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Part II: Some Processing Results on the Woollen System

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STUDIES ON THE MILD CARBONISING OF RAW WOOL AND MOHAIR
PART II: SOME PROCESSING RESULTS ON THE WOOLLEN SYSTEM

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ABSTRACT

The effects of a mild (partial) carbonising treatment on the characteristics of card slivers and slubbings produced on the woollen system of manufacture from various lambs wool lots are reported.

Multilinear regressions between the number of particles of the various VM classifications counted in the card slivers and the content of spiral burr, seed and shive and hard heads in the raw wool gave excellent statistical fits.

On the basis of these regressions the number and type of VM particles likely to occur in woollen slubbings for a range of specific VM types and levels of contamination were estimated.

INTRODUCTION

In the first part of this series[1], the necessity of totally effective carbonising of raw wool and mohair was questioned, and an alternative treatment, employing milder, less effective carbonising conditions, supplemented by traditional unsophisticated carding (and perhaps combing) operations, was proposed. The merits of such an alternative were illustrated by laboratory and pilot-scale work which indicated that excessive loss of fibre substance and excessive damage to the fibres occur when acid concentrations and immersion times in the acid bath are high, and when associated mechanical treatments are severe. While such conditions were often necessary to achieve total vegetable matter (VM) removal, it was shown that a milder carbonising treatment, together with the subsequent mechanical operations of carding and combing on the worsted system of manufacture, could achieve fairly satisfactory cleanliness of the material (for certain end-uses) while preserving or enhancing other attributes, such as mean fibre length, yield and colour. In some circumstances this could lead to normally unsuitable material being upgraded, a good example being the results of experiments reported on a lot of mohair which was heavily contaminated and matted with vegetable matter. In this case a light carbonising produced notable results, removing some 90% of the VM prior to carding together with improvements of 10 mm in the mean fibre length of the top and 10% in the top and noil yield over the results of the control lot which, under normal circumstances, could not have been processed commercially on the equipment used.

The worsted processing route is generally better suited than the woollen route for dealing with faulty wools, since not only are the cards generally more suitably designed for this purpose, but there is also a combing operation which allows for the post-carding removal of a significant proportion of the residual VM. The level and type of fault that can be handled depends upon the specific design of the card. With regard to the woollen system, many installations can only handle a relatively low percentage of VM in the raw material, this often being less than 1%, and sometimes the desired end-product can only be produced when the VM is less than 0,05%. When one considers that the bulk of the wool and mohair clip falls into the category range from "free to nearly free" to 1% VM, the bulk of the clip is excluded from use in many woollen mills unless the raw material is either carbonised or combed into broken tops. Seeing that conventional carbonising can result in appreciable loss in fibre mass as well as chemical and mechanical damage, and that combing represents a relatively expensive alternative for woollen end-use, it was considered to be of importance to study the consequences of the mild carbonising treatment of a variety of short wools, varying in their type and level of VM contamination, on woollen processing. If some of these could be processed successfully, it would enable normally unsuitable raw material to be upgraded.

A limited amount of work was carried out[2] on six different lambs wool blends ranging in VM content from 0,1 to 0,9%. These were carbonised with zero, 2,5% and 7,5% acid and their processing performance monitored on a woollen card. The results showed that treatment with 2,5% acid had a marginally adverse effect on subsequent fibre breakage, card yield and the mean spindle speed at break values. There was a marked deterioration in performance, however, when the acid concentration was increased to 7,5%. Some of the lambs wool blends were less affected by carbonising than others. VM levels after carbonising with 2,5% acid ranged from 0,1 to 0,2%.

The present report addresses the question of the characteristics of card slivers and slubbings produced on the woollen system from a variety of short raw wool lots carying greatly in their VM content and subjected to a mild carbonising treatment, and the correlation between the various parameters.

EXPERIMENTAL

Eight different lots of lambs wool were selected for the experiments described. These covered a range of staple lengths (45 to 70 mm), mean fibre diameters (about 19 to 23 microns), and VM (0,6% to 7,7%). Details are given in Table I, together with a breakdown of the VM into three separate categories, namely spiral burr, seed and shive, and hard heads as determined by standard core-test procedures.

Half-a-bale of each of the different lambs wool lots was scoured on a Petrie & McNaught pilot scale scouring plant (using the first two bowls for scouring and the third and fourth bowl for rinsing) and then dried. A further

halfbale of each lot was similarly scoured in the first two bowls of the scouring train, rinsed in the third bowl and given an acid treatment in the fourth bowl. These lots were dried in a similar way to the first half-bale lots and were then baked at 130° C, crushed in a 4-row burr crushing unit, dedusted twice through a Petrie & McNaught de-dusting machine and then neutralised in three bowls, rinsed in a fourth bowl and finally dried.

Each of the lots, both uncarbonised and carbonised, was willeyed in a Greenhalgh No. 21 Willow, then oiled with an emulsion comprising Duron SPS1 and water at an application level of 5% (omf) and then passed through a Wilson Knowles sample Fearnought.

Carding took place on a Tathams 2-part woollen carding machine, equipped with double swifts on both scribbler and finisher, clothed with flexible clothing throughout, a Peralta roller at the delivery end of the scribbler and a Scotch feed between the two parts of the card. Delivery was made onto a 6-height tape condenser producing 120 good ends, production being set at 10 kg/hour.

Those lots which had been *scoured only* were processed in succession, without allowing the card to run out between lots, commencing with the lot having the lowest total VM content followed in turn by the lot having the next highest total VM content, and so on until finally the lot having the highest total VM content was processed. In order not to risk damage to the finisher, processing of these specific lots was carried out on the scribbler section of the card only. The scribbler was then fettled after which those lots which had been *carbonised* were processed in succession, without allowing the card to run out between lots, and in the same order, as before. These carbonised lots were processed through the full carding machine into slubbings of 130 tex.

All the slubbings produced were spun into yarns of 100 tex Z250 on a Platts MR3 Woollen Ring Spinning Machine using 100 mm rings.

During the carding operation, samples of the sliver emerging from the scribbler were taken every 30 minutes after first allowing 45 minutes settlingin time after each new lot had reached the feed rollers of the machine. In this way four samples of each different lot were obtained for determination of the vegetable matter count. In the case of the carbonised lots, samples were taken at similar intervals, both of the slivers emerging from the scribbler as well as of the slubbings emerging from the finisher card.

The spinnablility of the slubbings was determined using the Mean Spindle Speed at Break (MSS) test. Reflectance and yellowness were measured on a Spinlab HVT system.

RESULTS AND DISCUSSION

The characteristics of the raw wool and resultant card slivers emerging from the scribbler of the woollen card are given in Table I. Also shown in the table are the characteristics of the carbonised wool slubbings emerging from the

TABLE I

CHARACTERISTICS OF RAW WOOL AND RESULTANT CARD SLIVERS AND SLUBBINGS

Lot No.	RAW WOOL CHARACTERISTICS						SCOURED				CARD SLIVER AND SLUBBING CHARACTERISTICS																
	Total VM (%)	Spiral Burr (%)	Seed & (%)	Hard Heads	m.f.d. (um)	Staple Length	Reflectance (%)		Yellowness (%)		Long Burr*			Short Burr*			Straw*			Bits*			Total VM Count*			Total Residual VM** (%)	MSS*** at Break (r/min)
							Uncarb	Carb	Uncarb	Carb	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c		
1	0,64	0,02	0,62	0,00	19,6	54	66	71	10	11	2	0	—	2	0	—	24	7	—	75	47	—	103	54	—	0,02	3860
2	0,66	0,00	0,64	0,02	23,3	55	67	73	10	12	3	0	0	4	0	0	24	4	1	66	31	3	97	35	4	0,02	3682
3	1,15	0,06	1,09	0,00	20,3	62	66	73	11	11	10	1	0	8	2	1	82	19	1	78	54	7	178	76	9	0,08	3852
4	1,63	0,08	1,55	0,00	20,6	63	62	67	10	12	5	0	0	7	1	1	251	63	7	147	92	11	410	156	19	0,02	3625
5	1,84	0,20	1,64	0,00	21,3	45	64	66	11	12	36	1	0	29	4	0	94	15	4	127	86	11	286	106	15	0,04	3647
6	5,52	3,92	1,60	0,00	20,2	60	70	68	10	12	366	32	5	184	61	6	365	71	20	186	161	35	1101	325	66	0,03	3832
7	6,29	0,94	5,35	0,00	18,8	61	68	66	10	12	49	1	0	257	14	1	436	116	18	409	156	20	1151	287	39	0,08	3860
8	7,73	1,31	3,09	3,32	21,5	70	59	59	12	13	65	5	1	79	16	2	654	215	53	234	199	68	1032	435	124	0,26	3792

* a = No per 20g measured on uncarbonised wool emerging from the scribbler
b = No per 20 g measured on carbonised wool emerging from the scribbler
c = No per 20g measured on carbonised wool emerging from the finisher

** VM determined chemically on carbonised card slivers

*** MSS determined at a yarn linear density of 100 tex

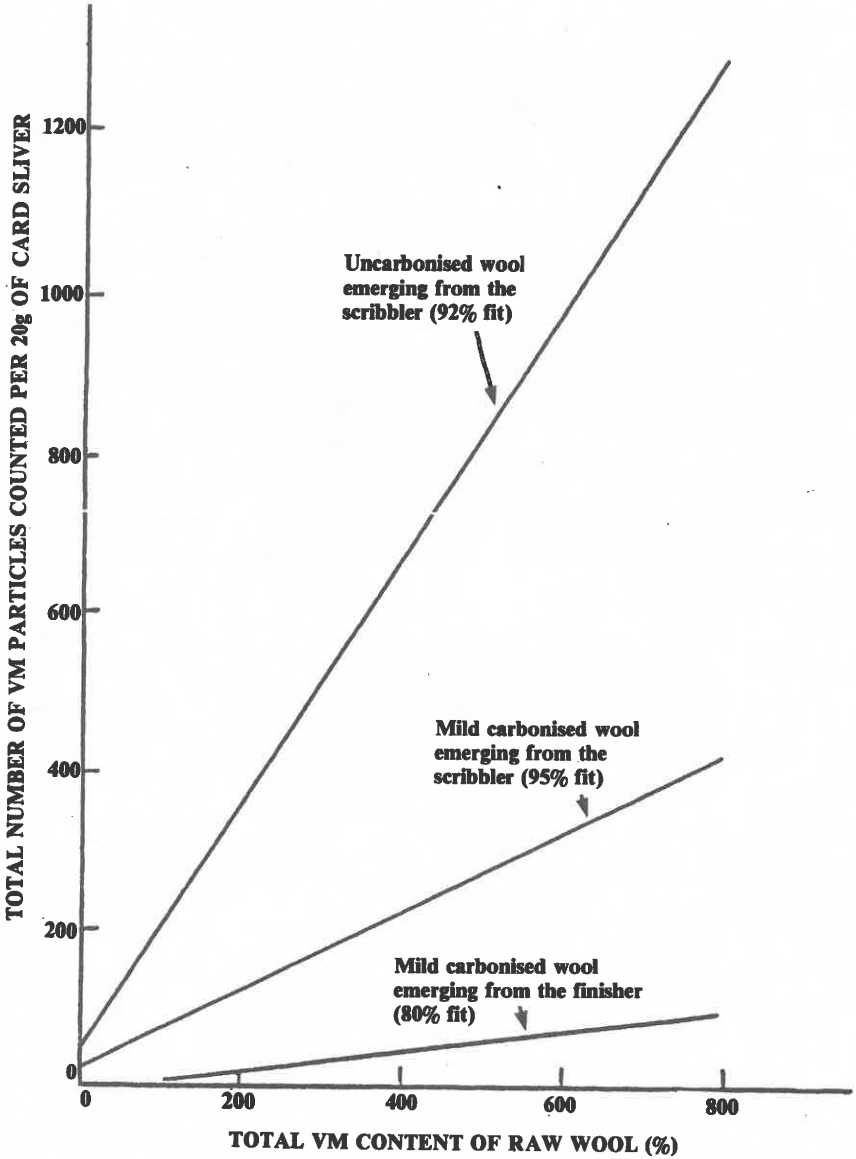

Fig. 1 – Regression lines showing the relation between the VM content of the raw wool and the total number of VM particles counted in the carded slivers.

finisher of the woollen card, including their spinning potential.

It can be seen from Table I that while total VM ranged from 0,6% to 7,7% for the various raw wool lots, the spiral burr content ranged from zero to 3,9% and was mainly confined to lots 6, 7 and 8 while only lot 8 contained any hard heads, this being at the level of 3,3%. All the lots were contaminated with seed and shive, this varying from 0,6% to 5,4% with the heaviest contamination in lots 7 and 8.

A simple linear regression between the total VM content of the raw wool and the total number of VM particles counted in the slivers emerging from the woollen card gave percentage fits of 92% and 95% for the uncarbonised and mild carbonised lots emerging from the scribbler, respectively and 80% for the mild carbonised lots emerging from the finisher. The respective regression lines are depicted in Fig. 1 and clearly show the dramatic improvement in the VM count from the uncarbonised control to the mild carbonised lots, the values being reduced to one third of their orginal value at the scribbler delivery point and to about one twelfth of their original value at the finisher delivery point.

Multilinear regressions between the long burr content, short burr content, straw content and bits content of the card slivers, each in turn, and the characteristics of the raw wool were carried out, and the following results were obtained —

Long burr:

$Y_{(a)} = 93,6X_1 - 9,24X_2 - 13,0X_3 + 14$ ..... % Fit = 99,6

$Y_{(b)} = 8,41X_1 - 1,53X_2 - 0,83X_3 + 1,45$ ..... % Fit = 99,8

$Y_{(c)} = 1,33X_1 - 0,28X_2 + 0,22$ ..... % Fit = 99,9

Short burr:

$Y_{(a)} = 38,9X_1 + 47,9X_2 - 22,8X_3 + 1,45$ ..... % Fit = 97,7

$Y_{(b)} = 15,5X_1 - 1,34X_3 + 0,17$ ..... % Fit = 99,9

$Y_{(c)} = 1,42X_1 + 0,25$ ..... % Fit = 93,8

Straw:

$Y_{(a)} = 60,7X_1 + 72,2X_2 + 103,4X_3 + 7,98$ ..... % Fit = 94,5

$Y_{(b)} = 22,5X_2 + 43,2X_3 + 1,9$ ..... % Fit = 92,7

$Y_{(c)} = 13,4X_3 + 8,5$ ..... % Fit = 82,4

Bits:

$Y_{(a)} = 13,1X_1 + 68,9X_2 + 20,4$ ..... % Fit = 98,6

$Y_{(b)} = 23,5X_1 + 19,2X_2 + 21,4X_3 + 37,8$ ..... % Fit = 95,8

$Y_{(c)} = 7,2X_1 + 15,2X_3 + 8,3$ ..... % Fit = 97,8

where $Y_{(a)}$ = No of particles per 20g on *uncarbonised* wool emerging from the scribbler.

$Y_{(b)}$ = No of particles per 20g on *mild carbonised* wool emerging from the scribbler.

$Y_{(c)}$ = No of particles per 20g on *mild carbonised* wool emerging from the finisher.

and X_1 = spiral burr content (%)

X_2 = seed and shive content (%)

X_3 = hard head content (%)

It can be seen from the above that excellent fits were obtained in nearly every case. Both the long burr and the short burr were mainly functions of the spiral burr content of the raw wool. The straw appeared to be mainly a function of the seed, shive and hard head content of the raw wool, whereas the bits were related to all types of VM in the raw wool.

Tests on the uncarbonised and carbonised wools prior to carding showed that the partial carbonising treatment resulted in improved reflectance values.

On the basis of the above regressions, an estimate has been made of the number of vegetable particles per 20g in each of the categories long burr, short burr, straw and bits, to emerge in the card sliver when the raw wool contains specific percentages of either spiral burr, seed and shive or hard heads. These estimates have been made for slivers emerging from the scribbler in the case of wools which have *not* been carbonised, and for slubbings emerging from the scribbler and finisher in the case of wools which have been given a mild carbonising pre-treatment for 45 seconds in the acidising bowl using a sulphuric acid concentration of only 2,5%. These estimates are given in Table II.

The estimates in Table II clearly illustrate the very high VM counts associated with scribbler slivers produced from faulty uncarbonised wools. A relatively high proportion of these VM particles is likely to be over 3 mm in length. All in all it would be highly inadvisable for such material to be used on the woollen card, with the possible exception of the case where the VM in raw wool comprises less than 0,5% of seed and shive.

Estimates for the slivers produced from wools which had been given a mild carbonising treatment show a considerable reduction in the VM count both in respect of number and size (length) of the particles. The slivers emerging from the scribbler which had been produced from raw wools containing up to 1% of spiral burr, or 1% of seed and shive or 0,5% hard heads are estimated to have total VM particle counts under 100 per 20g, and these estimates are significantly reduced when the slubbings emerge from the Finisher to a figure of around 20 particles per 20g. While the final count in the case of finisher slubbings appear to be independent of the seed and shive content of the raw wool, some caution

TABLE II

ESTIMATED NUMBER OF DIFFERENT TYPES AND SIZES OF VEGETABLE PARTICLES IN SLIVERS EMERGING FROM THE WOOLLEN CARD WHEN FED WITH WOOLS OF DIFFERENT VM TYPE AND CONTENT

		Estimated number of Vegetable particles per 20g of sliver from woollen scribbler (without pre-treatment)					Estimated number of vegetable particles per 20g of sliver from woollen scribbler after mild carbonising pre-treatment					Estimated number of vegetable particles per 20g of sliver from woollen finisher card after mild carbonising pre-treatment				
VM type	VM Content (% of wool base)	Long Burr > 3 mm	Short Burr < 3 mm	Straw > 3 mm	Bits < 3 mm	Total Count	Long Burr > 3 mm	Short Burr < mm	Straw > 3 mm	Bits < 3 mm	Total Count	Long Burr > 3 mm	Short Burr < 3 mm	Straw > 3 mm	Bits < 3 mm	Total Count
Spiral Burr	0,5	61	0	38	26	125	5	7	2	49	63	0	0	9	11	20
	1	80	0	69	33	182	9	15	2	60	86	1	1	9	15	26
	2	173	34	130	46	383	17	30	2	85	134	2	3	9	22	36
	3	267	73	191	59	590	26	46	2	109	183	4	4	9	29	46
	4	360	112	252	72	796	33	62	2	132	229	5	6	9	36	56
Seed & Shive	0,5	—	0	44	54	98	—	—	13	47	60	—	—	9	8	17
	1	—	4	80	89	173	—	—	25	57	82	—	—	9	8	17
	2	—	52	152	158	362	—	—	47	76	123	—	—	9	8	17*
	3	—	100	227	227	554	—	—	69	95	164	—	—	9	8	17*
	4	—	148	296	296	740	—	—	92	114	206	—	—	9	8	17*
	5	—	196	368	365	929	—	—	115	133	248	—	—	9	8	17*
Hardheads	0,5	—	—	59	—	59	—	—	23	48	71	—	—	15	15	30
	1	—	—	111	—	111	—	—	45	59	104	—	—	21	23	44
	2	—	—	'214	—	214	—	—	88	80	168	—	—	34	38	72
	3	—	—	317	—	317	—	—	131	101	232	—	—	48	53	101

* Possibly underestimated

should perhaps be exercised here due to the length of the runs on which these statistics have been based, and it is suggested that the characteristics of the scribbler sliver be taken into account in the total assessment.

It would appear that reasonably acceptable slubbings of improved reflectance could be produced on the woollen card from raw wools containing say, up to 1% spiral burr, or 2% seed and shive or 0,5% Hard heads.

Returning to Table I, it would appear that the residual VM content, determined chemically on the product of such wools would most likely be less than 0,04%.

SUMMARY AND CONCLUSIONS

The effects of a mild (partial) carbonising treatment (in which acidising took place for 45 seconds at a sulphuric acid concentration of 2.5%) on the characteristics of card slivers and slubbings produced on the woollen system of manufacture from various lambs wool lots are reported. The vegetable matter (VM) content of these wools ranged from 0,6% to 7,7%.

Because of the relatively high VM content of most of the wools, the control lots were only processed as far as the output stage of the scribbler section of the card, while the partially carbonised lots were processed through to the yarn stage.

High statistical correlations were found between the total VM content of the raw wool and the total VM particles counted in both the uncarbonised and partially carbonised lots emerging from the scribbler, as well as those counted in the partially carbonised lots emerging from the finisher card.

Multilinear regressions between the number of particles of the various VM classifications counted in the card slivers and the content of spiral burr, seed and shive and hard heads in the raw wool gave statistical fits approaching 100% in many cases.

On the basis of these regressions the number and type of VM particles likely to occur for a range of specific VM types and levels of contamination, has been estimated and it is concluded that reasonably acceptable slubbings of improved reflectance could be produced on the woollen card from raw wools such as those studied in this report containing up to 1% spiral burr, or 2% seed and shive or 0,5% hard heads after a mild carbonising treatment. This should greatly extend the range of raw wool types normally selected for processing on this system.

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