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ANALYSIS OF JUTE YARN QUALITY BY THE CHANGE OF DRAFTING ZONE OF THIRD DRAWING FRAME

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ABSTRACT

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In drawing frame, different pin settings are used to produce fine jute yarn in apron draft spinning frame. Among the pin settings of 1st draw frame**:** Draft-4.0, 2nd draw frame: 6.3 and 3rd draw frame: 6.5, Doubling- 2**:**1, 3**:**1 and 2**:**1 respectively achieved the highest quality at modified pin settings for said jute yarn. In this experiment, existing pins of 3rd Drawing frame are replaced by new sets of pins with different density, size and shape and yarns are produced from both systems. Physical and structural properties of both produced yarns are tested and found that the better quality yarns are produced by the modified pin settings.

Keywords: *drawing frame, jute yarn, lbs/spy, pin settings, quality ratio*

INTRODUCTION

Jute is a natural cellulosic bast fiber. It is a textile fiber of good spinable character. In drawing process, carded sliver fibers are randomly placed and more or less meshy in appearance, which is not suitable for spinning. Different drafts were given here for different yarn count.

Draft is the ratio of surface speed of delivery roller and feed roller. Draft plays an important role on the quality of yarn. Excessive drafts cause worse quality yarns and low drafts cause the low strength yarn (Annon 1999). Drawing frame machinery is a significant part for quality jute yarn.

During drawing operation, fibers are "combed" to make the fiber parallel. Simultaneously, two or three slivers are mixed together to make one in order to produce a uniform sliver by cancelling out thick and thin of them. Drawing is the operation of uniform elongation of the sliver to reduce it in size and to straighten the fibers in the sliver to make it suitable for the spinning frame. Generally, for Hessian and Sacking yarns three drawing passages are used with different draft and doubling (Ahmed 1966).

In the drawing frames, the action of the pins on the slivers from the finisher card is also in a straight path. Moreover, each row or rather double row, of pins is carried separately, which is termed a “faller”. The faller as a whole consists of three parts, a) A long iron or steel rod with provision for being moved in a closed circuit, b) Four or six brass plates, termed “gills” or “stocks,” fixed to the rod, and c) A series of short pins (one row sometimes about 1/8 in. shorter than the second row), termed gill or hackle pins, and set perpendicularly in the above gills (Atkinson 1964).

The gill pins in the fallers are used to restrain the movements of the fibers between two important pairs of rollers. There are actually about four sets of rollers from front to back of a drawing frame; one set of three rollers constitute the “retaining” rollers; then comes the drawing roller and its large pressing roller; immediately after this pair is the “slicking” rollers, and the last pair is the delivery rollers. The delivery rollers of one type of drawing frame, called the “push-bar” drawing frame. The large pressing rollers, which are in contact with the drawing roller, occupy the highest position in the machine and near the center of it. Between these rollers and the retaining rollers are situated the above-mentioned fallers with their complements of gill pins, forming, so to speak, a field of pins.

The actual distance between the retaining rollers and the drawing rollers is determined by the length of the fiber, and must in all cases be a little greater than the longest fiber. This condition is necessary because the surface speed of the drawing roller is much greater than that of the retaining rollers; indeed, the difference between the surface speeds of the two pairs of rollers is the actual draft (Ranjan 1985; Ahmed 1979).

Traditional Drawing machines are used for regular jute yarn. After some modifications in the pinning system of the 3rd drawing frame will improve the quality of the out-put sliver. This sliver is producing regular and fine jute yarn with higher quality than the traditional system. It is necessary to observe that how this modification of the Drawing machine behaves with jute and blended fiber and what types of effects will happen in fine jute yarn quality. All the three drawing machines (1st, 2nd and 3rd Drawing machine) will be improved but initially the experimental work has been done on 3rd Drawing machine (Atkinson 1965).

From the very inception of mechanical processing of jute, drawing lines were proved to be a critical part for processing jute into regular yarn. From last decade, some jute goods importing countries have raised objections regarding the quality of jute yarns. As a result, it has become predictable to find out the causes of yarn irregularity for hold the position in world jute market. Therefore, this work was aimed at identifying and finding a suitable pin setting at drawing frames for jute processing which could be used effectively for jute industry and at the same time it is found acceptable to the importers. The private mills will be able to produce fine yarn at an economic way by using this developed technology (Miazi 1997; Kashem 1992). This work was undertaken by considering this point of view.

MATERIALS AND METHODS

Materials

Bangla Tossa-B (*Corchorus olitorius*) grade of jute fiber with linear density 2.13 was used for spinning of yarns. The tenacity and elongation at break of jute fiber is 30.1 cN/Tex and 1.54% respectively.

Methods

Preparation of yarns

The raw jute fibers were softened in the softener machine with an application of 25% emulsion on the weight of fibers. Then the softened jute fibers were stored in a bin for pilling or conditioning for a period of 24 hours as commonly practiced in jute mills and these pilled fibers were processed through conventional jute processing sequence i.e. breaker card, finisher card, 1st and 2nd draw frame machine. Drafting and Drawing zone of the existing 3rd Drawing machine was changed with different pin arrangements of the faller bars. Gap between pins, size, and shape of the pins of the Drawing zone are responsible for the quality of jute sliver. Pin arrangement and its distribution improve the sliver quality for the production of fine jute yarn (Ranjan 1973; Sheikh 1982). Two different pin settings were used in the drawing process. The specification of the modified and existing faller bars are given below:

Existing Faller bar specification	Modified Faller bar specification
1. No. of Faller bar = 36	1. No. of Faller bar = 36
2. Total Pin assembly length = 72 mm	2. Total Pin assembly length = 72 mm
3. Total No. of Pin assembly = 4	3. Total No. of Pin assembly = 4
4. No. of Pins per assembly = 18	4. No. of Pins per assembly = 20
5. Pin to Pin Gap in each assembly = 4 mm	5. Pin to Pin Gap in each assembly = 3.5 mm
6. Pin assembly to pin assembly gap= 67 mm	6. Pin assembly to pin assembly gap = 67 mm

The 2nd drawn sliver was passed through modified 3rd drawing machine. The output sliver was spun through apron draft spinning machine having spindles speed 4200 rpm for spinning yarns of 5 lbs/spy (count in tex system= lbs/spy × 34.45) = (172.25 tex).

Determination of tensile properties and quality ratio

The tensile properties of yarns were evaluated at 65±2% RH and 20±2ºC on an Instron Tensile Tester. Yarns were tested in 300 mm test length and 250 mm/min cross-head speed. The quality ratio was calculated using the following relationship:

$$\text{Quality ratio (\%)} = \frac{\text{Tensile Strength in lbs}}{\text{Count of yarn (lbs/spy)}} \times 100$$

Determination of structural properties

The IR spectrum of existing (unmodified) yarn sample peaks at 2957.89 and 2923.17 cm^{-1} which can be assigned to $\mathbf{v}_{as}$ (-C-H, aliphatic) and $\mathbf{v}_s$ (-C-H, aliphatic) respectively (Pavia *et al.* 2001). The broad shoulder around 3200-3600 cm^{-1} cannot support the existence of -OH (alcoholic) stretching due to weak absorption (may be peak of moisture) Pavia *et al.* (2001). The peaks arose around 400-1400 cm^{-1} are too weak to investigate. The peak at 1774.64 cm^{-1} is so weak to assign as $\mathbf{v}_s$ (C=O) (Pavia *et al.* 2001). The etheroic peaks around 1200-1300 cm^{-1} which could be strong ones are absent in the present spectrum (Pavia *et al.* 2001).

The IR spectrum of the modified yarn sample shows peaks at 2852.77 and 2922.21 cm^{-1} which can be assigned as $\mathbf{v}_s$ (-C-H, aliphatic) and $\mathbf{v}_s$ (-C-H, aliphatic) respectively (Pavia *et al.* 2001).

The broad peak around 3487.36 cm^{-1} strongly support existence of alcoholic (-OH) group (Pavia *et al.* 2001). The peaks at 1741.75 and 1643.38 cm^{-1} are so weak to assign as carbonyl absorption (Pavia *et al.* 2001). The other peaks in the finger print region are too weak.

RESULTS AND DISCUSSION

3rd drawing sliver was spun through apron draft spinning machine. Physical and structural properties of both produced yarn were measured. The test results with respect to quality ratio and tensile strength of produced yarns are given in Table 1 & 2 respectively.

Quality ratio is the property of jute yarn which indicates the load at break (lbs/count). Yarn of higher quality ratio indicates also yarn of higher strength. So, it is generally said that high tenacity at break causes maximum quality ratio. In this experiment, it is observed from Table-1 and 2 that the tenacity of modified yarn is better than existing (unmodified) yarn and also shows the produced modified yarn's quality ratio increase with the increase of tenacity, which is shown in figure 1.

Again it is exhibited from the IR spectrum data (Figure-2&3) that major remarkable change between the existing (unmodified) and modified produced yarn sample in the region around 3487.36 cm^{-1} which was absent in existing (unmodified) produced yarn sample. From that it can be explained that modification in the 3^{rd} drawing frame developed -OH (alcoholic) functional group, which are polar and will therefore attract polar water molecules. Thus -OH groups are mainly responsible for the moisture absorbency or hydrophilic which will tend to make the fibre more comfort to wear. Again the polarity of -OH group will develop to help formation of hydrogen bonds, which will contribute significantly towards the coherence of the fibres polymer system so that fibers are more strong (Gohl and Vilensky, 2005).

Table 1. Physical properties of 5 lbs/spy jute yarn by the existing pin arrangement of drawing machine at the temperature of 20 ± 2^0C and R.H 65 ± 2%

Sl No	Tensile Strength (lbs)	Average Tensile Strength (lbs)	Standard Deviation (SD) for Tensile Strength	Coefficient of Variation (CV%) for Tensile Strength	Quality Ratio (QR%)
1	4.7	4.42	0.1248	2.823	88.40
2	4.3				
3	4.4				
4	4.3				
5	4.4				
6	4.4				
7	4.3				
8	4.4				
9	4.4				
10	4.6				

Table 2**.** Physical properties of 5 lbs/spy jute yarn by the modified pin arrangements of 3^{rd} drawing frame at the temperature of 20 ± 2^0C and R.H 65 ± 2%

Sl No	Tensile Strength (lbs)	Average Tensile Strength (lbs)	Standard Deviation (SD) for Tensile Strength	Coefficient of Variation (CV%) for Tensile Strength	Quality Ratio (QR%)
1	4.8	4.72	0.1248	2.644	94.4
2	4.9				
3	4.8				
4	4.7				
5	4.7				
6	4.8				
7	4.8				
8	4.7				
9	4.5				
10	4.5				

** lbs/spy indicates the fineness or coarseness of yarn and it is determined by the weight of 14400 yards (= 1 spyndle) length of yarn in pounds (lb)

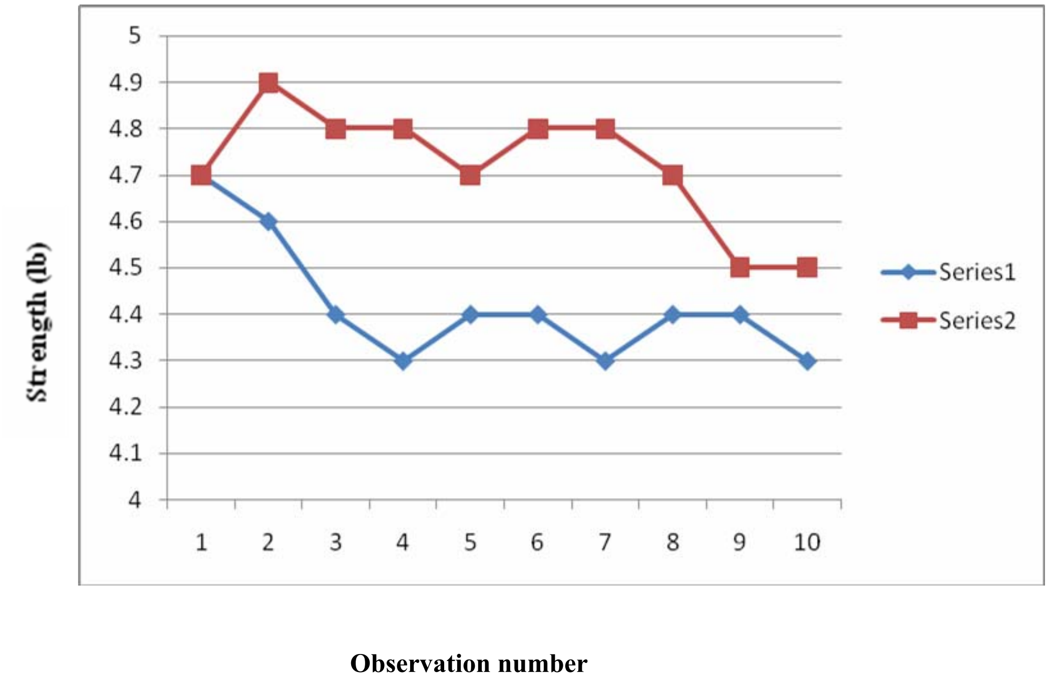

Figure 1. Tensile strength of produced yarn

Series 1: Produced yarn tensile strength from existing pin arrangement of draw frame
Series 2: Produced yarn tensile strength from modified pin arrangement of 3rd draw frame

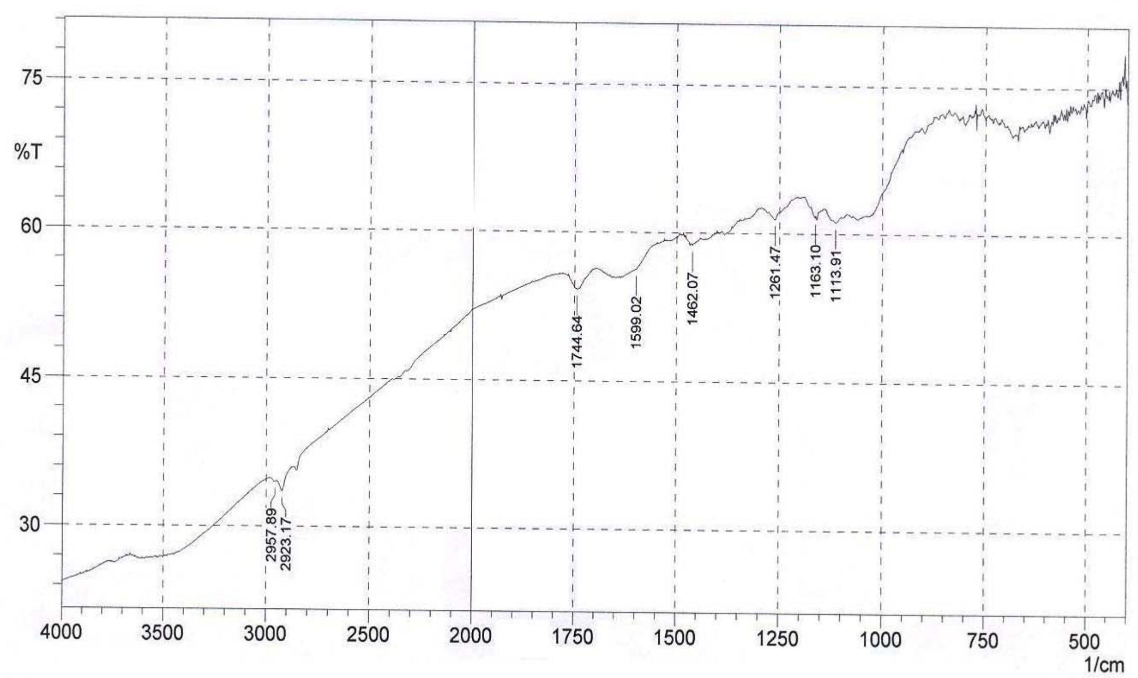

Figure 2. IR spectrum of existing (unmodified) yarn sample in KBr pellet

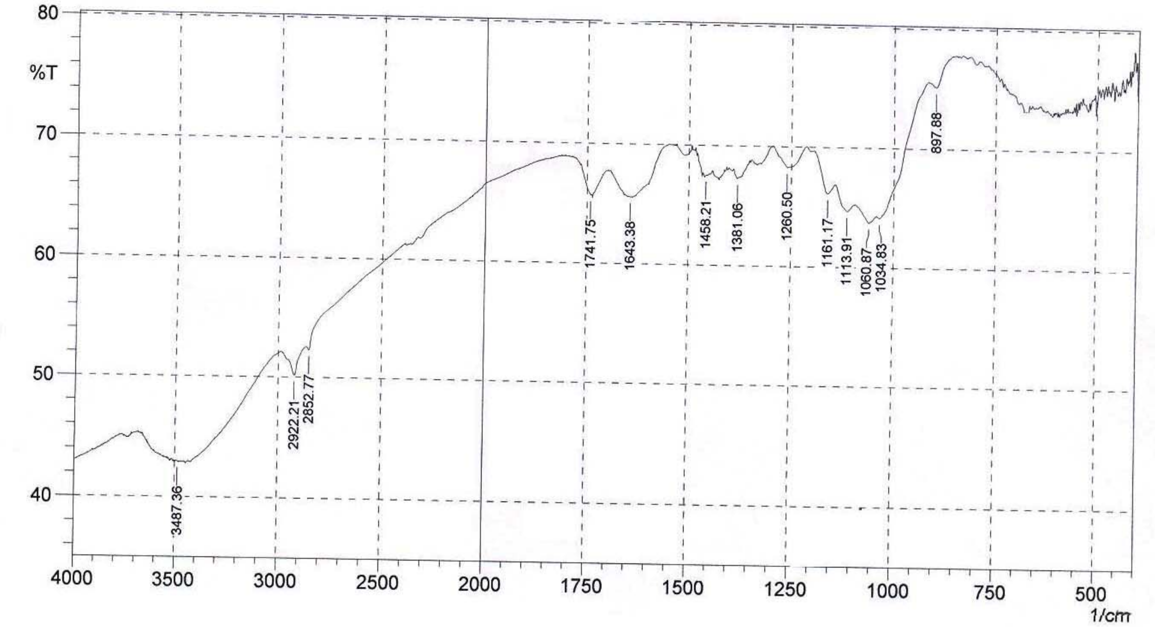

Figure 3. IR spectrum of existing (modified) yarn sample in KBr pellet

CONCLUSION

From the study, it was clearly exhibited that Tensile strength, Quality ratio, Coefficient of variation and Standard deviation of produced yarn was better due to modified system. The produced modified yarn was more regular and uniform comparing to the existing (unmodified) drawing frame and also introduce -OH (alcoholic) functional group which gives more strength and responsible for hydrophilic nature. As a result, pin arrangements of the drawing machine shows positive impacts on yarn properties.

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