A Study of the Drafting Tenacity of Jute Slivers

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The drafting tenacity of jute slivers has been measured and its relationship with various processing parameters and fibre properties assessed. The drafting tenacity of jute slivers of different qualities and its dependence on sliver weight and sliver crimp have been estimated. The drafting force required for white variety is more than that for the tossa variety. Drafting force has a linear regression with sliver weight and crimp. Drafting force variation has been correlated with sliver irregularity as well as with irregularity of the resultant yarn. The effect of different amounts of batching oil and cationic softeners on the drafting tenacity of the sliver has also been studied. The drafting tenacity increases with increase in the amount of oil up to 2.2% and decreases thereafter.

Keywords: Batching oil, Cationic softener, Crimp, Drafting tenacity, Jute sliver, Sliver irregularity

1 Introduction

Drafting force has been considered by many researchers as a fundamental parameter that can be related in many ways to virtually all the aspects of drafting operation. A great deal of research has therefore been conducted on the measurement of drafting force and its relation with various processing parameters and fibre properties for cotton, worsted and some synthetic fibres. However, no such study has been reported for jute fibres. This paper presents the results of such a study on jute.

2 Methods

2.1 Measurement of Drafting Force

A number of methods have been reported for the measurement of drafting force. In the original method, due to Martindale, in a two-roller drafting system the drafting roller assembly itself is made the deflecting element of the force transducer. The movement of the drafting roller is suitably amplified and recorded. Instruments using this principle have been used by many workers and are now commercially available. Some workers have used a method in which the drafting rollers are fixed and a separate deflecting element, introduced in the drafting zone, measures the drafting force. A third method is based on an entirely different principle. In this method, the power consumed by the drafting roll motor, as measured by a sensitive wattmeter, is taken as a direct measure of the drafting force.

In the present study, basically the Martindale's method has been followed. In the drafting system, as shown in Fig. 1, the front roller assembly is placed over a set of three stiff vertical flat spring plates, placed side by side, and the movement of the roller during drafting is detected by means of a pair of strain gauges pasted on the two faces of the middle spring plate, amplified and recorded on a high speed chart recorder. To dampen the natural oscillations of the cradle, two supports are provided with two coiled springs placed on both the sides of the middle spring plate along the direction of the sliver path. The heights of these two supports are so adjusted that the natural vibrations of the front roller assembly die out quickly, without significantly affecting the detection of the drafting force.

To get an idea of the order of force to be measured, preliminary tests were carried out on an Instron tester using sufficiently wide gauge length so that practically no fibre in the sliver was gripped by the two jaws.

2.2 Calculation of Drafting Tenacity

The instrument was calibrated by deflecting the front cradle with known loads applied horizontally be means of weights suspended from a horizontal thread passing over a pulley.

For finding the average drafting force the whole chart for a sample piece was divided into 20 zones and the maximum and minimum drafting force for each zone were noted. The average
drafting force for the sample piece was calculated from these 40 readings.

Each test piece was 4.5 m long and for each sample, 3 such pieces were tested. This was found to give an accuracy within 5% level. Since the drafting force is greatly affected by the number of fibres within the drafting zone, the normalization of the force with respect to the linear density of the input sliver, i.e. drafting tenacity, was considered.

To find the drafting tenacity, the average drafting force was divided by the weight per unit length of the sliver. To find the weight per unit length, a revolution counter was fitted to the back roller to read the correct length of sliver tested and the total weight of the sample after the test was divided by this length.

3 Results and Discussion
3.1 Effect of Roller Setting
For one particular sample the drafting tenacity was measured for different roller separations from 25 cm to 45 cm. A plot of $1/F$ ($F=$ Drafting tenacity) against $1/RS$ ($RS=$ Roller setting) was found to be linear (Fig. 2) as reported by Foster. The measurements were done with slivers with the same average crimp. The roller setting for all other experiments was kept at 35 cm.

3.2 Effect of Speed on Drafting Force
The speed of the rollers was increased from 12 cm/s to 24 cm/s, keeping the draft constant. The drafting force increased with increase in front roller speed (Fig. 3), as reported by Audivert et al. in the case of cotton.

3.3 Effect of Draft on Drafting Tenacity
Drafting tenacity was measured for different drafts ranging from 1.2 to 3.2. A plot of $1/F$ against draft was found to be linear (Fig. 4).
PMR (per cent mean range) of drafting force showed a linearly increasing relationship with draft (Fig. 5).

3.4 Drafting Force of Different Varieties of Jute

The drafting force of different counts (2.70-4.70 ktex) of slivers prepared from white and tossa jute was measured. Fig. 6 shows that the drafting force has a linear regression with sliver weight, the correlation coefficient being 0.95 and 0.81 for tossa and white varieties respectively. For the same sliver count, the drafting force required for the white variety is greater than that for the tossa variety. This is evidently due to the tossa fibre having a smoother surface than the white fibre.

3.5 Effect of Crimp on Drafting Force

In normal processing, jute slivers are given some crimp for better cohesion of fibres. To study the effect of crimp on drafting force, slivers were prepared with different amounts of crimp by varying the crimping load in the crimp box. As it was not possible to keep the sliver weight constant, partial correlations between drafting force and crimp and drafting force and weight were calculated. Table 1 shows that the average drafting force is significantly correlated with crimp, the drafting force increasing with increase in crimp. This is expected because the higher the crimp the greater will be the lateral cohesion of fibres and so higher the force required to separate them. In Table 2,
the order of correlations of drafting force with crimp and sliver weight is shown for tossa and white jute slivers and mesta sliver.

The average crimp was measured by a method due to Mukhopadhyay and Basu\(^1\). In this method, the crimped slivers are decrimped by passing through a pair of squeeze rollers and the increase in length on decrimping, expressed as the percentage of the original length, is taken as the percentage crimp.

### 3.6 Correlation between Drafting Force Variation and Sliver Irregularity

Samples of crimpless slivers were tested first in the Uster evenness tester for U% and then for drafting force. From the drafting force chart, the PMR of drafting force was calculated. Fig. 7 shows that PMR of drafting force and U% are linearly correlated (\(r = 0.69\)).

### 3.7 Drafting Tenacity and Yarn Properties

Yarns were spun from the slivers for which the drafting force was measured. Drafting tenacity of the sliver and the yarn tenacity, expressed as quality ratio%, were found to be correlated (Fig. 8), the correlation coefficient being 0.66.

#### Table 2 - Correlations of Drafting Force (\(F\)) with Weight (\(W\)) and Crimp % (\(C\)) for White, Tossa and Mesta Slivers

<table>
<thead>
<tr>
<th></th>
<th>White</th>
<th>Tossa</th>
<th>Mesta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial corr. coeff.</td>
<td>(r_{FWC})</td>
<td>0.62</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>(r_{FWC})</td>
<td>0.70</td>
<td>0.72</td>
</tr>
<tr>
<td>Multiple corr. coeff.</td>
<td>(R_{FWC})</td>
<td>0.82</td>
<td>0.86</td>
</tr>
<tr>
<td>% Explained by sliver weight and crimp</td>
<td>68</td>
<td>73</td>
<td>42</td>
</tr>
</tbody>
</table>

The PMR of drafting force was found to be correlated with the unevenness of yarn (Fig. 9), the correlation coefficient being 0.71.

### 3.8 Effect of Batching Oil and Cationic Softener on Drafting Tenacity

Jute fibre is softened by an emulsion of mineral oil and water for processing. The effect of different amounts of oil on drafting tenacity was studied. The samples processed from the same quality of fibre with different amounts of oil were tested at a draft of 1.83. The nominal amounts of oil were 0%, 2%, 4%, 6% and 9%. The drafting tenacity increased with increase in the amount of oil up to 2.2% and decreased thereafter (Fig. 10).
The drafting tenacity curve shows more or less the same trend as that for frictional force curve with different amounts of batching oil at the same moisture regain (13%) (Sanyal D P and Mukhopadhyay U, unpublished data).

The effect of different amounts of cationic softener, mixed with 4% batching oil, is shown in Fig. 11. The figure shows that the drafting tenacity decreases with increase in the amount of softener up to 0.5% but increases with further increase in the amount of softener. In actual practice, the cationic softener concentration used does not exceed 0.5% because the addition of higher amounts of softener tends to produce a stickiness on the fibre, causing fibre lapping. This also explains the increase in drafting tenacity with increase in cationic softener concentration.

References