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Differential Span Length as an Index of Fibre Hook Removal

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The difference in the cutting ratio in forward and reverse directions was compared with the difference in span lengths in these two directions for 66.7 and 50% levels. A significant correlation of 0.88 was obtained in both the cases. The index of fibre hooking calculated by using the cutting ratio corresponded very closely with the differential hook percentage at 2.5% span length, the correlation coefficient being 0.87.

Keywords: Cutting ratio, Combing ratio, Differential hook percentage, Fibre hooking index, Span length

1 Introduction

Since direct analysis of hooked fibres by tracer fibre techniques is complicated and time-consuming, indirect methods like Lindsley[1] and fibrograph[2] clamp techniques are widely used for measuring fibre hooks. These are much faster in giving the overall picture of fibre configurations present in sliver or roving. However, a detailed study of hooked fibres and their extent is not possible by these methods. In order to assess the reliability of the indirect methods of measuring fibre hooks, many research workers have compared the measures obtained on the Lindsley and fibrograph techniques with the results of the tracer technique[3,4].

Wakankar *et al.*[5] observed that the index of the combing ratio in the forward direction was always more than that in the backward direction. They found good correspondence between the difference in the number of hooks in the forward and backward directions and the difference in combing ratios in these directions.

Simpson[6], comparing the values of the cutting ratio and the combing ratio at different plate widths with the results obtained visually by the photographic techniques using tracer fibres, concluded that the difference between cutting ratios in the forward and backward directions can be used for determining the predominance of hooked ends in a given direction.

Deluca[7] observed very high correlation (0.95) between the hook percentage measured by the tracer technique and percentage of hook extent (E'_o) estimated by the modified Lindsley technique. Ghosh and Bhaduri[8] noted a curvilinear relationship between the mean cutting ratio and the mean total hook extent for card sliver. Kopkar and Smith[9], studying nylon fibres, observed a good correlation between the cutting ratio and the combing ratio with hook extent and orientation index (which is the ratio of fibre extent to fibre length) respectively. Later, Rao and Garde[10] computed two indices, viz.

$$\text{Fibre configuration, } C = \frac{2(1+R_l)}{(R_f+R_b+2)} \times 100 \text{ and}$$

$$\text{Fibre hooking, } \quad I = \frac{2(R_f-R_b)}{(R_f+R_b+2)} \times 100$$

using combing ratios of forward (R_f) and backward (R_b) directions, R_l being the combing ratio computed for an ideal sliver.

In the fibrograph clamp technique, Simpson[11] attributed the improvement in the leading hook clamp span length to the reduction in the trailing hooks as the process advances from card to roving and, conversely, leading hook reduction to the increased trailing hook clamp span length. The work carried out in CTRL showed that the values of fibre extent of all cottons at card, first and second draw frame slivers as measured by the optical tracer technique had a very good correlation of 0.80 with 50% span length values, as measured by the fibrograph clamp technique[12]. Further, the parallelization percentage by optical techniques agreed closely with that of uniformity ratio determined by the fibrograph.

In this paper, the sensitivity of the cutting ratio, the combing ratio, indices of hook removal, and differential hook percentages as measures for measuring fibre configuration are discussed.

2 Materials and Methods

The data collected earlier[12] on the cutting ratio and the combing ratio for six cottons and the processed

materials by the modified Lindsley technique were further analyzed. Similarly, the span lengths determined at 66.7, 50, 5.5 and 2.5% levels were used for the study.

3 Results and Discussion

Iyer *et al.*[12] had observed that the cutting ratio of card sliver decreases with decrease in the staple length of cotton with a maximum value of 0.1775 (major hooks) for Giza 45 to a minimum value of 0.0811 (major hooks) for AK.235 and is higher for major hooks than for minor hooks. The average value reduces as the process advances from card to roving. In contrast to this the combing ratios are higher for short-staple cottons than for long-staple cottons, the values for AK.235 and Giza 45 being 1.7469 and 0.9384 respectively. The average combing ratios (major and minor) for all six cottons were also found to reduce from 1.2753 for card sliver to 0.7782 for draw frame 1 sliver to 0.6785 for the second draw frame, and to 0.5866 for roving. Further, the improvement in the cutting ratio (major) is found to reflect the improvement in minor hook (leading) clamp span length. Similarly, the improvement in cutting ratio (minor) is found to reflect the improvement in major hook (trailing) clamp span length.

In this study the index of fibre hooking as suggested by Rao and Garde[10] was used for calculating the hooking effect from cutting and combing ratios. The data on indices of fibre hooking are given in Table 1. The indices for card sliver range from 4.35 for Giza 45 to 6.05 for Gujarat 67. Long- as well as short- staple cottons have more or less equal indices, indicating that the influence of plate width is eliminated. Except for Giza 45, whose value is 5.2 at draw frame 1, all other cottons have values, on an average, of about 3.0. The average index value (5.1) of six cottons at card gets reduced to 3.44 and 1.65 at draw frame 1 and draw frame 2 respectively.

Similarly, the indices calculated with the combing ratio also reduce from 7.77 at card to 4.28 at draw frame 1. But the value of 4.29 at draw frame 2 indicates that the combing ratio is sensitive not only to hooked fibres but also to other causes like crimped and short fibres.

The average span lengths were measured at 66.7, 50.0, 5.5 and 2.5% in forward and reverse directions and their differences were calculated. The span lengths were found to increase as the process advanced from card to draw frame 2, as observed in earlier studies[10], with a simultaneous reduction in the difference as between the two directions. In order to obtain a quantitative

Table 1—Index of Fibre Hooking for Cutting and Combing Ratios

Material	Cutting ratio			Combing ratio		
	Card	DF_1	DF_2	Card	DF_1	DF_2
Giza 45	4.35	5.22	1.92	7.07	1.85	4.25
MCU.4	5.52	2.47	1.00	9.26	3.03	4.53
Elpaso	5.10	3.31	1.57	7.03	5.78	3.09
Gujarat 67	6.05	3.56	2.43	8.29	5.42	5.97
Khandwa 2	4.80	2.91	0.93	6.44	2.17	0.71
AK.235	4.81	3.14	2.04	8.53	7.40	7.81
Average	5.10	3.44	1.65	7.77	4.28	4.29

Table 2—Difference and Average of Span Lengths in Major and Minor Hook Directions for all Cottons

Span length %	Difference in span lengths in major and minor hook directions, mm (*A*)			Average of span lengths in major and minor hook directions, mm (*B*)			Differential hook percentage $\left(\frac{A}{B}\times 100\right)$		
	Card	DF_1	DF_2	Card	DF_1	DF_2	Card	DF_1	DF_2
66.7	2.85	2.08	1.03	13.67	15.87	17.24	21.05	13.63	6.38
50	2.70	2.30	0.50	16.05	18.30	19.54	17.07	12.86	4.14
5.5	2.36	1.32	0.47	27.09	28.76	29.46	8.80	4.61	1.68
2.5	1.99	1.30	0.32	29.55	31.05	31.58	6.84	4.25	1.12

measure of hooked fibres, the differential patterns of hooking in the major and minor hook directions were determined. These differences in fibre extents are expressed as a ratio of the mean value of span lengths in forward and reverse directions. Owing to the voluminous nature of data only the average values of six cottons at 66.7, 50.0, 5.5 and 2.5% levels are given in Table 2. The difference in span lengths between major and minor hook directions is greater for the long-staple cottons like Giza 45, Elpaso and Gujarat 67, being 3 mm for 66.7% span length in the card sliver and lower for shorter staples. The average difference for all cottons at 66.7% is 2.85 mm in card sliver, reducing to 2.1 mm in draw frame 1 sliver and to 1.03 mm in draw frame 2 sliver. Similar observations were made for 50% span length. The differences in span lengths for 5.5 and 2.5% were slightly lower. The average differences are 1.99 mm, 1.3 mm and 0.3 mm for card, draw frame 1 and draw frame 2 slivers at 2.5% level.

On analysis of the differential hook percentage, it was observed that the values were higher for 66.7 and 50.0% span lengths than for 5.5 and 2.5% span lengths.

3.1 Comparison of Index of Fibre Hooking with Differential Fibre Hooking Percentage

The cutting ratio being more sensitive to the presence of hooked fibres in sliver than the combing ratio, the difference in the cutting ratio in the forward and reverse directions was compared with the difference in span lengths in these two directions for 66.7 and 50.0% levels. A significant correlation of 0.88 for both 66.7 and 50.0% span lengths was obtained and the correspondence is also expressed graphically in Figs 1 and 2.

However, poor correlations of 0.63 and 0.50 between differences in the combing ratio in the forward and reverse directions and the differential span lengths at 66.7% and 50% respectively indicate

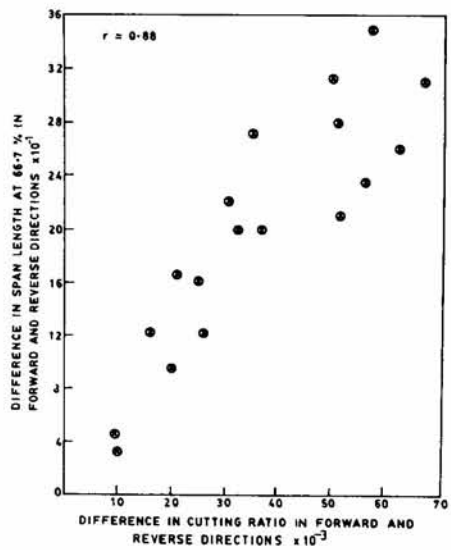

Fig. 1 —Comparison of differences in cutting ratio and span length (66.7%) in forward and reverse directions

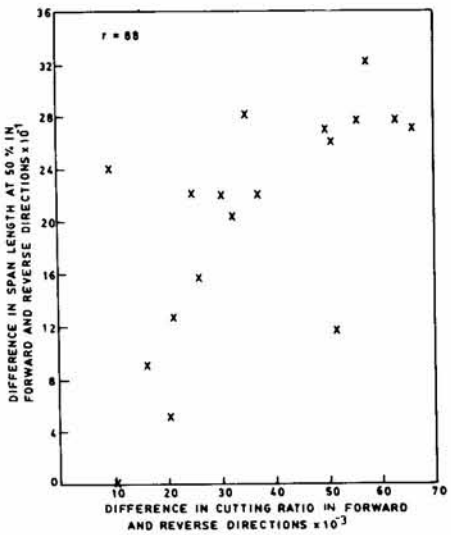

Fig. 2 —Comparison of differences in cutting ratio and span length (50%) in forward and reverse directions

Table 3 —Differential Hook Percentage[a] at 2.5 and 5.5% Span Lengths

Material	2.5% Span length			5.5% Span length		
	Card	DF_1	DF_2	Card	DF_1	DF_2
Giza 45	5.08	3.55	0.34	6.96	4.15	0.99
MCU.4	7.86	3.09	0.09	10.48	3.06	0.53
Elpaso	6.48	4.26	0.82	8.32	5.12	1.72
Gujarat 67	6.44	5.15	1.84	8.75	5.76	2.55
Khandwa 2	7.31	5.44	1.66	8.71	5.72	0.93
AK.235	7.86	4.01	2.00	9.61	3.85	3.36
Average	6.84	4.25	1.12	8.80	4.61	1.68

[a]Differential hook percentage $= \frac{(SL_R - SL_F)}{(SL_R + SL_F)} \times 100$, where SL_R is the span length in reverse direction and SL_F the span length in forward direction.

that the combing ratio is not so sensitive for measuring hooked fibres and is also affected by the inclination of fibres with the sliver axis as opined by Rao and Garde[10].

When the differential hook percentage at 2.5% span length (Table 3) was compared with the index of fibre hooking for cutting ratio, a significant correlation coefficient (0.87) was obtained. However, a lower correlation of 0.67 was obtained between indices calculated with the combing ratio and differential hook percentage at 5.5% span length, which is also influenced by short fibre content.

4 Conclusion

Since the index of fibre hooking, calculated by using cutting ratio, agrees very closely with that of indices of differential hook percentage at 2.5% span length, the fibrograph clamp technique can be used even for the quantitative measurement of fibre hooking.

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