jute fiber is composed of small units of cellulose surrounded and cemented together by lignin and hemi-cellulose. The low cellulose content, coarseness, stiffness, low extensibility, low grip performance and some other disadvantages seriously restrict the raw jute fiber from spinning. So a series of wet chemical processing sequences are needed to improve the spinnability of jute. Jute is one of the cheapest, eco-friendly fibers which is renewable, light in weight and sound absorbent. Jute fiber possess some advantageous physical and chemical properties, like high tensile strength, specific stiffness, low

thermal conductivity, antistatic properties and good dyeing ability, but has drawbacks like relative coarseness, brittleness, hardness in feel, rugged appearance, inextensibility, poor washing ability, prickliness and fiber shedding [2, 3]. Jute is cellulosic and viscose is regenerated cellulosic fiber and there are many differences in fiber properties [4]. Recently, due to the improvement of people's living standards and need for environmental protection, the demand of natural biodegradable and eco-friendly fibers is rising worldwide day by day [5].

A large area of consumption of jute is converting jute fiber into the blended textiles in combination with viscose and other fibers to spin finer yarns for home textile use. Effective blending (fiber to fiber homogeneous mixing) of jute with viscose and other man made fibers in the back process of ring or rotor-spinning system is gaining appreciation. Effective blending provides a better scope for utilizing the advantage of the intrinsic properties of the component fibers and performed mainly to endow the required characteristics to the end products, compensate for variation in the characteristics of the raw materials and to hold down raw material cost.

The process of converting fibers into yarn is complex, and requires many investigations and new technical & technological solutions [6]. In the case of jute blended spun yarn on rotor spinning system, the structure-property relationship is not yet understood thoroughly, although a few reports [7, 8 & 9] are available on the tensile properties. Nawaz, S.H. et al. [7] investigated the spinning performance for rotating ratios of jute/cotton, jute/viscose and jute/polyester blends to improve the tensile behavior of composite structures, fabricated at ring, rotor and air jet spinning systems. Cierpucha, W. et al. [8] presented the results of tests on rotor-spun blended yarns, made with a high proportion of flax, and rotor-spun all-cotton yarns showed a comparative analysis of the produced cotton yarn and flax/cotton yarn. But this study is different in its approach as it has been conducted at different rotor parameters to observe the yarn properties using cotton/cottonized jute fibers blending. Sett S.K et al. [9] studied the influence of jute/viscose blending ratio on yarn properties and revealed that an increase in percentage of jute in blended yarns recorded a decrease, both in its tensile strength as well as elongation, while it helped to obtain an improved initial modulus.

The objective of this experiment was to produce the quality jute blended yarn that can be used for weaving and knitting fabrics by using rotor spinning system. Selected rotor parameters were subjected to examine the impact on the characteristics of viscose-jute blended yarn. Yarn quality was treated as tensile and evenness properties. This study used the advantage of the open-end-rotor (OER) spinning frame and the modified jute fibers were adopted as the materials to spin 30, 40, 50, 60, 80 tex yarn for quality woven and knitted fabrics at low price, as well as to enhance use probability of the jute fiber and OER spinning frame to show the increased effectiveness. The major processing parameters that affect OER spinning were taken as control factors. These factors included opening roller speed, rotor speed. This experiment could be used as a reference for spinners and researchers.

MATERIAL AND METHODS

Preparation Of Jute Fibers For Blending

Jute (Grade-BWB) of 38 mm cut length and normal viscose (38 mm, 1.5 denier) was selected for this study. The sample of jute fibers were treated in a bath with sodium chlorite 1.5g/L, liquor ratio 1:10 and kept at 30°C for 30 min. and then thoroughly washed. The pre-chlorite jute fiber was treated with hydrogen peroxide (H₂O₂) 10g/L and kept at 60-90 °C for 60 min with fiber to liquor ratio 1: 10. At the end of the desired treatment, the fibers were neutralized with sulphuric acid and then thoroughly washed with distilled water [10].

The modified jute fibers were dried and opened manually. The viscose and jute fibers were mixed at 80:20 ratios and processed in the blow room and carding section at normal machinery adjustments. The card slivers were followed by two drawing process for better fiber straightening and parallelization. The slivers of 65 grains/yard were processed. After finisher drawing, the slivers were feeding to the rotor machine. The yarn linear density of 60 tex was produced at opening roller speed 5500, 6500, 7500, 8500, 9000, 9500 10000 rpm to investigate the effect of opening roller speed and rotor speed 50000, 60000, 70000, 80000 and 90000 rpm to investigate the effect of rotor speed on yarn characteristics. The yarn linear density of 30, 40, 50, 60 and 80 tex were produced to investigate the effect of yarn linear density on yarn characteristics under normal adjustment.

Rotor Machine Details

Machine manufacturer	: Schlafhorst saurer
Model	: BD 330
Rotor diameter	: 34 mm
Rotor air suction	: 3980 pa
Opening air suction	: 850 pa

Tensile Properties Of Yarn

Tensile properties viz., single yarn strength and elongation were measured at Uster Tensorapid, which applies the principle of constant rate of extension (CRE) for testing. CRE describes the simple fact that the moving clamp is displaced at the constant velocity. As a result the specimen between the stationary and moving clamp extended by a constant distance per unit time and the force required to do so is measured. The breaking tenacity is calculated from the peak force, which occurs any where between the beginnings of the test and the final rupture of the specimen. The breaking elongation is calculated from the clamp displacement at the point of peak force. Average of twenty tests was taken for final result at each trial.

Unevenness of Yarn

Uster Tester 3 was used to determine the unevenness and imperfections (IPI) of the yarn at a speed of 400 m/min. for a period of one minute. The observed parameters were Um%, thin (-50%), thick (+50%) & neps (+280%). Average of ten tests was taken for final result at each trial. All experiments were performed at temperature $20 \pm 2^\circ\text{C}$ and relative humidity $65 \pm 2\%$.

RESULTS AND DISCUSSIONS

The influence of opening roller speed, rotor speed and yarn linear density on the physical properties of jute & viscose blended rotor spun yarn are shown in table 1 – 3. The yarn properties were treated as tenacity (gm/tex), breaking elongation%, unevenness and imperfections (IPI).

Yarn tenacity and breaking elongation% increases with the increase in opening roller speed up to 8500 rpm and then start reducing. This is partially similar to the findings of Ulku et al. [11], in which there is deterioration in yarn tenacity after a certain range. Yarn unevenness and imperfections (IPI) value decreases with the increase in opening roller speed. The difference in this behavior may be due to the fact at high opening roller speed there is increase in fiber breakage in case of open end rotor (OER) spinning, which lead to deterioration in yarn tenacity. The reduction in unevenness is due to better individualization of fibers. At higher opening roller speed the velocity of fibers inside the transport channel increases and fibers may be transported to the rotor groove in a much more uniform way and of smaller size tufts. The decrease in imperfections with the increase in opening roller speed is due to better deposition of individualized fibers at higher suction air pressure.

It was initially planned to process the yarn by rotor speed 90000 rpm but it was practically unattainable due to frequently yarn breakage. So, it was not possible to test the unevenness of the yarn due to sufficient yarn length.

Yarns of linear densities 30, 40, 50, 60 and 80 tex were made at opening roller speed at 8500 rpm and rotor speed at 60000 rpm from the same material.

Table 1: Effect of opening roller speed on the physical properties of rotor spun yarn

Opening roller speed (rpm)	Tenacity (cN/tex)	Breaking Elongation (%)	Um%	Thin place (-50%)	Thick place (+50%)	Neps (+280%)
5500	8.6	5.1	10.31	5	81	107
6500	8.9	5.45	10.2	5	68	75
7500	9.05	6.02	10.02	3	56	61
8000	9.1	6.03	9.9	2	37	49
8500	9.3	6.2	9.75	0	31	42
9000	9	6.18	9.72	0	34	40
9500	8.7	5.94	9.7	2	36	47
10000	8.62	5.7	9.68	2	47	58

Table 2: Effect of rotor speed on the physical properties of rotor spun yarn

Rotor speed (rpm)	Tenacity (cN/tex)	Breaking Elongation (%)	Um%	Thin place (-50%)	Thick place (+50%)	Neps (+280%)
50000	10.13	6.31	9.59	0	30	38
60000	9.3	6.2	9.69	0	31	42
70000	9.15	6.13	9.93	4	55	63
80000	8.83	6.1	10.23	7	72	77
90000	8.35	4.79	-	-	-	-

Table 3: Effect of yarn linear density on the physical properties of rotor spun yarn

Linear density (tex)	Tenacity (cN/tex)	Breaking elongation (%)	Um%	Thin place (-50%)	Thick place (+50%)	Neps (+280%)
30.2 (27.00)* 39.8	8.3	4.1	11.6	4	89	112
-23.36 51.2	8.75	4.56	10.68	2	67	89
-20.34 59	9	5.04	10.39	1	50	56
-17.46 81.2	9.3	6.6	9.69	0	31	42
-14.1	9.8	7.02	9	0	18	33

*Value in parentheses indicate twist per inch (TPI)

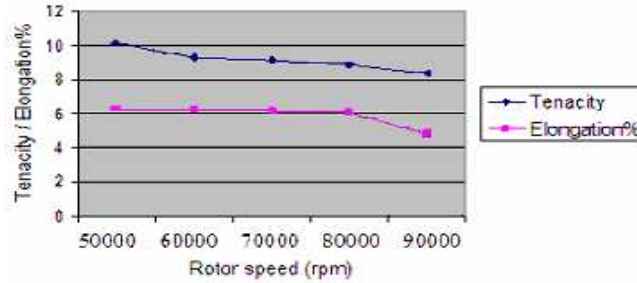


Fig 1. Effect of rotor speed on tenacity & elongation% of yarn

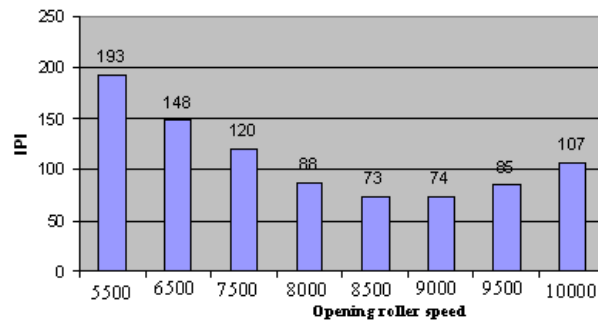


Fig 2. Opening roller speed vs. IPI

The results show that tenacity and elongation% at break increases with the increasing of yarn linear density. This reason may be explained as number of fibers in yarn x-section reduces with decreasing the yarn linear density. Jute fiber is more bulk than cotton fiber.

CONCLUSIONS

The following conclusion may be drawn based on the observation carried out during this study. The results are valid only within the experimental regions.

- 1.The best results were obtained at opening roller speed 8500 rpm for 60tex jute & viscose blended yarn at rotor speed 60000 rpm.
- 2.An increase in the opening roller speed positively affects the unevenness and IPI values.
- 3.The tenacity, unevenness and imperfection of jute & viscose (60tex) blended yarn decreases with increasing the rotor speed at opening roller speed 60000 rpm.
- 4.The tenacity were decreasing with increasing the linear density of the yarn and breaking elongation % increases with the increasing the linear density of the yarn.

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