ADAPTATION OF RING SPINNING IN THE FLYER SPINNING MACHINE FOR PRODUCTION OF FINE JUTE YARN

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Abstract An Apron Draft Spinning machine was converted into ring spinning system. In this conversion, rings and travellers were used and fine yarn upto 103 tex (3 lb / spy) was produced . It was shown that the converted machine was capable of producing fine yarn which was not possible by existing flyer spinning machine. The speed of the spindles increased upto 8000 rpm from its original flyer speed 4250 rpm. Bangla Tossa B (BTB) and Bangla White C (BWC) grade Jute fibers were used for producing fine Jute yarn. The spinning performance and physical properties of produced yarns are found comparable with standard fine yarns.

INTRODUCTION

Jute is natural cellulosic bast fibre. It is a textile fibre of good spinnable character. At present there is large number of man - made fibre in the world textile market. Jute fibre has been facing a tough competition with man-made fibre since their presence in the world textile market. To overcome this competition it is necessary to produce fine jute yarn by developing / modifying the existing jute machinery. Through this development it may be possible to make fine jute yarn which can be used for diversification of jute, such as light weight shopping bag, furnishing fabric, decorative farbric etc. As a result, jute fibre may be used in the production of fabric which leads to increasing its uses in various fields of textiles. The aim of this study is to develop a technique for the production of fine jute yarn by the developed spinning system.

There are various methods of jute spinning both in the conventional area and in the non conventional area. Under the conventional area the following methods have been used. They are cap spinning , Mule spinning, Flyer spinning, Ring spinning, Centrifugal spinning etc.

Flyer Spinning

This is the most popular and widely used spinning system. Here jute spinning frame inserts the twist by means of overhung flyers suspended above the bobbin. The flyers are carried on ball bearing. Wharf's are mounted in the front of the frame at about waist-height. The wharf is driven by cotton flat belt from the main cylinder of the machine. This system is not suitable for producing fine count yarn due to the presence of drag force during spinning.

Apron Draft Flyer Spinning Machine

This machine is the latest addition by James Mackie and Sons Ltd. to their range of jute manufacturing machinery (Figure 1). This machine is definitely an improved version spinning frame with higher rate of production.

Drafting of material in the machine is by means of moving apron which provide a very good control of material through out the entire drafting zone. As a result, the yarn produced is more regular than a conventionally spun yarn. This regularity in the yarn brings in good appearance and increased strength.
Two types of spinning frame with this apron draft arrangement are available , that is 10.8 cm frame and 12 cm frame of 100 and 80 spindles per frame and better appearance but also reduces the number of breaks per unit time.

This apron draft flyer spinning frame has an automatic cleaner which traverses full length of machine and thus increase yarn cleaniless reducing operators work load. The apron for drafting is removable to ensure cleaning and replacement of new apron if necessary.

All rollers are mounted on ball and roller bearings to allow smoother running, reliability and durability. However the machine can not produce finer yarn like 3 lb/spy.

Specification of the Experimental Machine (Apron draft spinning frame)

No of spindles	8
Pitch of spindles	12 cm
Range of Flyer speed	3500-4750 rpm
Draft constant	666
Twist constant	204
Motor power	3.75 kW

Spinning tension of yarn is an important criterion for spinning of a desired count of yarn. Two levels of tension are generally encountered, on winding tension and transmitted tension. On winding tension is the tension developed in the part of the yarn between the flyer eye and the surface of the bobbin. Transmitted tension is the tension in the part of the yarn above the wharf-cap . The transmitted tension is always lower than the on-winding tension.

The relationship between the on-winding tension and the transmitted tension is given by $T_t = T_o \exp(\mu\theta)$, where T_t is the transmitted tension, T_o the on - winding tension, μ is the co- efficient of friction of jute yarn on steel and θ is the total angle of warp on the flyer leg and any other bearing surface.

In the Flyer spinning system the spinning tension is comparatively higher than that developed in the ring system. The fine yarn, less than 5 lb/spy, cannot withstand the developed level of tension in the flyer system. As a result fine yarn like 3 lb/spy can not be produced by the flyer spinning system. Since on-winding tension is higher than the transmitted tension, it is observed that yarns always break at the on- winding part. On the 10.8 cm frame a popular choice of hessian yarn, the on-winding tension is normally 0.8 kg, although wide variation in these values are found.

For producing 8 lb/spy jute yarn this may be around 1-1.5 kg. From this value the on-winding tension should be 0.375-0.562 for the spinning of 3 lb/spy yarn. But the actual tension in flyer spinning system is 0.8 kg , which is about twice than the acceptable on - winding tension. So it is not possible to make fine yarn like 3 lb/spy by the flyer system.

The limitation of producing fine yarn due to spinning tension of flyer spinning system may be overcome by introducing ring system in the flyer spinning machine. In the ring system, on winding tension is negligible because there is no drag force which is developed by the bobbin carrier of the flyer spinning system. It may be possible to produce fine jute yarn through introducing of ring system by eliminating flyer and bobbin carrier of existing flyer spinning system.

Ring Spinning

The system is suitable for producing fine jute yarn. In the system rings and travelers are used instead of flyers. There are different types of ring spinning

a) The Weller Ring Spinning Frame: The machine is of rigid construction and vibration free but noise level is higher. There is no on-winding tension.

b) The Bolleli Ring Spinning Frame: The ring spinning frame is available with single draft or double draft, being able to draft long fibres from 40 mm upto 350 mm. The speeds of the frame can be varied by moving a knob. The range of draft is from 4 to 120.

Centrifugal Spinning (Gardella spinning frame) :
The Gardella is a centrifugal type dry spinning system . The machine is of 40 spindle running at 9000 rpm. The yarn can be spun from 72 tex (2.08 lbs/spy) to 276 tex (7.74 lbs/spy).

Presently ring spinning frame and centrifugal spinning machine like Gardella spinning are producing fine yarn but initial investment of this machinery are exorbitantly high which leads to the higher production cost of fine yarn.

MATERIALS AND METHODS

The following materials were used for the modification of the flyer spinning frame into ring system :

Name	Specification
(a) M.S.Roller	90 cmx13.5cm
(b) Bearing	No. 6203
(c) Roller stand	36cmx20 cm
(d) Cotton flat belt	2 cm x 1mm
(e) U channel	10 cm x 5cm x 124 cm
(f) Ring	75 mm
(g) Traveler	No. 1.0
(h) Yarn guide	74 mm
(i) Bobbin	23 cm x 25 cm x 2cm
(j) Spindle	22 cm.

In this modification, there is no on-winding tension due to replacement of flyer and existing bobbin by introducing ring and traveller. But proper spindle speed is essential for making a yarn of definite linear density. The proper spindle speed was fixed by series of trials. From the result of trials it was found the machine can produce fine yarn between 6000 to 8000 rpm spindle speed.

In this experiment apron draft ring sprnning machine was used (Figure 2). Two tests were conducted. One was carried out by Bangla Tossa B and another was conducted by Bangla White C grade jute fibre. The finisher drawing slivers were taken from the experimental spinning mill of BJRI. In both cases, it was possible to produce fine yarn upto 103 tex. Slightly heavier yarn was possible to produce through this developed system. In this experiment the back processing of jute fibre was the conventional system and the draft of the spinning machine was 20. The only change was done at its twisting and winding zone.

The physical properties of yarns were tested by a Computerised Instron Machine of testing and standardization department of Bangladesh Jute Research Institute under standard atmospheric condition, 65 + 2%% R.H and 20^0c.

RESULTS

Test results of jute yarn varied from one to another due to presence of thick and thin places in the produced yarn. To achieve an acceptable result various samples were taken for each test and their mean was tabulated. The BTB jute fibre was better than the yarn produced from BWC fibre. In addition co-efficient of variation of different spinning properties of BTB yarn was less than the yarn produced from BWC fibre.

The test results of produced yarns are given in the following tables.

Sample: Jute Yarn,
Linear density: 103 tex (3 lb/spy)
Bobbin Speed : 7000 rpm.

Table –1 Physical properties of jute yarn produced by the modified system from BTB Jute fibre

Sample No.	Load at Break (kgf)	Strain at Break (%)	Tenacity at Break (N/Tex)	Textile Modulus (N/Tex)	Quality Ratio (%)
1	0.785	1.247	0.075	6.04	58.4
2	0.786	1.307	0.074	5.70	57.8
3	1.114	1.535	0.106	6.88	81.9
4	1.221	1.534	0.116	7.55	89.7
5	1.263	1.447	0.120	8.28	92.8
6	1.182	1.337	0.112	8.38	86.8
7	1.149	1.165	0.109	6.75	84.4
8	0.947	1.438	0.090	6.24	69.6
9	0.995	1.406	0.094	6.71	73.1
10	1.040	1.726	0.099	5.72	76.4
11	1.350	1.644	0.128	7.78	99.2
Mean	1.077	1.476	0.102	6.91	79.1
S.D	0.184	0.150	0.107	0.97	13.5
C.V	17.050	10.014	17.050	13.99	17.0

Table –2 Physical properties of jute yarn produced by the modified system from BWC Jute fibre

Sample No.	Load at Break (kgf)	Strain at Break (%)	Tenacity at Break (N/Tex)	Textile Modulus (N/Tex)	Quality Ratio (%)
1	0.998	1.556	0.094	6.02	72.6
2	1.178	1.420	0.112	7.87	86.6
3	0.505	1.287	0.048	3.97	37.1
4	0.743	1.144	0.070	6.15	54.6
5	0.647	1.163	0.061	5.27	47.5
6	0.796	1.343	0.075	5.72	58.5
7	0.592	1.131	0.056	4.99	43.5
8	1.239	1.447	0.117	8.12	91.0
9	0.480	1.001	0.045	5.54	35.3
10	0.795	1.123	0.075	6.09	58.4
Mean	0.796	1.273	0.075	5.87	58.5
S.D	0.265	0.170	0.025	1.32	9.04
C.V	32.236	13.387	33.236	22.53	33.2

Table –3 Comparison between properties of yarns produced by Gardella Spinning Machine and modified ring spinning machine (103 tex, BWC jute fibre).

Name of the machine	Load at Break (kgf)	Strain at Break (%)	Tenacity at Break (N/Tex)	Textile Modulus (N/Tex)	Quality Ratio (%)
Gardella Spinning	0.873	1.528	0.083	5.70	64.50
Modified ring spinning.	0.796	1.273	0.75	5.87	58.50

DISCUSSION

In this study, the experiments were carried out on two samples, BTB and BWC. In both cases their spinning performance, like load at break, %strain, tenacity and textile modulus were satisfactory. The quality ratio is an important criteria for assessing a yarn. In this study it was shown that the quality ratio is 79.1 (Table 1) for BTB fibre and 58.5 (Table 2) for BWC fibre and 64.5 (Table 3) for the yarn produced from BWC fibre by the Gardella spinning frame. The jute fibre of BTB is better than BWC. So the quality of yarn produced from BTB is better than the yarn produced from BWC. So it is preferred better quality jute fibre for making fine yarn. The yarn produced by the standard Gardellla spinning machine from the same grade of jute fibre was compared and shown in Table 3. It is shown that yarns produced by the modified machine are comparable and the machine can be able to produce fine yarn like 103 tex (3 lb/spy). As a result the modified system can be introduced in the jute mills. The mills will be able to produce fine jute yarn at a competitive cost.

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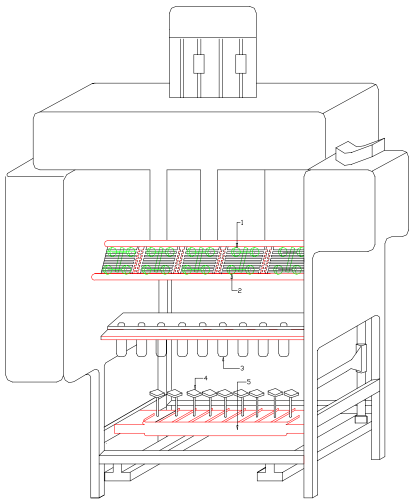
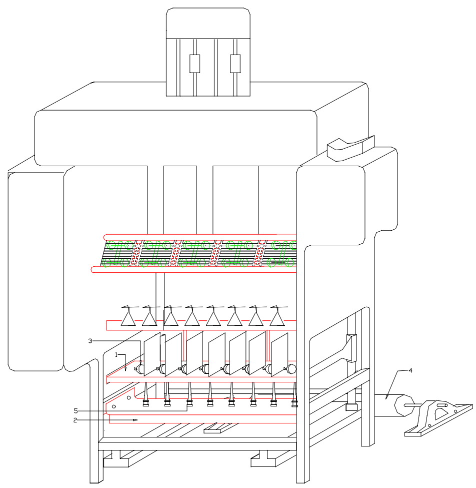


1.Retaining roller 2.Delivery roller 3.Flyer
4.Bobbin carrier 5.Rail

Fig. 1 Existing apron draft flyer spinning machine



1.Upper rail 2.Lower rail 3.Ring

Fig. 2 Modified ring spinning machine