Jute Processing in Rotor Spinning for Making Jute and Jute Blended Fine Yarn

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Abstract

Jute is a natural bastfibre popularly known as the golden fibre. It has been used for thousands of years to made rope, twine and hessian. Recently jute has been considered as a technical fibre throughout the world for diversified uses, such as composite material, geo-textile, decorative fabric, fine fabric etc. A good quality yarn is essential for making desired fabrics/products. Selection of suitable spinning machine is most important for making a particular type of yarn. Spinning is the process where jute yarns are spun from finisher drawing sliver with the help of spinning machine. There are many type of spinning. Flyer and ring spinning are commonly used for jute fibre, however ring and rotor for cotton and manmade fibre. Rotor spinning is suitable for coarse and medium count cotton yarn. In this study jute and jute-acrylic blended yarns of 172 tex were produced by using rotor spinning and conventional apron draft flyer spinning machine. Characteristics of yarns produced by both systems were compared. This work reports how jute fibre can be used as raw material in short staple spinning process along with acrylic, polyester, cotton etc. fibre to make fine yarn for apparel fabrics. The present work is concerned with the investigation into physical properties such as tenacity, elongation at break, breaking work, breaking force, unevenness, thick, thin, neps, hairiness of jute blended rotor spun yarn. The process parameters such as blend ratio, twist, machine variables and yarn linear density were also studied and optimized for manufacturing of jute and jute blended yarn. The results show that rotor speed and twist have considerable influence on properties of yarn. From the mechanical/physical properties of yarn produces by using rotor spinning machine, it is clear that rotor spinning has a potential feasibility in use of jute yarn production.

Keywords: *Jute fibre, flyer, rotor spinning.*

1. Introduction

Textile and jute sector is the backbone of Bangladesh economy. Bangladesh has been ranked second in global apparel exports and has grabbed approximately 5% market share according to recent world Trade Organization (WTO) report and has taken over 54.3% of the world trade in jute products. Bangladesh secured the 3rd position in terms of value followed by China, EU-27 countries. There are currently has 394 spinning mills, 777 weaving mills,234 woven, printing dyeing and finishing mills, 8000 knitting and knit dyeing mills, 4882; garments factories, 20 jute mills (Govt.), 50 jute spinning mills (private). Jute & textile industry provides employment to 6.8 million people, contributes around 11% of the country's GDP, 42% of manufacturing value addition and 84% export earnings. Research activities in this field are demand of time. Important characteristics of jute fibre are its silky, luster, high tensile strength, low extensibility, and considerable heat and fire resistance. Because of its great abundance and shortage of cotton, jute is blended with synthetic fibre i.e. acrylic and jute acrylic blended yarns are manufactured mainly to take advantages of the higher

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strength of acrylic fibre. For the survival of jute industry, it is of jute and develop new products with raw jute fibres. Blending is done to improve the uniformity of product, obtain certain physical characteristics in the yarn or fabrics (Hadina J, Kovacevic S Report 1998) .Jute is blended with synthetic and natural fiber and the blended yarns are used for production of blended fabrics as blanket, wool, sweater, and fine quality shopping bags, furnishing fabrics and for other upholstery purposes to discover a new concept and technological solutions to make jute blended yarn using short & long staple spinning system and innovate the manufacturing systems applicable in the field of textile Goswami BC, Martindle JG, Scardino FL Report 1977).

2. Experimental Procedure

Different spinning process parameters draft, speed, twist, roller setting, shore hardness of rubber cot, cot grinding, apron, spacer, ring traveler etc of apron draft spinning frame and rotor spinning frame were studied. These parameters affect the physical properties of the produced yarn. The concerned properties of the yarn are evenness; mass variation at various cut lengths, thick, thin, neps, hairiness, strength, elongation etc.

In apron draft spinning frame

- One type of jute fibre, BWC grade and acrylic fibre were selected as raw material for the project.
- The entire finisher card processed jute slivers were processed on drawing frames for producing 172 tex (5 lbs/spy) yarns.
- To spun 5 lbs/spy jute count i.e. 172 tex yarn, different processing parameters were applied on apron draft spinning frame and for these drafts back processing will be arranged accordingly.
- Lastly, the spun yarns were tested as per standard methods.

In Rotor spinning machine

The following process was applied for producing the yarns in rotor spinning system.

- Mixing
- Blow room,
- Carding,
- Drawing to Rotor spinning
- Determination of physical properties of the yarns.

Machine Specification

1. Rotor Speed	: 62,000 rpm
2. Rotor Dia	: 34 mm
3. Opening Roller Speed	: 8200 rpm
4. Opening Roller Dia	: 45 mm
5. Feed Roller Speed	: 1.12 m/min
6. Feed Roller Dia	: 32 mm
7. Delivery Roller Speed	: 95.8 m/min
8. Draft	: 80-90
9. No. of delivery/frame	: 24
10. Twist multiplier	: 64

The modern machinery were used for making yarn and modern laboratory equipment such as Uster Tester-5, Uster Tens rapid, strength tester etc. were used to determine the properties of produced yarn (Hearle JWS, Behery H, El MA Report 1959).Contribution of the process parameters such as speed, twist, sliver/roving hank, cot hardness and grinding etc. are significant for producing quality yarn. It is necessary to optimize the setting and selection of the parameters to spin quality yarn

In this study, changing a particular parameter of the spinning machines remaining the others constant, yarn was produced and the physical properties of the produced yarn were investigated. Optimizations of investigated machine parameter were determined according to the quality of the producedyarn.

3.Tables

Determination of Fibre Properties

Physical properties such as strength, fineness and elongation of jute fibres and polyester fibre have been determined. Measured physical properties are furnished below.

Table-1: Physical Properties of BWC.

Grade	Statistics	Fineness Diameter (μ)	Bundle strength (Pressly Index)	Linear Density (Tex)	Breaking Tenacity (g/Tex)	Breaking Elongation (%)
BWC	Mean	28.5	6.9	2.1	18.2	0.9
	Range	20-40	3.3-4.41	1.2-4.2	10-41	0.29-1.7
	CV%	27	21	28.8	31	32.6

Table-2: Fibre characteristics.

Fibre	Length (Cm)	Fineness (Tex)
Acrylic	4.1	1.5-2.1

Table 3: Physical characteristics of 172 tex jute-acrylic blended yarn in apron draft spinning frame.

Flyer speed (rpm)	Tensile strength (lbs)	Tensile strength (CV %)	Elongation at break (%)	Tenacity (g/tex)	Quality ratio (%)
2900	7.02	6.17	3.34	13.21	100.29
3300	7.31	6.51	3.41	13.77	104.50
3600	7.72	7.09	3.47	14.53	110.32
4000	7.90	7.26	3.50	14.87	112.86
4500	8.04	7.47	3.46	15.14	114.89
4700	8.37	7.62	3.42	15.76	119.63
4850	7.66	7.85	3.30	14.42	109.42

Table 4: Effect of twist on the tensile properties of 172 tex jute-acrylic blended apron draft spun yarn.

Twist (TPI)	Tensile strength (lbs)	Tensile strength (CV %)	Elongation at break (%)	Tenacity (gm/tex)	Quality ratio (%)
5.9	6.44	8.157	2.85	12.11	91.93
6.2	6.58	8.090	2.92	12.39	94.05
6.5	7.72	7.093	3.42	14.53	110.32
6.8	7.90	7.256	3.50	14.87	112.86
7.1	7.67	7.045	3.40	14.44	109.57
7.4	7.52	7.619	3.33	14.16	107.48
7.7	7.30	8.101	3.24	13.75	104.35

Table 5: Effect of rotor speed on tensile properties of 40 texture-acrylic blended yarn.

Rotor speed (rpm)	Breaking-force (N)	Elongation (%)	Elongation (CV %)	Tenacity (cN/tex)	Tenacity (CV %)	Breaking-work (cN.cm)
50000	4.499	7.37	11.21	9.69	14.98	685.518
60000	4.411	7.23	10.99	9.50	14.69	672.076
70000	3.501	6.89	12.58	7.54	12.85	533.394
80000	3.676	6.03	11.98	7.92	12.24	560.063
90000	3.393	5.56	17.87	7.31	23.50	516.982

Table 6: Effect of rotor speed on evenness properties of 40 texjute-acrylic blended yarn.

Rotor speed (rpm)	Um%	CVm%	Thin/km (-50%)	Thick/km (+50%)	Neps/km (+280%)	Hairiness (Index)
50000	14.22	17.77	86	163	124	7.51
60000	14.08	17.59	89	169	129	7.60
70000	14.36	17.94	91	172	132	7.75
80000	14.79	18.48	94	178	136	7.98
90000	15.09	18.85	95	181	138	8.14

Table 7: Effect of rotor speed on end breakage and productivity of 40 texjute-acrylic blended rotor yarn.

Rotor	End breakage per 100 rotor-hour	Grams per rotor per day	Efficiency (%)
50000	5.10	4301.72	95.24
60000	5.20	5060.84	93.37
70000	9.36	4541.78	71.83
80000	20.59	4718.73	65.30
90000	41.60	4537.24	55.81

Table 8: Tensile properties of 172 tex jute blended apron drafted spun yarn.

Mixing type	Tensile strength (lbs)	Tensile strength (CV %)	Elongation at break (%)	Tenacity (gm/tex)	Quality ratio (%)
Jute/Acrylic	8.40	7.26	3.40	15.81	120.00
100% Jute	6.74	9.10	1.97	12.69	96.29

Table 9: Evenness properties of 172 tex jute blended apron drafted spun yarn.

Mixing type	Um%	CVm%	Thin/km (-50%)	Thick/km (+70%)	Neps/km (+280%)	Hairiness (Index)
Jute/Acrylic	22.07	27.58	1457	562	143	10.71
100% Jute	28.14	37.60	2660	1240	240	13.63

4. Interpretation of Results and Conclusion

Jute/acrylic (J/A) blended yarn was made by apron draft spinning machine at seven different flyer speed 2900, 3300, 3600, 4000, 4500, 4700 and 4850 rpm remaining the other parameters constant like twist per inch (TPI), yarn linear density etc. The linear density of J/A blended yarn was 172 tex and its TPI 6.8. The effect of flyer speed on tensile properties of 172 tex J/A blended is given in Table 3. Optimum tensile properties i.e tensile strength, elongation at break, tenacity and quality ratio were observed at flyer speed 4000 rpm for 172 tex J/A blended yarn.172 tex J/A blended yarns were made at different twist level. The tensile properties of yarns made by using twist per inch (TPI) 5.9, 6.2, 6.5, 6.8, 7.1, 7.4 and 7.7 were observed at constant flyer speed 4000 rpm. The effect twist on tensile properties of 172 tex J/A blended yarn are given in Table 4. The result reveal that the optimum twists range for processing J/A blended yarn in the ended yearn in the apron draft machine is TPI 6.5 to 7.1 for the yarn of 172 tex.

The productivity and hence the efficiency of the machine are very dependent upon the rotor speed of rotation. 40 tex jute/acrylic (80/20) blended yarn was manufactured at five different rotor speeds (50000, 60000, 70000, 80000 and 90000 rpm) and tensile & evenness properties were observed for each trial that are provided in Table 5 and Table 6 respectively. The results reveal that tenacity and Breaking-work of the yarn decreases with increasing the rotor speed. This cause may be explained by higher rotor speeds reduce the fiber parallelisation as well as uneven distribution of fibres in yarn X-section. The optimum rotor speed for processing the jute/acrylic blended was 60000 rpm.

The end breakage in rotor spinning not only reduces the running efficiency of the process, but also decreases the quality of the yarn in terms of presence of piecing slubs. End breakage was recorded during running the machine per 1 hour among 100 rotor units. Average production in gram was recorded per day per rotor unit. End breakage rates were increased and efficiency were decreased with the increase of rotor revolution. The excessive end breakages were observed above the rotor speed of 70000 rpm. The effect of rotor speed on end breakage rate, production and efficiency of machine are presented in Table 7. The optimum rotor speed for processing the jute/acrylic blended was 60000 rpm since at rotor speed 60000 rpm end breakage rate is low and production is high.

Tables 8, 9 show yarn Characteristics of 100% jute & jute acrylic blended yarn. The results reveal that appearance and surface properties of 172 tex jute blended yarn are better compare to 100% jute yarn, moreover jute -acrylic blended yarn poses the higher value in tenacity and quality ratio. Um% (unevenness) value is the highest in 100% jute yarn i.e. 100% jute yarn is very uneven compare to others. Thin, thick and neps places in the yarn are comparatively more in comparison to jute/acrylic (J/A) blended yarn.

It is important to point out here that surface integrity of yarn is related to fabric properties. Appearance integrity consistency) is the most used characterisation of spun yarns. All spinners aim at producing yarns of better appearance; that is better evenness, minimum thick and thin places, and minimum neps.

It is known that rotor spinning technology is appropriate for low-grade cotton and cotton waste processing. In this study it is observed that fine quality jute-acrylic blended yarn is possible to spin using Rotor spinning technology. From the analysis of the results it is seen that some properties of jute-acrylic blended yarn are very nearer to 100% cotton yarn.

5. Summary of the Work

The output of the proposed work would be the suitability of spinning machine and identification of optimum process parameters of the spinning machine for producing quality yarns. The findings will have a direct impact on the spinning industry and it certainly can be helpful to produce better quality yarns by adopting the method suggested. Consequently the quality of yarn will improve and uses of domestic yarn will be increased. Valuable foreign currency earning will be increased and sustainable by fulfill the yarn quality demands of customer.

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