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Studies on the Mild Carbonising of Raw Wool and Mohair

Part I: Some Laboratory Studies Together with Processing Results on the Worsted System

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STUDIES ON THE MILD CARBONISING OF RAW WOOL AND MOHAIR
PART I: SOME LABORATORY STUDIES TOGETHER WITH PROCESSING RESULTS ON THE WORSTED SYSTEM*

by D.W.F. TURPIE

SUMMARY

The necessity of totally effective carbonising of raw wool and mohair is questioned, and an alternative treatment, employing milder, less effective carbonising conditions supplemented by traditional unsophisticated carding (and perhaps combing) operations, is proposed. The merits of such an alternative are illustrated by laboratory and pilot scale work which indicate 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 are often necessary for total vegetable matter (VM) removal it is shown that a milder carbonising treatment, together with the subsequent mechanical operations of carding and combing on the worsted system of manufacture can 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. It is envisaged that in some circumstances this could lead to normally unsuitable material being upgraded. Studies involving processing on the woollen system of manufacture are in progress.

INTRODUCTION

Vegetable matter (VM) contamination of raw wool and mohair is a naturally occuring phenomonen during the life of the sheep or goat, and is a function of factors such as the conditions of grazing and the production area. The degree of contamination varies from near zero to over 25% (expressed on clean mass of fibre) and there are numerous different types of VM from various grasses and seeds to burrs. Bellies and locks are generally more heavily infested than the fleece lines. Heavily infested lots can suffer considerable price penalties due to processing and other textile consequences [1,2].

Effective removal of vegetable contaminants is of particular importance in both woollen and worsted processing in order to avoid faults in the yarn and fabric. While there is little problem in achieving good mechanical removal of VM during carding when VM levels are low, faulty materials generally require rather more sophisticated deburring arrangements, otherwise card clothing can become damaged or clogged up hence ineffective, or the card will produce slivers

* Extended version of paper entitled "An Introductory Study on the Mild Carbonising of Raw Wool and Mohair", presented at the IWTO 56th International Conference, Rio de Janerio, June 1987.

which are too heavily contaminated for commercial purposes. In extreme cases of infestation, mechanical removal by such means cannot be attempted safely.

In general, the more faulty the raw material the lower the production rates on the card and the higher the card rejects and frequency of fettling. In some cases dust and fly can be a serious problem. The worsted route is generally better suited that 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 post-carding removal of a significant proportion of the residual VM. Unless the card is adequately equipped, however, faulty raw material must be avoided or, alternatively, carbonised. Furthermore, unless the card delivers a fairly clean sliver, production on the combs can be limited and a "dirty" noil of relatively low value can result. 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%. Raw material having higher levels of VM therefore require an effective mechanical treatment (e.g. broken tops) or chemical treatment (e.g. carbonising) prior to woollen processing.

Removal of vegetable matter from raw fibre by carbonising is simple and normally extremely effective, yet it is generally associated with a number of disadvantages. In a recent review[3] reference is made to a number of adverse changes in fibre properties during carbonising.

Carbonising of raw wool for *worsted* processing has generally been considered to be unsatisfactory due to appreciable losses in fibre mass and chemical and mechanical damage, with consequent heavy increases in noilage and significant decreases in mean fibre length.[4,5] Nossar and Chaikin,[5] however, have suggested that carbonising can be useful for worsted processing if the process can be designed and regulated in such a way that the fibres are left virtually undamaged. They described an unconventional prototype processing plant which they claimed could lead to reduced losses and better yarns in woollen manufacture as well as new possibilities in worsted yarn manufacture, particularly in the use of burry wools for the production of tops.

Other workers [4,6] have suggested carbonising at the carded sliver stage. Although the results quoted with respect to sliver carbonising reflect a significant improvement in the vegetable matter count of the resultant tops, mechanical removal of much of the vegetable matter present in the scoured wool by the *carding* machine must still be relied upon and the problems which can be experienced in this regard have already been referred to.

The question of loss in fibre mass, together with deterioration in fibre strength, length and colour which takes place during the carbonising process, would seem to be a major deterrent against the wide-spread use of carbonising vis-a-vis mechanical means for VM removal. *Average* fibre mass losses of 3,6% have been reported[3], but *heavily* contaminated raw material could necessitate even more drastic treatment than normal and cause more severe damage and considerably higher fibre mass loss.

The question arises as to whether it would not be feasible, for at least certain end-uses, to use less drastic carbonising conditions. Although this would be accompanied by a reduction in VM removal efficiency, less fibre damage would occur as well as less fibre mass loss. The subsequent mechanical processing sequence could then be selected so as to cleanse the partially carbonised material to the desired level of VM. In this context, not only could a processor usefully employ relatively unsophisticated carding equipment, but he could now purchase faulty raw material which he would normally have rejected as being unsuitable for his particular operation. This would enable normally unsuitable raw material to be upgraded.

With regard to carbonising conditions, widely different values have been quoted in the literature[3]. For example, the concentration of sulphuric acid in the acidising bowls has varied from as low as 2,4% to as high as 8%, immersion times have varied from 15 seconds to 10 minutes and temperatures of the acid solution from 10° C to 38° C. Various suggestions have been made with respect to the use of auxiliary chemicals in the acidising bowl, and to the drying and baking stages, particular in respect of temperature and associated regains. Some suggestions have been made with respect to burr crushing and dedusting to reduce fibre damage, and also with respect to the neutralising stage. While conventional neutralising involves treatment with soda ash, alternative neutralising agents have been suggested, notably ammonia.

Mindful of the research already carried out on this area and the numerous different practices and recommendations, SAWTRI entered into a programme of research to have a new look at the carbonising process with particular emphasis on the possibility of *a mild carbonising treatment* which would allow the reduction of the VM to acceptable levels for processing through a conventional unsophisticated woollen or worsted processing sequence without suffering the traditional disadvantages associated with carbonising. To date, processing trials have concentrated on the worsted system.

EXPERIMENTAL, RESULTS AND DISCUSSION

Laboratory-Scale Experiments:

Some laboratory-scale experiments were carried out on clean dried scoured wools fibres in which the fibres were subjected to immersion times of 1 minute and 10 minutes respectively in sulphuric acid solutions having acid contents of 2,5%, 5% and 10%[7]. After this they were immersed for two minutes in a neutralising solution of 0,5% sodium carbonate and then rinsed and dried.

The results in Table I show the dramatic increases in loss of fibre substance with increases in acid concentration and immersion time, thus highlighting the importance of short immersion time and low acid content from the point of view of minimising fibre loss.

TABLE I

LOSS OF FIBRE SUBSTANCE AFTER CARBONISING* (%)

Immersion time (mins.)	ACID CONTENT (%)		
	2,5	5	10
1	1,5	3,2	6,6
10	3,3	5,3	9,3

* Lab experiment on "clean" fibre

Pilot-Scale Experiments

The above laboratory experiments were followed by experiments on a 4-bowl Petrie & McNaught pilot-scale plant. Initially, experiments were carried out on scoured wool containing about 6% of VM. The wool was pre-wetted in the first three bowls and acidised in the fourth bowl. The wool then passed through a drying oven followed by a baking oven, a burr-crushing unit and a dedusting machine. The material was passed through the burr-crushing unit and dedusting machine a second time, and then the bowls of the scouring train were dropped and refilled and the material neutralised and rinsed.

Three acid levels (2,5%, 5% and 9%), two immersion times (45s and 75s) and two baking temperatures (115° C and 130° C) were used.

Tables II and IV give values of the significant parameters which emerged after statistical analysis.

Table II shows the residual VM values after carbonising and indicates that to obtain a value approaching zero, an acid content of 10% or more and a baking temperature of 130° C or even higher were required. On the other hand, if these results are expressed in terms of VM removal as in Table III, some 96% of the VM was actually removed under the relatively mild conditions of 2,5% acid and 115° C baking temperature.

Table IV shows the alkali solubility values after different immersion times in the acid bowl. All the values were relatively low although low immersion times were clearly preferable.

Table V shows that a slight decrease in bundle tenacity took place with increasing acid content, and Table VI shows that a marginal increase in yellowness took place with an increase in baking temperature.

Carbonising and Topmaking Experiments on Wool

After completion of the above experiments, some further pilot-scale experiments were carried out involving the carbonising of *scoured* wool and *raw*

TABLE II

VM (%) AFTER CARBONISING*

Baking temp. (°C)	ACID CONTENT (%)		
	2,5	5	10
115	0,23	0,19	0,12
130	0,17	0,13	0,06

* Av VM Content prior to carbonising = 5,7%

TABLE III

VM REMOVAL AFTER CARBONISING (%)

Baking temp. (°C)	ACID CONTENT (%)		
	2,5	5	10
115	96	97	98
130	97	98	99

TABLE IV

ALKALI SOLUBILITY AFTER CARBONISING (%)

RESIDENCE TIME IN ACID BOWL (seconds)		
0	45	75
14,8	15,8	17,1

wool, the product in all cases being taken right through to the top stage. All lots were sprayed with a lubricant prior to carding. Carding took place on an FOR double swift card equipped with a breast, morel and burr beater. A second burr beater was fitted to the licker when carding the control lots which had *not* been carbonised. Three gillings were carried out prior to combing on a Schlumberger PB26 Comb.

TABLE V

BUNDLE TENACITY AFTER CARBONISING
(cN/tex)

ACID CONTENT (%)			
0	2,5	5	10
11,7	11,0	10,5	9,5

TABLE VI

YELLOWNESS AFTER CARBONISING
(measured on Elrepho)
(%)

BAKING TEMP. (°C)		
Control	115	130
10,7	12,0	12,8

(a) Experiments on Scoured Wool

The experiments which were carried out on *scoured* wool were done simply for convenience to avoid having to carry out a scouring operation for each experiment prior to carbonising, and thus to minimise errors due to possible variations in scouring. (It was not intended that the carbonising of scoured wool should be viewed commercially.)

Table VII shows the results obtained under seven different treatment conditions for a scoured wool containing 5,5% of *burrs* (referred to as Lot A). Immersion time was fixed at 45s and baking temp at 120°C. The results given for the first three experiments are intended as a basis of reference, and did not involve carbonising. "Dummy" carbonising (Exp. 3) implies that the material was actually passed through all the operations that the carbonised material was subjected to in subsequent experiments, except that no acid or neutralising agent was used. The results illustrate that the action of re-scouring (Exp. 2) and re-scouring plus dummy carbonising (Exp. 3) resulted in an increase in percentage noil and a decrease in top and noil yield and top m.f.l. when compared with the results of Exp. 1. The vegetable matter in the noil was high in all cases, but decreased with an increase in mechanical action. It should be noted that in this, as well as subsequent tables, the percentage noil has been expressed on a *clean* basis to facilitate comparisons.

TABLE VII

RESULTS FOR SCOURED WOOL LOT A
VM = 5,5% (Burrs)

Exp. No.	Processing	VM before Carding (%)	VM removed (%)	Card Waste (%)	Noil (clean basis) (%)	VM in Noil (%)	Top and Noil Yield (%)	Top reflect-ance* (%)	Top yellow-ness* (%)	Top m.f.l. (mm)	Neps in top per 20 g	Veg in top per 20 g
1	Control (i.e. not re-scoured or carbonised)	5,5	0	11,5	5,6	19,2	58,5	67,8	22,2	56,7	5	64
2	Rescoured	5,5	0	11,8	5,9	18,0	57,7	68,8	22,9	56,2	4	37
3	Rescoured + dummy carb.	5,0	9	9,5	8,9	12,9	55,3	70,6	23,0	50,6	9	39
4	Rescoured + carb. (1% acid)	3,2	33	8,4	8,0	9,2	56,5	72,5	22,5	51,4	9	29
5	Rescoured + carb. ($2^1/_2$% acid)	0,6	90	5,8	7,5	1,1	56,8	72,9	22,3	51,1	8	16
6	Rescoured + carb. (5% acid)	0,3	95	6,1	10,4	0,2	55,8	73,2	22,5	47,6	6	7
7	Rescoured + carb. ($2^1/_2$% acid) but not dedusted	2,4	56	9,8	7,3	1,3	56,6	69,0	21,8	53,0	7	18

* Measured on Spinlab HVT Colormeter

The results given in Exps. 4, 5 and 6 compare the effects of acid concentrations of 1%, 2,5% and 5%. As would be expected, VM before carding decreased significantly with an increase in the acid level, about 95% being removed at a level of 5%. The VM in the noil also decreased significantly with an increase in the acid level. There was a deterioration in the top m.f.l. especially at 5% acid concentration. When compared with the results for the control lot No. 3, the performance of Lot 5, which had been treated with 2,5% acid appeared promising. In this case about 90% of the burrs were removed; there was less noil and the noil was also relatively clean; a better top and noil yield had been obtained and the top was marginally better in length. The yellowness of the top was about the same and reflectance slightly higher.

The results of Exps. 4, 5 and 6 indicate that carbonising *per se* had little if any detrimental effect, *mechanical* treatments during carbonising appearing to be responsible for the higher noil, lower yield and lower m.f.l. of the resultant top compared to the uncarbonised wool lots 1 and 2. This is further supported by the results of Exp. 7, in which the mechanical operation of dedusting was omitted leading to a gain of 2 mm in the m.f.l. of the top compared with Exp. 5. The relatively mild treatment with 2,5% acid produced appreciable improvement in the levels of card waste and vegetable matter in the top.

Table VIII shows the results obtained under 6 different treatment conditions for another *scoured* wool (Lot B). This contained 6,3% of vegetable matter comprising *seed, shive* and *burrs*. Immersion time and baking temperature were fixed at 45s and 120°C respectively, as before.

The results for the first two experiments (Exps. 8 & 9) are again intended for reference, and did not involve carbonising. It should be noted, however, that the act of re-scouring plus dummy carbonising significantly increased the percentage noil and decreased the m.f.l. of the top. In the remaining four experiments, the acid level was fixed at 2,5%, but mechanical treatment was reduced progressively. In Exp. 10, the conventional dedusting machine was used after burr crushing. In Exp. 11 this was replaced by a willeying machine. In Exp. 12, no dedusting or willeying was carried out. In Exp. 13, the wool was hand-fed to the carbonising line and the neutralising line and the number of bowls used for wetting out reduced by three. Mild carbonising resulted in VM removal efficiencies of about 85% in Exps. 10 and 11, but when no dedusting or willeying was employed or the wool was hand-fed and the number of bowls reduced, the efficiency dropped to about 68%.

It is important to note that as the mechanical treatments were reduced in severity, from Exp. 10 through to Exp. 13, percentage noil decreased significantly and top m.f.l. improved significantly. The values eventually attained were not far off the uncarbonised control values and the noil was far less contaminated with vegetable matter. Furthermore, the vegetable matter in the resultant top was significantly reduced. It is also of extreme importance to note that *the carbonising process had not resulted in any reduction of the top and noil yield.*

TABLE VIII

RESULTS FOR SCOURED WOOL LOT B
VM = 6,3% (Burrs 23%, Seed and Shive 77%)

Exp. No.	Processing	VM before Carding (%)	VM removed (%)	Card Waste (%)	Noil (clean basis) (%)	VM in Noil (%)	Top and Noil Yield (%)	Top reflect-ance (%)	Top yellow-ness (%)	Top m.f.l. (mm)	Nep in Top per 20 g	Veg in Top per 20 g
8	Control (i.e. not rescoured or carbonised)	6,3	0	12,8	7,4	9,5	54,3	70,2	21,4	60,0	10	62
9	Rescoured + dummy carb.	3,0	52	7,9	11,4	2,6	53,3	69,3	22,6	53,7	15	61
10	Rescoured + carb. ($2^1/_2$% acid)	1,2	81	6,1	11,1	0,7	53,3	69,5	21,4	50,8	11	17
11	As in (10) but willeyed not dedusted	0,7	89	6,7	10,5	0,4	53,3	71,1	21,5	51,6	12	14
12	As in (10) but not dedusted or willeyed	2,1	67	9,7	9,6	0,6	53,4	71,0	21,8	53,3	12	18
13	As in (10) but hand-fed and number of bowls reduced	2,0	68	9,9	8,3	1,5	53,4	71,5	22,4	56,2	16	32

(b) Experiments on Raw Wool

From the results obtained on scoured wool, it clearly emerged that it was important to scour and carbonise in one single sequence to minimise unnecessary mechanical treatment.

Table IX shows the results of a further series of experiments which were carried out on a *raw wool* lot, (Lot C). This was in fact the raw wool from which the scoured wool, referred to as Lot B in the previous series of experiments, was produced. In this series of experiments and all further series of experiments on the pilot plant, the raw fibre was *scoured in two bowls, the third bowl was used for rinsing and the fourth for acidising.*

The results of 5 different treatment conditions are shown in Table IX, the first condition (Exp. 14) representing a control lot which was not carbonised. Again, as previously, the following experiments, (Exps. 15 to 18) were intended to represent progressively less severe mechanical action. Mild carbonising resulted in VM removal efficiencies of about 80% excepting where willeying or dedusting was omitted in which case the efficiency dropped to 54%. The results for Exps. 15 to 18 again illustrate trends of reduced noil as the mechanical action was reduced, and improved m.f.l. when dedusting or willeying was omitted. In the final case, namely Exp. 18, not only was there no more noil produced than in the case of the uncarbonised control, but the noil was considerably cleaner, and the yield of top and noil was actually higher by about 1%. The m.f.l. of the top, however, was about 2 mm lower than that for the uncarbonised control. The mild carbonising treatments resulted in significantly less card waste and significantly lower VM levels in the top.

Tables X and XI show the results of three different treatment conditions for a further two lots of *raw wool.* (Lots D & E). Both wools were fairly heavily contaminated with *burrs, seed* and *shive*, and Lot E also contained a significant proportion of hard heads and twigs. Normally these lots would *not* have been considered for processing on the specific FOR card used.

In the case of both tables, the first condition (Exps. 19 & 22) refers to the control lots which were scoured and then blank carbonised. Even after blank carbonising the VM levels on entry to the card were relatively high and in the case of Lot 19, would normally still not have been attempted on the specific FOR card used. The second treatment condition (Exps. 20 and 23) comprised the usual sequence of scouring and carbonising operations, but in the third condition (Exps. 21 & 24) the dedusting operation was omitted.

In the case of Lot D some 93% of the VM was removed by mild carbonising when dedusting was included in the processing sequence, but in the case of Lot E, only 68% was removed in this way.

Compared with the results for the control lots, the results in Tables X and XI showed that considerably less noil could be obtained by adopting a mild carbonising treatment, and that not only were significant improvements in top and noil yield (up to 4% and 5%) recorded, but gains of some 2 mm were achieved in the m.f.l. of the tops, the noils were clean and VM levels in the tops were significantly lower.

TABLE IX

RESULTS FOR RAW WOOL LOT C

VM = 6,9% (Burrs 21%, Seed and Shive 79%)

Exp. No.	Processing	VM before Carding (%)	VM removed (%)	Card Waste (%)	Noil (clean basis) (%)	VM in Noil (%)	Top and Noil Yield (%)	Top reflectance (%)	Top yellow-ness (%)	Top m.f.l. (mm)	Neps in Top per 20 g	Veg in Top per 20 g
14	Control (i.e. scour only)	6,3	9	12,8	7,4	9,5	54,3	70,2	21,4	60,0	10	62
15	Carbonised with 3-bowl neutralising	1,1	84	6,1	9,3	1,5	54,6	70,8	22,8	55,7	26	14
16	Carbonised with 2-bowl neutralising	1,6	77	6,7	9,7	1,9	53,3	72,2	22,7	54,3	29	13
17	As above, but willeyed instead of dedusted	1,3	81	6,1	8,3	2,0	54,6	71,2	23,2	55,5	14	18
18	As for (16), but not dedusted or willeyed	3,2	54	10,1	7,3	2,6	55,7	70,8	22,8	57,7	11	28

TABLE X

RESULTS FOR RAW WOOL LOT D
VM = 15,2% (Burrs 24%, seed and shive 76%)

Exp. No.	Processing	VM before Carding (%)	VM Removed (%)	Card Waste (%)	Noil (clean basis) (%)	VM in Noil (%)	Top and Noil Yield (%)	Top Reflectance (%)	Top Yellowness (%)	Top m.f.l. (mm)	Neps in Top per 20 g	Veg in Top per 20 g
19	Control (blank carbonise)	11,3	26	14,4	12,8	17,1	43,2	65,7	26,6	46,5	6	16
20	Carbonised	1,1	93	8,2	10,5	0,8	47,3	68,4	25,2	48,1	10	7
21	Carbonised without dedusting	5,7	62	13,4	10,3	0,5	48,1	69,4	25,9	48,4	5	9

TABLE XI

RESULTS FOR RAW WOOL LOT E
VM = 6,8% (Burrs 51%, seed and shive 23%, hard heads and twigs 26%)

Exp. No.	Processing	VM before Carding (%)	VM Removed (%)	Card Waste (%)	Noil (clean basis) (%)	VM in Noil (%)	Top and Noil Yield (%)	Top Reflectance (%)	Top Yellowness (%)	Top m.f.l. (mm)	Neps in Top per 20 g	Veg in Top per 20 g
22	Control (blank carbonise)	4,3	37	10,3	8,3	9,5	47,4	65,7	23,5	50,2	8	26
23	Carbonised	2,2	68	7,9	7,6	0,6	48,7	69,6	22,4	51,3	6	8
24	Carbonised without dedusting	2,8	62	10,6	7,5	0,7	51,3	69,2	23,0	52,1	5	10

Carbonising and Topmaking Experiments on Mohair

The work carried out on wool reported above was followed by some experiments on a commercial lot of adult mohair which was severely matted with a high proportion of vegetable matter (11,8%) and typical of a number of such lots which reached the market place after a season of exceptionally good rains.

Table XII gives the results of five different treatment conditions on the raw hair.

In the first experiment (Exp. 25), the mohair was scoured in the first two bowls of the pilot plant, and rinsed in the third and fourth bowls. It was then dried, lubricated and carded on the FOR card using burr beaters on both the licker and the morel. Carding of such matted and contaminated material would definitely *not* be undertaken on such equipment commercially and the experiment was therefore purely of academic interest, (i.e. for comparative purposes only). The card sliver was gilled twice and then combed on the Schlumberger PB26 Comb.

In the second and subsequent experiments (Exps. 26 to 29) the hair was opened on a miniature Fearnought prior to wet treatment, then scoured in two bowls, rinsed in the third bowl and acidised in the fourth bowl. Immersion time in the acidising bowl was fixed at 45s. The hair was dried, baked at 120° C, passed through the set of crushing rollers and the dedusting machine twice and then neutralised and rinsed. Carding and combing were carried out as before, but only one burr beater was used in Exp. 26 and no burr beaters in Exps. 27 to 29.

The results for Exp. 25 show that when the hair was not carbonised, an extremely large amount of card waste (35%) was produced together with a relatively poor top and noil yield, high short fibre content and low mean fibre length of the top. The number of vegetable particles in the top was also relatively high.

When the mohair was dummy carbonised as in Exp. 26, vegetable matter removal efficiency was about 48% prior to carding and not only was the card waste significantly reduced, but fibre breakage was also reduced as evidenced by a dramatic increase in the top and noil yield as well as the mean fibre length of the top, together with significant improvement in both short fibre content and tail length. There was also a significant reduction in the number of vegetable particles in the top.

The results for Exps. 27, 28 and 29 illustrate the effects of carbonising with progressively increased concentrations of acid in the acidising bowl from 1% to 7,5%. Under such conditions, vegetable removal efficiency before carding ranged from 61% to 97%, the top and noil yield again showed a further significant improvement, as also did the brightness of the tops. Residual VM levels in both top and noil decreased significantly with increasing level of acid as also did the card waste, all being lower than when no carbonising took place. While the reflectance of the top was highest when 7,5% acid was used, there was evidence of a lower hauteur and a slight deterioration in short fibre content, tail

TABLE XII

RESULTS FOR ADULT MOHAIR SEVERELY MATTED WITH FAULT VM = 11,8% (Burrs 6%, Seed and Shive 94%)

Exp. No.	Processing	VM before Carding (%)	VM Removed (%)	Card Waste (%)	Noil (clean basis) (%)	VM in Noil (%)	Top and Noil Yield (%)	Top Hauteur (mm)	CV (%)	% Fibre <25 mm	Tail (5%) length (mm)	Top Reflect-ance (%)	Top Yellow-ness (%)	Top Alkalai solubility (%)	Neps in Top per 20 g	Veg in Top per 20 g
25	Scoured only	9,4	20	35	0,7	9	57	78	48	10	137	56	9	11	0	91
26	Dummy Carbonised with 0% Acid	6,1	48	18	0,3	6	62	87	40	5	140	54	10	10	0	68
27	Carbonised with 1% Acid	3,9	67	11	0,6	11	68	88	40	5	141	62	10	9	0	44
28	Carbonised with 2,5% Acid	1,5	87	10	0,4	2	67	88	39	5	140	63	10	9	0	11
29	Carbonised with 7,5% Acid	0,4	97	8	0,4	1	67	84	42	6	138	68	11	9	0	5

length and yellowness, compared to when the lower acid levels were used. Optimum all-round performance was obtained when using 2,5% acid in the acidising bowl.

Some Laboratory Studies on Medicago Minima

The effect of baking temperature, baking time, heat source and immersion time, as well as the effect of some non-ionic and anionic wetting agents incorporated in the acid bath on the carbonising of the burr known as *medicago minima* has been studied in the laboratory in parallel with the above practical work.[7]

After treatment in acid under the required conditions, the burr samples were dried by squeezing between a number of layers of tissue paper. The dried burrs were then baked under the required conditions. The acid content of the burrs was determined before and after baking by extraction in boiling water.

Some of the main findings of this study were —

1. The acid uptake of the burr varied from as low as 2,9% to as much as 4,5% for the same conditions of treatment, but appeared to be marginally lower for bigger burrs than smaller ones.
2. The acid uptake of the burr was higher for higher acid concentrations and longer immersion times in accordance with published literature.
3. For short immersion times such as one minute, it was found on average that 2,5% of acid was taken up by the burrs.
4. The acid uptake of the burr depended on the choice and concentration of surfactant, this again being in agreement with published literature. Certain surfactants, particularly anionics, resulted in higher acid uptake than others.
5. The acid content of the burr *after baking* decreased progressively with increasing baking time, but was also dependent on the surfactant selected.
7. The measured decrease in acid content of the burr after baking correlated with progressive break-down of the burr. This was shown by scanning electron microscope studies which illustrated that there was considerable surface erosion of the burr after baking when the burr had been previously immersed in the acid bath for only 0,5 minutes. There was deep-seated cracks and longitudinal striations in the burrs when the immersion time in the acid bath was 1,0 minute. A major breakdown or structural collapse of the burr was evident when the immersion time in the acid bath was 2,5 minutes.
7. Infra-red baking of the burrs was considerably more effective than a circulating air oven.

With regard to the finding that certain surfactants resulted in higher acid uptake by the burr than others this suggests that certain surfactants in the acidising bowl may have advantages over others in terms of the efficiency of carbonising the *vegetable matter*. Seeing, however, that the selection of surfactant in the acidising bowl is also known to play an important role in terms of minimising damage to the *fibre*, it would be very interesting to investigate whether the "best of both worlds" can be achieved by selecting a single surfactant for use in the acidising bowl which will allow for optimum degradation of the vegetable matter, while at the same time minimising damage to the fibre.

SUMMARY AND CONCLUSIONS

Pilot-scale work has shown that a mild carbonising treatment incorporated at the end of the scouring line can remove some 90% of the VM in wool and mohair prior to carding, even with relative high levels of VM infestation. It is considered that the product so produced could well find application in both woollen and worsted end-uses. With regard to worsted end-use, it was shown that tops can be made from such material without any loss, and sometimes a significant gain, in top and noil yield and without any materially important increase in percentage noil of yellowness. Furthermore, a considerably better noil is produced. In most cases, processing of the uncarbonised material selected for these experiments would not have been undertaken commercially on the equipment selected for the experiments.

Some reductions in top m.f.l. were recorded in the earlier experiments reported on scoured wool, and to a lesser extent in the first series of experiments conducted on raw wool, and these appeared to be related to the additional mechanical treatments to which the wool had been subjected during carbonising. In later experiments reported on raw wool, significant gains in m.f.l. were recorded when compared to blank carbonised control lots.

With regard to the experiments reported on mohair which was heavily infested and matted with vegetable matter, light carbonising produced notable results, removing some 90% of the VM prior to carding with improvements of 10 mm in the m.f.l. 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.

A major finding which has emerged, is that wool and mohair which are too faulty to be processed commercially on a worsted plant designed for a specific level of fault in the raw material, can now be considered for processing on such equipment after a mild carbonising treatment which does not inflict serious damage to the fibres and does not lead to much loss in fibre mass. However, the cost of such treatment must be considered in relation to the benefits which accrue.

A limited amount of work has been done on the mild carbonising of wool destined for processing on the woollen system and further experiments are in progress, the results of which will be reported in due course.

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USE OF PROPRIETARY NAMES

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