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Processing Performance of South African Wools on the Woollen System of Manufacture

Part II: The Effect of Fibre Properties on Carding

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PROCESSING PERFORMANCE OF SOUTH AFRICAN WOOLS ON THE WOOLLEN SYSTEM OF MANUFACTURE PART II: THE EFFECT OF FIBRE PROPERTIES ON CARDING

by J.P. VAN DER MERWE

ABSTRACT

The effect of fibre diameter, length and resistance to compression on woollen carding performance was investigated. In general, the results showed that mean fibre diameter, CV of diameter, mean fibre length and resistance to compression were the most important fibre properties influencing carding yield, fibre breakage and variation across the width of the card. It was found that increased yields were obtained when fine, long fibres having a low CV of diameter were carded.

Fibre length after carding increased as diameter and length of the raw fibre increased while an increase in resistance to compression caused carded fibre length to decrease.

Variation across the card increased when fibre diameter and CV of diamter increased. An increase in resistance to compression caused the cross card variation to decrease.

INTRODUCTION

This report, the second[1] in this series of publications, deals with the effect of fibre properties on the woollen carding performance of South African wools ranging in diameter between 18,8 to 30,4 μm destined for apparel end-use. No systematic study has been reported in the literature in this field, although some studies[2] have been reported in which these effects were studied on New Zealand wools destined for carpet end-use. In this latter work it was reported that carding yield increased with an increase in fibre length. Carding of longer fibres resulted in slubbings comprising longer fibres resulting in stronger yarns.

It has also been reported that a high crimp wool produced more fly[3] during woollen carding than a wool of normal crimp.

EXPERIMENTAL

A summary of the most important fibre properties of the sixty-eight wool lots, included in this study, is given in Table 1. Details of the individual wool lots, the methods of preparation and carding of the blends were given in the first report[1] of this series.

TABLE 1

MEANS AND RANGES OF THE VARIOUS RAW AND CARDED WOOL FIBRE PROPERTIES

Code	Description	Mean		Standard Deviation		Range	
		Raw	Carded	Raw	Carded	Raw	Carded
D	Diameter (μm)	24,1	24,0	3,4	3,1	18,8 - 30,4	19,4 - 30,7
CV_d	CV of diameter (%)	24,7	26,2	3,9	3,9	20,3 - 43,1	20,8 - 40,6
L	Length (mm)	80,9	38,2	14,0	7,2	41,2 - 106,1	23,2 - 55,1
CV_ℓ	CV of length (%)	33,6	49,4	7,5	6,3	22,1 - 63,9	29,9 - 64,7
RC	Resistance to Compression (mm)	18,1	18,9	2,0	1,8	14,8 - 24,2	16,2 - 23,3

Carding yield determination

The carding yield was determined from the following equation:

$$\text{Carding yield (\%)} = \frac{\text{Mass of Slubbing produced}}{\text{Mass of scoured wool}} \times 100$$

Cross card variation

Approximately 100 m of slubbing were run onto bobbins with detachable flanges. The bobbins were doffed, the flanges removed and the individual 100 m lengths of slubbing weighed after conditioning in a standard atmosphere for testing. The coefficient of variation across the card was calculated from the values obtained. The values of one end at both ends of the four bobbins were omitted to eliminate possible variation introduced by the intermediate feed.

Fibre breakage

Mean fibre length was determined on the raw wool and again on the carded slubbings by means of the WIRA single fibre length method. The percentage of fibre breakage was calculated, using the following formula:

$$\% \text{ Fibre breakage} = \frac{\ell_1 - \ell_2}{\ell_1} \times \underline{100}$$

where ℓ_1 = mean fibre length of wool prior to carding
ℓ_2 = mean fibre length of carded wool.

RESULTS AND DISCUSSION

Multiple quadratic regression analysis was performed on the results in their standard form. The procedure of forward selection was employed and significance was tested at the 95% ($p = 0,05$) level. Regression analysis was carried out with carding performance values as the dependent variables and fibre properties as the independent variables.

Effect of fibre properties on carding yield and carded fibre length

When carding yield was regressed against fibre properties as independent variables the following best fit equation was obtained:

$$\text{Carding Yield} = -0{,}016\ D.CV_d + 0{,}0028\ CV_d.L + 97{,}3$$

$$r = 0{,}657;\ n = 58$$

(Where D = mean fibre diameter; CV_d = coefficient of variation of fibre diameter and L = mean fibre length).

The equation shows that carding yield increased with an increase in mean fibre length and a decrease in mean fibre diameter and CV of mean fibre diameter. The term $D.CV_d$ contributed 86% to the multiple correlation coefficient. The trends are illustrated in Fig. 1.

To establish the influence of fibre properties on carded fibre length a multiple regression analysis was performed of fibre length after carding against raw fibre diameter, fibre length, their variability and resistance to compression, as independent variables. The following best fit multiple regression equation was obtained:

$$L_c = 0{,}013\ D.L - 0{,}007\ L.RC + 22{,}0$$

$$r = 0{,}85;\ n = 68$$

The above equation shows that fibre length after carding (L_c) increased as the diameter (D) and length (L) of the raw wool fibre increased and as the

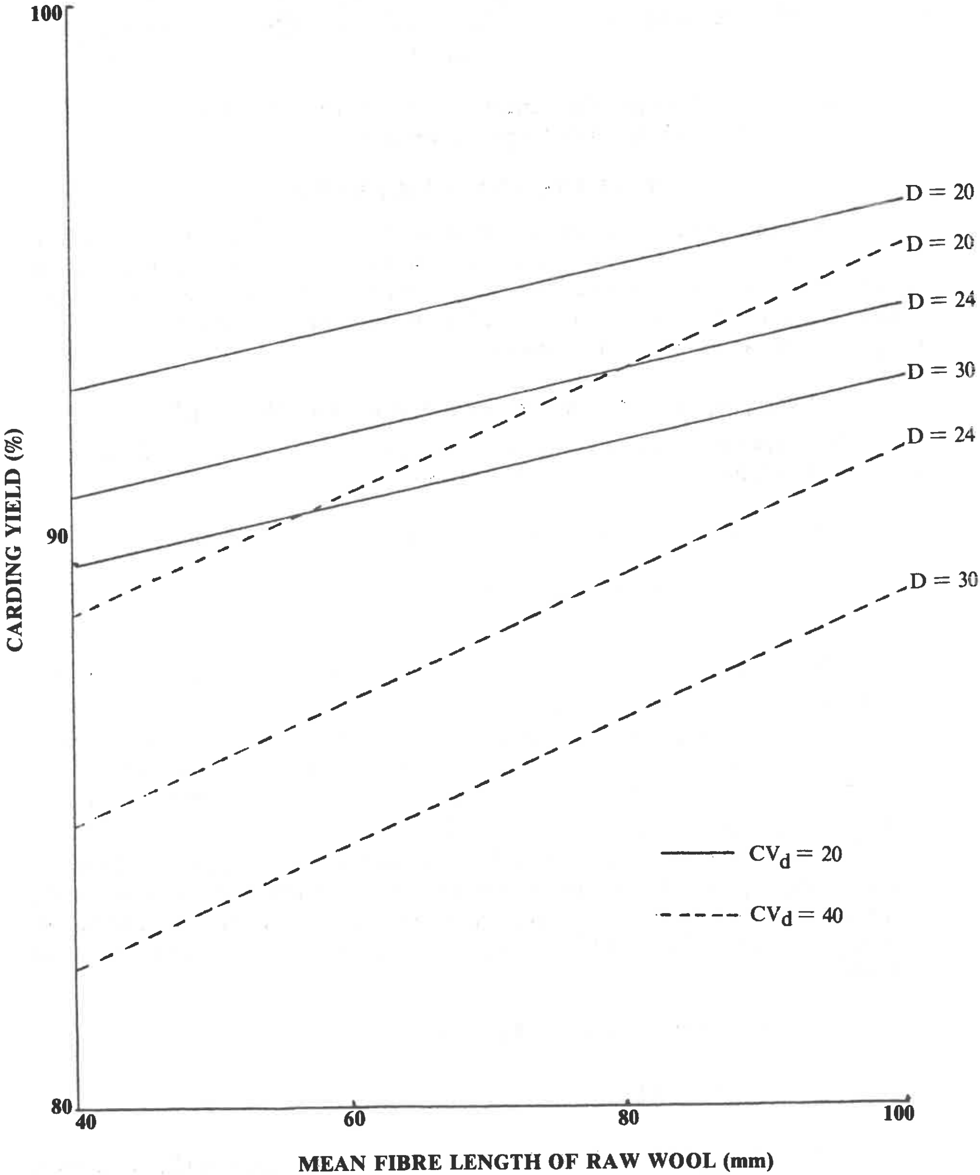

Fig. 1 – Regression lines illustrating the effects of fibre length, fibre diameter (D) and CV of diameter (CV_d) on carding yield.

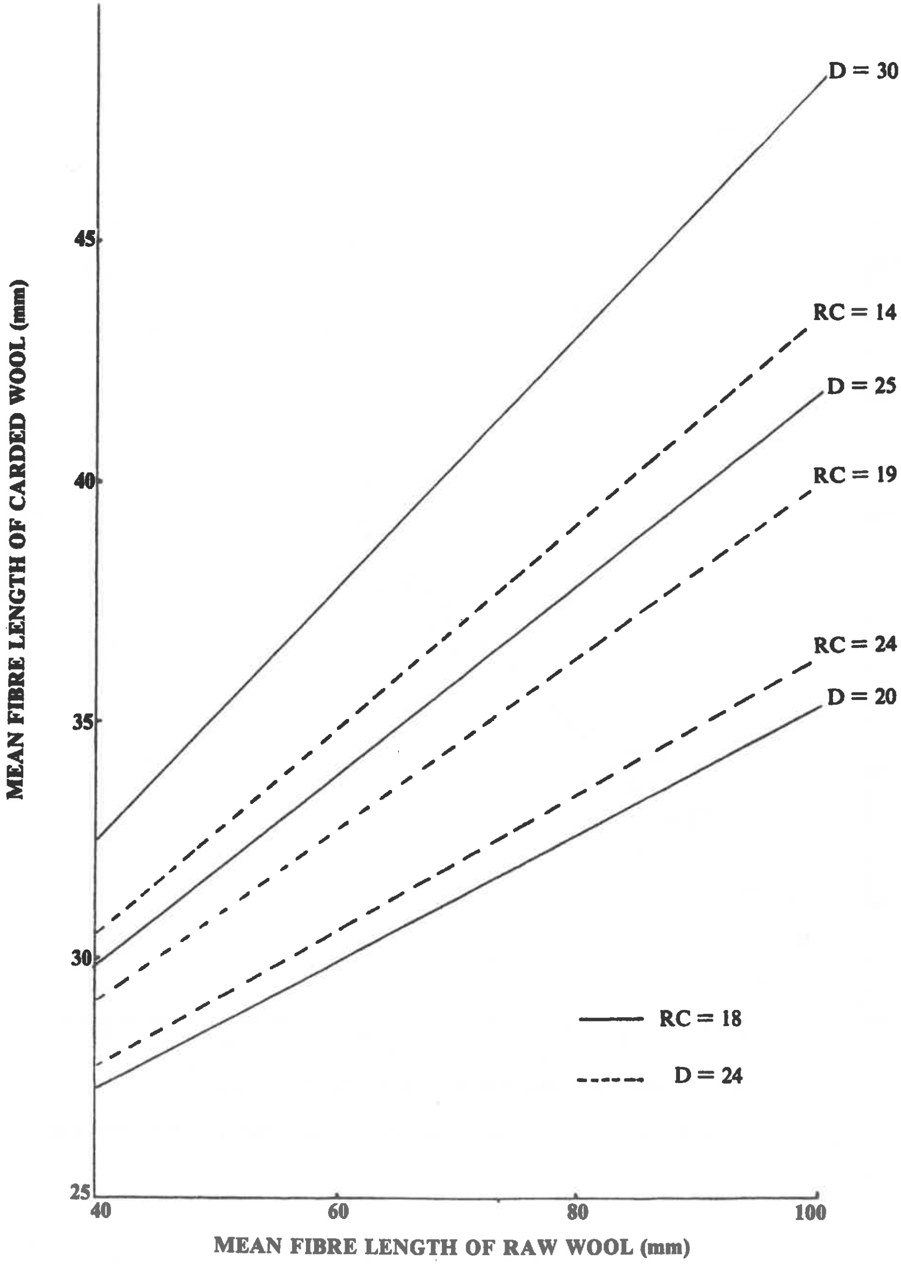

Fig. 2 – Regression lines illustrating the effects of fibre length, fibre diameter (D) and resistance of compression (RC) on the mean fibre length of carded wool.

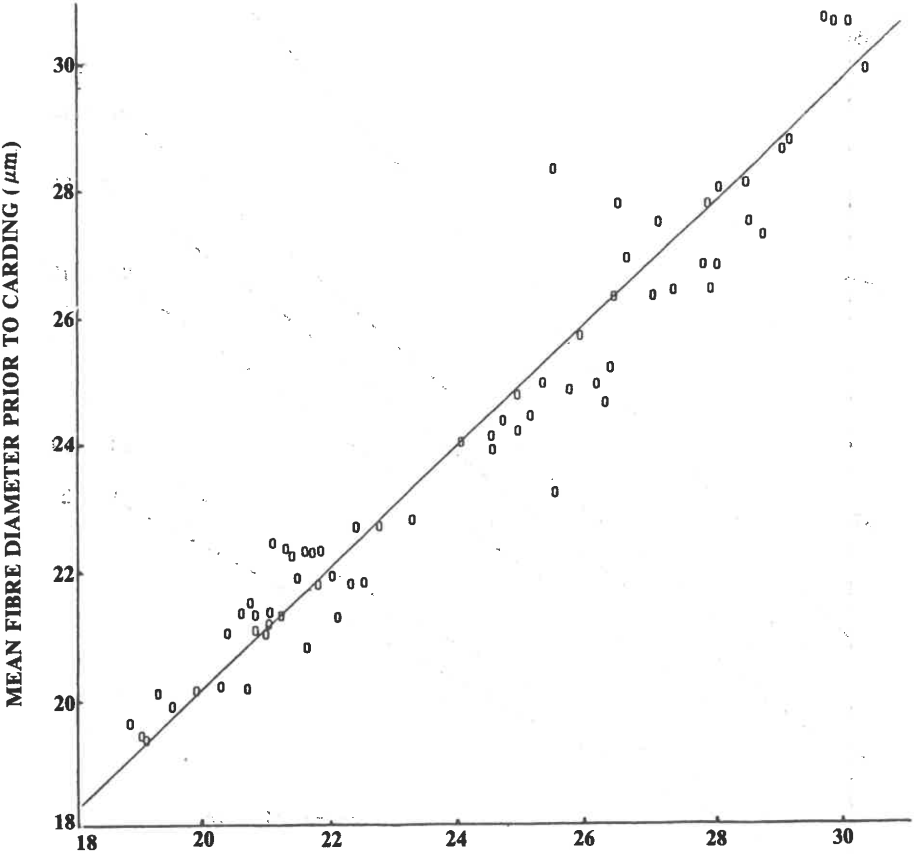

Fig. 3 – Mean fibre diameter after carding versus that prior to carding.

resistance to compression (RC) decreased (Fig. 2). The term D.L contritubed 93% to the multiple correlation coefficient.

The fibre diameter of the carded fibre was almost identical to that of the raw material (Fig. 3).

Effect of Fibre Properties on Cross Card Variation

Variation between the individual slubbings across the width of the card can be caused by uneven distribution of the fibres, tape differences, particularly so in the case of series tapes with variation in tension between tapes or differences in the winding and winding motions. Variation between slubbings can be controlled to within certain limits but is influenced by fibre length and length variability[4]. The longer the fibres in the blend the higher and the better the chances are that they can reach over the width of two or more tapes, such fibres are either broken or pulled from one tape to the next when the web is split into the various fibrous strands. The latter effect, commonly known as tape robbing, will cause considerable variation in slubbing density. If slubbing and thus cross card variation is influenced by long fibres it must also be influenced by fibre length variability. Other workers have shown[4] that when two fibre lots with the same mean fibre length but differing in their variability were carded, the one with the higher variability yielded slubbings with a higher variation across the card than the lot with low length variation.

When cross card variation was regressed, as dependent variable, against fibre properties as independent variables, the following best fit equation was obtained:

$$CC = 0{,}0066\ D.CV_d - 0{,}0055\ D.RC + 2{,}54$$

$$r = 0{,}706\ ;\ n = 68$$

The equation shows that cross card variation (CC) increased when fibre diameter (D) and CV of diameter (CV_d) increased and when resistance to compression (RC) decreased, with CV of diameter having the largest effect (Fig. 4).

The importance of fibre diameter and its variability is surprising because it was previously shown[4] that cross card variation was related to fibre length and not fibre diameter. The abovementioned workers[4] investigated the influence of fibre length and length variability upon cross card variation. It does, however, seem from the present study that diameter and CV of diameter were more important than fibre length and its variability.

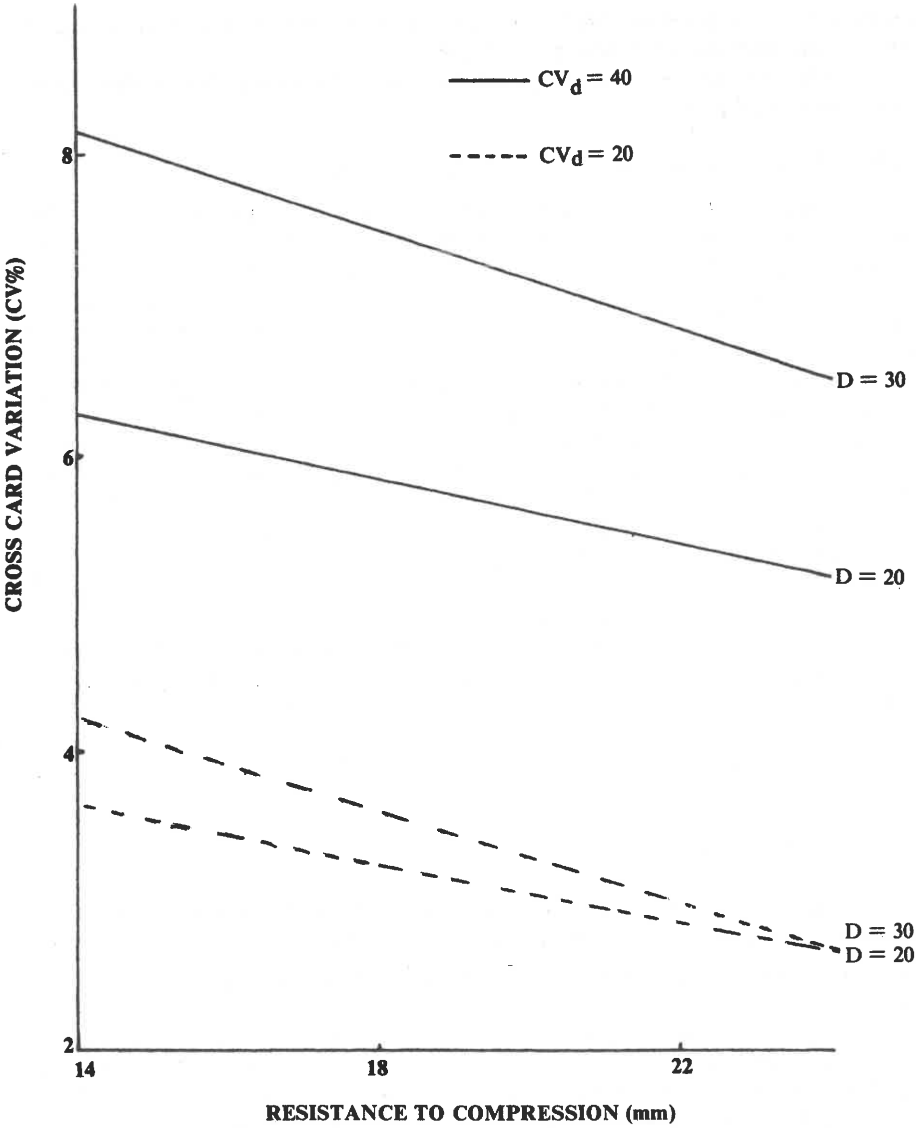

Fig. 4 – Regression lines illustrating the effects of resistance to compression, fibre diameter (D) and CV of diameter (CV_d) on the cross card variation.

Resistance to compression is positively correlated with crimp and high crimp is normally associated with fine fibres. Highly crimped fibres should have a lower fibre extent than coarse uncrimped fibres. Highly crimped fibres with a high resistance to compression would therefore have a smaller chance of reaching across the width of two tapes, compared to under crimped fibres, and thus reduce the effect of tape robbing. Further, fibre breakage during carding increased with an increase in resistance to compression resulting in fewer long fibres reaching across the width of two tapes, also reducing the effect of tape robbing thus resulting in the production of more even slubbings.

SUMMARY AND CONCLUSIONS

In this study, the effects of fibre properties on carding yield, fibre breakage during carding and cross card variation of 68 wool lots have been investigated for the woollen system.

Multiple regression analysis was carried out on the results to determine which fibre properties had significant effects on carding yield, fibre breakage and cross card variation.

It was found that carding yield increased as fibre diameter and CV of diameter decreased and as fibre length increased.

Carded mean fibre length was found to increase when mean fibre diameter and mean fibre length of the raw wool increased and when resistance to compression decreased.

Cross card variation increased as mean fibre diameter and CV of diameter (CV_d) increased and as resistance to compression decreased.

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USE OF PROPRIETARY NAMES

The names of proprietary products where they appear in this report are mentioned for information only. This does not imply that SAWTRI recommends them to the exclusion of other similar products.

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