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The Cleanliness of Rectilinear Combed Tops

Part 1: The influence of Gauge Setting and Gill-Feed

by

De V. Aldrich and P. J. Kruger

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

P. O. BOX 1124
PORT ELIZABETH
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THE CLEANLINESS OF RECTILINEAR COMBED TOPS*

PART I: THE INFLUENCE OF GAUGE SETTING AND GILL-FEED

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ABSTRACT

The influence of gauge setting and gill-feed on the efficiency with which the rectilinear comb removes impurities was investigated. The nep content of the top decreased with increasing gauge setting, provided an efficient top comb was used. Vegetable particle content of the top decreased with increasing gauge setting, irrespective of the top comb used. At very small gauge settings (smaller than 23 mm) the nep content of the top increased with increasing gill-feed, while at higher gauge settings it showed a tendency to decrease. The number of vegetable particles in the top increased with increasing gill-feed, but the increase diminished with increasing gauge setting. At gauge settings of 28 mm and higher the vegetable particle content was hardly influenced by gill-feed.

KEY WORDS

Rectilinear combing – wool – gauge setting – gill-feed – top cleanliness – neps – vegetable particles.

INTRODUCTION

The removal of neps and vegetable particles from worsted card slivers, remains one of the inherent problems associated with the worsted processing of wool. The removal of these impurities is, therefore, one of the most important objectives of the combing process, as the quality of the top produced benefits greatly from the absence of impurities. In view of this, attempts were made to investigate the mechanism by means of which impurities are removed.

Belin[1] made a study of the behaviour of neps and vegetable particles during rectilinear combing. The distribution of vegetable particles in the beard before and after withdrawal was determined and possible mechanisms by means of which a vegetable particle could be transferred from behind the top comb into the combed sliver were discussed. No vegetable particles were observed in the zone of fibre ends to be withdrawn. It was argued that the top comb acts as an impedance to the forward movement of vegetable particles and to some extent also to that of neps. Depending on the size of the neps, the top comb can, however, also act as a sieve.

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*Part of a Ph.D. Thesis submitted by De V. Aldrich at the University of Port Elizabeth

A mathematical model[2] that accounts for the distribution of vegetable particles in the beard of a rectilinear comb was developed.

From further investigations of the transfer of vegetable particles from the beard to the combed sliver, Belin and Verhagen[3] concluded that particles found in the combed sliver appeared to originate largely in a region near the front of the top comb. The poorly combed region near the nipper brush was the major source of vegetable particles found in the top.

The present paper describes an investigation of the influence of gauge setting and gill-feed on the efficiency with which the rectilinear comb removes impurities.

EXPERIMENTAL

Materials:

All the experiments described here were carried out on Merino wool of around 64^S quality. Three lots, designated A, B and C, were used throughout. The characteristics of the precombed slivers of these wools are given in Table 1.

TABLE 1

THE CHARACTERISTICS OF THE PRECOMBED SLIVERS USED

WOOL		A	B	C
Mean fibre length (mm)		56,0	65,7	66,0
Coefficient of Variation (%)		65,1	45,1	54,2
% Fibre shorter than 25 mm		35,0	10,7	16,2
Mean fibre diameter (microns)		22,1	22,5	20,7
Ether extractable matter (%)		0,98	0,95	0,69
Impurities per 20 grams:				
Neps		456	481	229
Vegetable particles:	>10 mm	100	–	–
	> 3 mm <10 mm	506	134	100
	< 3 mm	1053	129	100
Total number of vegetable particles		1659	263	200
% Vegetable matter (by mass)		1,3	–	–

Scouring, carding and gilling:

Scouring was carried out on a four-bowl Petrie and McNaught pilot scale scouring plant, using a nonionic detergent with 0,1% soda ash in the first bowl. Each lot was well mixed before it was scoured to a residual grease content varying from 0,3% to 0,6%. After scouring 1% Eutectal (0,3% dichloromethane extractable) was added to each lot.

The wool was carded on a F.O.R. Biella Worsted Card with a continental forepart at a swift speed of 78 r.p.m. and a production rate of 16 to 18 Kg per hour. The card slivers were subsequently conditioned for at least 48 hours in an atmosphere of 20°C and 68% relative humidity. All subsequent experiments were carried out under these conditions.

Each lot was given three preparatory gillings on a NSC Intersecting gillbox with fallers having a pin density of 6,5 pins per cm.

TABLE 2

DETAILS OF THE TOP COMBS USED

TOP COMB	PINS per cm	PITCH (microns)	PIN DIMENSIONS		GAP (microns)	% VOID
			Thickness (microns)	Width (microns)		
L	30	333	305	746	28	8,4
M	28	358	307	738	51	14,3
N	25	400	326	735	76	19,0
O	21	475	269	755	206	43,4

Combing:

The slivers were combed on a Schlumberger (Model PB 26 L) rectilinear comb. Care was taken to set the comb properly before the commencement of each series of experiments. In all cases combing was carried out with the slivers entering the comb in the same direction as that in which they had left the card.

The comb was equipped with a conventional comb cylinder suitable for combing 64^s quality wools. The characteristics of the top combs used are given in Table 2.

For each of the eight ratchets, driving the back feed rollers, a gill-feed setting was chosen so that the tension of the slivers between the feed-gill and feed rollers remained constant for each ratchet and gill-feed setting combination. The *actual* forward movement of the feed-gill was then measured at each setting. Throughout this report the term "gill-feed" is used when the *actual* forward movement of the feed-gill is referred to.

The comb was allowed to run for at least 10 minutes before commencing with a series of experiments. For each experiment three 3-minute tests were carried out, and the average value taken to be the result of the experiment.

Measurements:

The nep and vegetable particle content of the precombed and top slivers were determined with a Toenniessen Top Tester. In the case of the precombed slivers, six determinations were carried out (three each by two operators) on six samples drawn from six alternative cans as they left the third gillbox. A mass of 30 grams was tested per sample, or 500 impurities (neps plus vegetable particles) counted, whichever limit was reached first. The results of the six determinations were then averaged. For the nep content *all* neps were included and not only the large neps, and consequently the values quoted for nep content appear to be rather high.

In the case of the top samples a mass of 50 grams was tested, or 250 impurities counted, whichever limit was reached first, for every test. The results of the six determinations by two operators (one each per test), which involved a minimum of

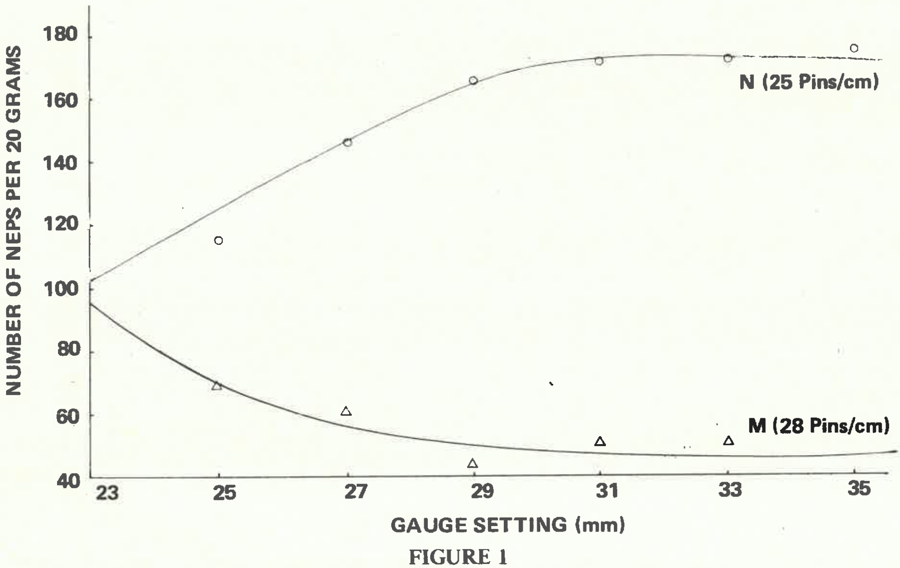

FIGURE 1

Number of Neps per 20 grams versus Gauge Setting for different Top Combs (Wool A)

300 grams of material or 1 500 impurity counts, were then averaged and taken as the impurity content for the particular experiment.

In all cases the nep and vegetable particle contents are expressed as the number of each per 20 grams material. Where relevant, the vegetable particles were divided into three groups, those shorter than 3 mm, those longer than 3 mm but shorter than 10 mm, and those longer than 10 mm.

Fibre length measurements of the precombed slivers were carried out on the WIRA Single Fibre Length Tester.

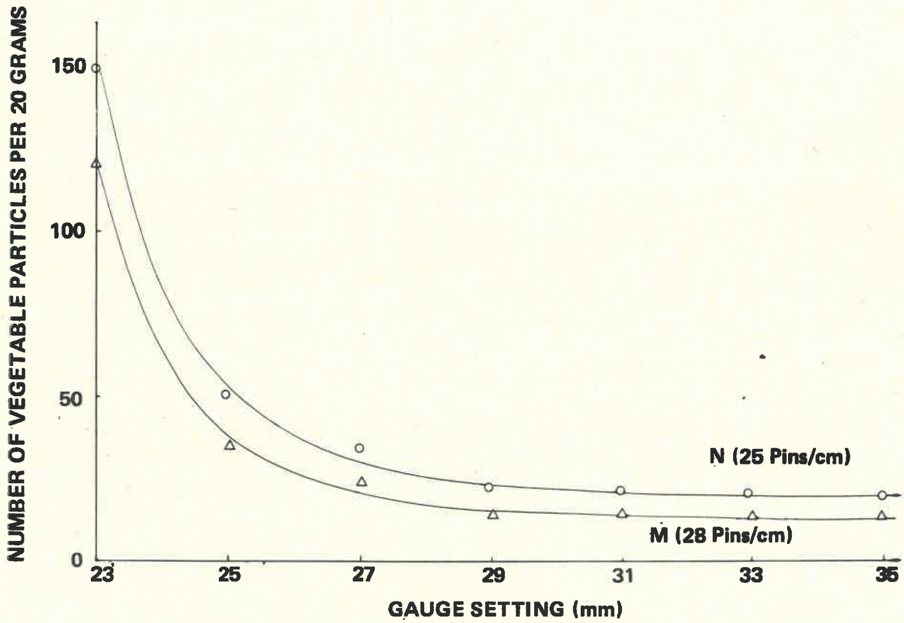

FIGURE 2

Number of Vegetable Particles per 20 grams versus Gauge Setting for different Top Combs (Wool A)

RESULTS AND DISCUSSION

I EFFECT OF GAUGE SETTING

The graphs of the total number of neps and total number of vegetable particles versus gauge setting for the different top combs are given in Figs. 1 and 2 for wool A and Figs. 3 and 4 for wool B. The percentage noil showed the normal increase with increasing gauge setting for both wools, and is not given. Top comb

In Table 3 the percentages neps and vegetable particles removed from the input sliver during combing at different gauge settings (using top comb M) are given. In all cases there was a sharp increase in the efficiency of removal of impurities in the gauge setting region 23 mm to 26 mm. The efficiency with which neps were removed was, however, markedly lower than that with which vegetable particles were removed.

It is generally accepted that the use of larger gauge settings results in cleaner tops. This was, in fact, verified by the results given in Figs. 1 and 3 provided that top combs M and L (28 and 30 pins per cm, respectively) were used. The results for these two top combs are in line with that of Belin[1] who used a top comb of 26 pins per cm (with spacings between the pins of 70 microns). From the results in Figs. 1 and 3 it is clear that it cannot be concluded that the nep content of a top invariably decreases with increasing gauge setting, the deciding factor being the characteristics of the top comb.

The movement of neps behind and through the top comb will depend on, amongst other factors, the characteristics of the neps and of the top comb. With increasing gauge setting the distance between the top comb and the feed-gill increases and the control which the feed-gill exerts on the movement of fibres (and neps) behind the top comb becomes smaller. The result is that neps float forward more easily at higher gauge settings than at lower gauge settings. If the characteristics of the top comb are such that it cannot effectively stop these floating neps, they will float through the top comb into the combed sliver. With inefficient top combs the nep content of the combed sliver will therefore increase rather than decrease with increasing gauge setting. For both wools A and B the top combs N and O yielded tops with unduly high nep content, and they will probably not be used in practice for these types of wool. The choice of top comb should be such that it yields a decreased nep content with an increase in gauge setting, and the characteristics of such a top comb will depend on the character of the neps and on the type of wool being combed.

The effect of gauge setting on the number of neps in the combed sliver diminished for gauge settings larger than 28 mm for all top combs. This may be explained by two opposing phenomena: the increased floating of fibres and neps behind the top comb which tends to increase the advancement of neps into the combed sliver, and the increased length of fringe presented to the comb cylinder where it is completely stripped of all neps which will in turn result in a cleaner combed sliver.

The number of vegetable particles invariably decreased with an increase in gauge setting. Different top combs only influenced the overall level of the impurity content, but exhibited the same tendency (see Figs. 2 and 4). The same factors which influence the advance of neps into the comb sliver are also applicable to the advance of vegetable particles, the only difference being that vegetable particles behave more individually than neps. In the case of neps, protruding fibres which extend into the withdrawal zone, may be present, in which case the nep attached to such a fibre is drawn through the top comb if allowed to do so by the gaps between the pins. Vegetable particles, however, are held in the sliver merely by fibre contact and fibre entanglement. They are, therefore, readily blocked by the top comb and only those which can pass through the top comb advance into the combed sliver. This difference in the behaviour of neps and vegetable particles is illustrated in Table 3 where the percentages of the original number of neps and vegetable particles removed in combing are given. The efficiency with which the comb removes neps is clearly lower than that with which it removes vegetable particles. Other factors being equal, the efficiency with which the comb is able to remove impurities will, however, depend on the character of the impurities and the influence of neighbouring fibres during withdrawal. The latter factor is of more importance for neps than for vegetable particles, and its effect increases with increasing gauge

TABLE 4

THE EFFECT OF GAUGE SETTING ON THE IMPURITY CONTENT OF THE TOP FOR DIFFERENT TOP COMBS (WOOL A)

Top comb (pins/cm)	Gauge Setting (mm)	Noil (%)	Impurities per 20 grams				
			Neps	Vegetable Particles			
				>3 mm, <10 mm	>10 mm	<3 mm	Total
25	23	6,53	108,1	46,4	9,8	94,3	150,5
(N)	25	7,73	115,0	14,8	2,8	32,4	50,0
	27	8,29	150,2	10,3	1,9	22,3	34,5
	29	8,90	170,5	6,6	0,5	15,4	22,5
	31	9,81	175,1	2,2	0,7	18,6	21,5
	33	11,14	171,4	3,9	0,0	16,8	20,7
	35	12,80	174,6	2,7	0,3	16,2	19,2
28	23	7,22	94,3	35,9	9,1	75,6	120,6
(M)	25	8,20	68,6	7,5	3,4	24,4	35,3
	27	8,92	59,8	7,0	2,7	14,2	23,9
	29	9,91	43,6	2,1	1,0	10,5	13,6
	31	10,88	50,0	3,7	0,2	10,2	14,1
	33	12,09	50,2	2,5	0,5	10,3	13,3
	35	13,81	45,0	1,5	0,0	11,7	13,2

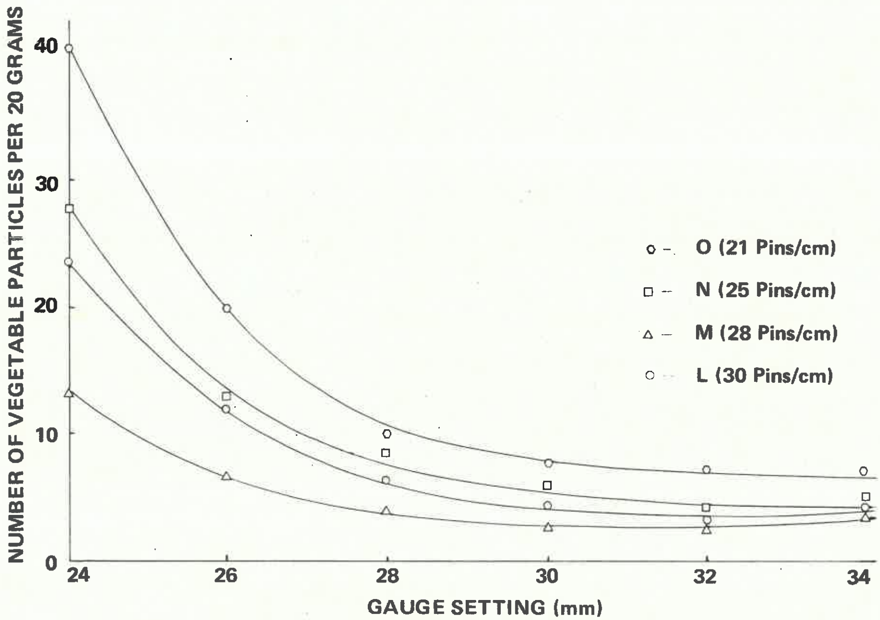

FIGURE 4

Number of Vegetable Particles per 20 grams versus Gauge Setting for different Top Combs (Wool B)

setting, due to the reduced control of floating fibres and neps behind the top comb.

If the ratio of vegetable particles longer than 3 mm to those shorter than 3 mm is taken as an indication of the relative efficiency with which these two types of particles are removed, then it is clear that particles longer than 3 mm are more readily removed at larger gauge settings than are shorter particles. This ratio decreased from 0,60 at 23 mm gauge setting to approximately 0,18 at 35 mm gauge setting for both top combs (see Table 4). From this table it is also clear that for an increase in gauge setting from 23 to 35 mm the number of particles longer than 3 mm decreased more than those shorter than 3 mm. The former decrease was 96% and the latter 85%. At large gauge settings, therefore, the short particles (generally referred to as bits) formed the major component of vegetable particles present in the top and proved to be the most difficult to remove.

The same tendency was observed in the case of wool B, but on average the ratio decreased from 0,25 to 0,12 only. This is clearly due to the relatively smaller number of vegetable particles longer than 3 mm that were originally present.

TABLE 5

THE EFFECT OF GILL-FEED ON THE IMPURITY CONTENT OF THE TOP FOR DIFFERENT GAUGE SETTINGS (WOOL A)

Gauge Setting (mm)	Gill-feed (mm)	Noil (%)	Production Rate (kg/hr)	Impurities per 20 grams				
				Neps	Vegetable Particles			
					> 3 mm <10 mm	>10 mm	<3 mm	Total
23	2,3	7,77	7,9	50,0	9,5	3,2	20,0	32,7
	2,9	7,71	8,9	49,8	16,6	3,4	21,9	41,9
	3,6	7,57	9,8	52,0	26,6	4,5	31,8	62,9
	4,2	7,60	11,0	64,5	34,1	8,1	44,6	86,8
25	2,3	8,45	8,0	54,0	7,6	1,6	16,3	25,5
	2,9	8,42	8,9	50,8	8,5	1,8	12,8	23,1
	3,6	8,41	9,9	51,2	10,8	1,8	19,4	32,0
	4,2	8,46	11,0	52,0	14,0	2,1	23,5	39,6
	5,0	8,48	12,3	49,0	25,1	3,1	37,5	65,7
27	2,3	9,50	8,0	58,0	3,9	0,7	11,8	16,4
	2,9	9,29	8,8	48,9	7,1	0,8	14,8	22,7
	3,6	9,25	9,9	48,7	6,1	1,8	15,1	23,0
	4,2	9,10	11,0	42,5	8,4	1,7	15,1	25,2
	5,0	9,25	12,2	35,0	8,0	1,7	18,3	28,0
	5,7	9,92	13,2	32,0	11,1	1,8	25,4	38,3
29	2,3	10,88	7,9	47,5	5,2	0,5	13,3	19,0
	2,9	10,65	8,9	45,0	5,3	0,5	13,8	19,6
	3,6	10,40	9,9	45,0	5,7	0,6	13,7	20,0
	4,2	10,25	11,1	37,6	6,8	0,7	14,5	22,0
	5,0	10,15	12,3	36,2	4,6	0,7	15,1	20,4
	5,7	10,35	13,2	36,0	4,7	0,9	16,5	22,1
	6,5	11,00	15,0	32,5	5,3	1,0	17,9	24,2

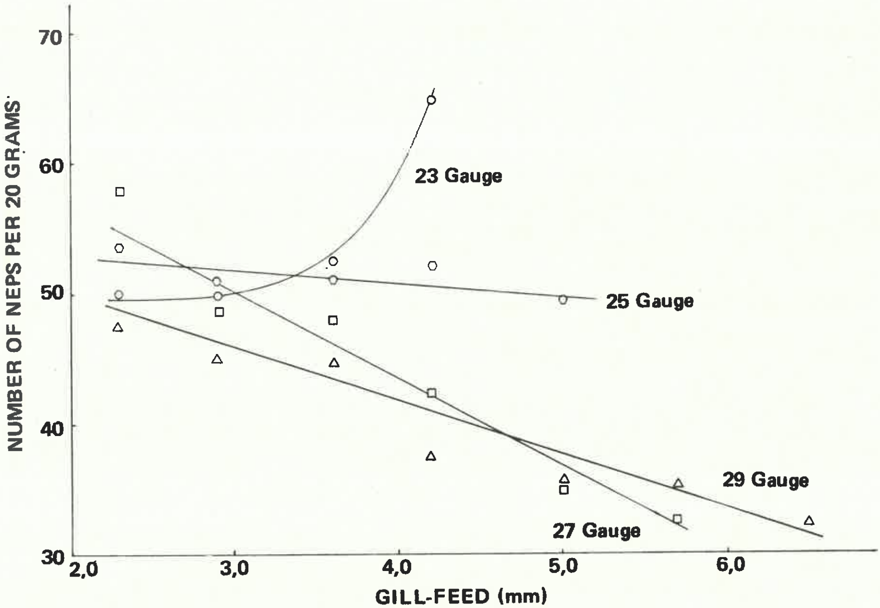

FIGURE 5

Number of Neps per 20 grams versus Gill-feed for different Gauge Settings (Wool A. Top Comb – M (28 pins/cm))

II EFFECT OF GILL-FEED

The graphs of the total number of neps and the total number of vegetable particles in the top versus gill-feed at different gauge settings are given in Figs. 5 and 6, and 7 and 8 for wools A and C, respectively. The graphs of percentage noil versus gill-feed are given in Fig. 9 for wool C. Similar results of percentage noil versus gill-feed were obtained for wool A as shown in Table 5.

The total number of vegetable particles (Figs. 6 and 8) increased with increasing gill-feed at all gauge settings, but the slope of the curves decreases with increasing gauge setting. Thus the effect of gill-feed on the number of vegetable particles decreased as the gauge setting increased until there was virtually no effect at gauge settings of 30 mm and higher. This is also true for the vegetable particles of different sizes as shown in Table 5. The selective removal, favouring the longer vegetable particles, noticed when the gauge setting was increased, did not occur with increasing gill-feed at a constant gauge setting. The ratio of the number of vegetable particles longer than 3 mm to those shorter than 3 mm remained approximately constant for different gill-feeds at constant gauge settings.

For both wools A and C the number of neps increased with increasing gill-feed at gauge settings of 22 and 23 mm (Figs. 5 and 7). For gauge settings of 24 and 25

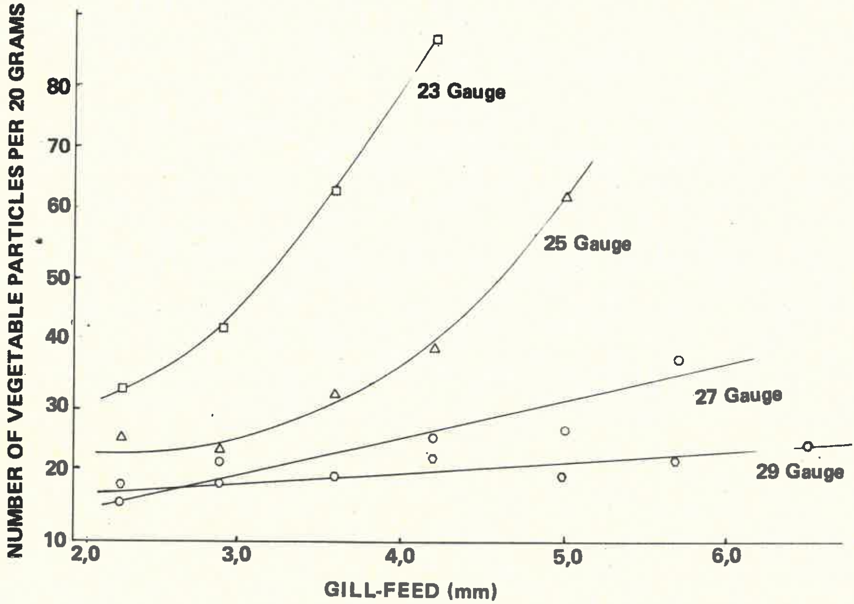

FIGURE 6

Number of Vegetable Particles per 20 grams versus Gill-feed for different Gauge Settings (Wool A. Top Comb – M (28 pins/cm))

(wool C, Fig. 7 and wool A, Fig. 5 respectively) the effect of gill-feed on the number of neps was relatively small, but there appeared to be a slight tendency to decrease with increasing gill-feed. At higher gauge settings (27 to 32 mm) the effect was more pronounced with a larger decrease in the number of neps.

To ensure that the complete length of each fibre is combed (by the comb cylinder and the top comb), the point of entry of the top comb into the fringe should be at least within the region of the fringe already combed by the comb cylinder. The further the point of entry of the top comb is moved backwards, the smaller will be the overlap between the two combing actions. The point of entry, and, therefore, the overlap, is controlled by the gill-feed (for a constant gauge setting). The higher the gill-feed, the smaller the overlap. For a constant gill-feed, however, the amount of overlap also decreases with a decrease in gauge setting. At small gauge settings such as 22 and 23 mm, and with an increase in gill-feed of above 2,3 mm, the amount of overlap becomes critically small. Under these conditions the point of entry of the top comb into the beard is such that impurities are present in front of the top comb before withdrawal. These impurities are then readily advanced into the combed sliver. Therefore, at the small gauge settings (22 and 23 mm) both the nep and vegetable particle contents of the top should

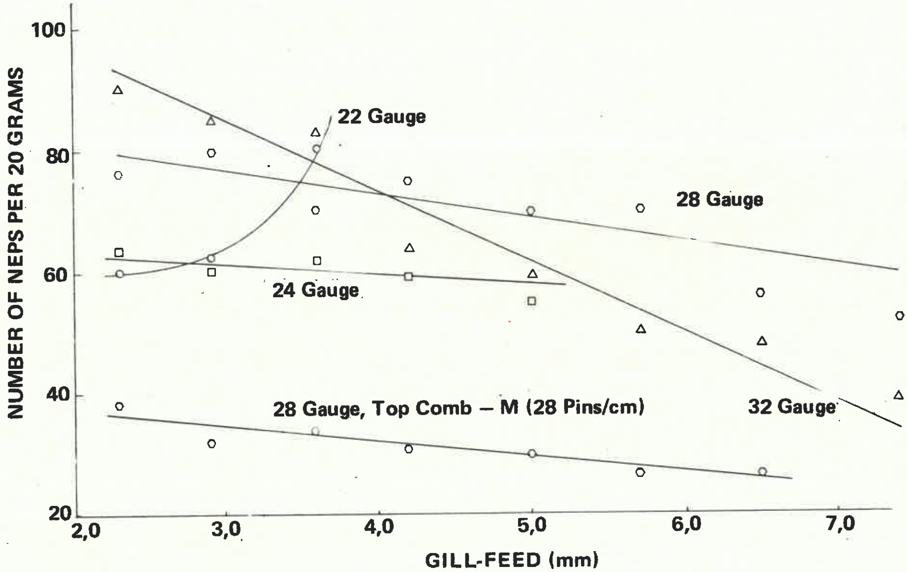

FIGURE 7

Number of Neps per 20 grams versus Gill-feed for different Gauge Settings (Wool C. Top Comb – N (25 Pins/cm))

increase with an increase in gill-feed due to the critical effect of gill-feed on the amount of overlap at these small gauge settings. This is, in fact, shown by Figs. 5, 6, 7 and 8.

Careful scrutiny of Figs. 5, 6, 7 and 8 reveals that for both neps and vegetable particles the average slope of the curves of these impurities versus gill-feed, decreases with increasing gauge setting. The difference is that, in the case of vegetable particles, the slope decreases more slowly and more persistently with increasing gauge setting.

Fig. 10 derives from Fig. 8 and gives the number of vegetable particles versus gauge setting for gill-feeds increasing from 2,3 mm to 5,0 mm. This set of graphs, which illustrates more clearly the effect of gill-feed shows that for gauge settings of below 28 mm, the gill-feed has a profound influence on the number of vegetable particles, whereas for gauge settings of above 28 mm the effect is negligible.

Regarding vegetable particles, the results are in line with those of Belin[1]. In the case of neps, however, Belin concluded that gill-feed had no effect on the nep content of the top, and stated that this was probably due to the high experimental error in counting neps in the top. Saxl[5] offered an equation for the calculation of a coefficient of cleanliness, and stated that if the gill-feed is increased, the gauge setting must also be increased to obtain tops of the same cleanliness. In doing so, a

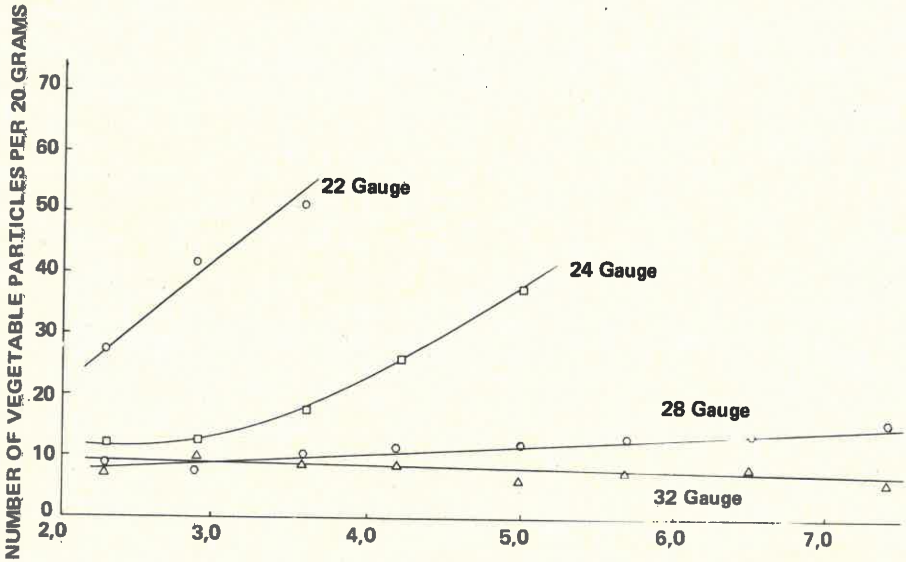

FIGURE 8

Number of Vegetable Particles per 20 grams versus Gill-feed for different Gauge Settings (Wool C. Top Comb – N (25 pins/cm))

constant overlap is achieved which, in turn, ensures that the fibres are subjected to the same amount of combing for different gill-feed and gauge setting combinations.

CONCLUSIONS

It was found that the number of vegetable particles invariably decreased with increasing gauge setting and that the use of different top combs only affected the general level of the vegetable particle content. In the case of neps, a decrease or an increase in nep content with increasing gauge setting was found, the deciding factor being the characteristics of the top comb. The results indicate that the use of an efficient top comb is a prerequisite for obtaining a decrease in nep content with increasing gauge setting. Whether a particular top comb will effect an increase or decrease in nep content with increasing gauge setting will depend on the characteristics of the top comb and on the characteristics of the neps and the wool. Top combs giving an increase in nep content with increasing gauge setting will, however, produce tops with nep contents of an unacceptable level, and will generally not be used. It is probably for this reason that it is generally accepted that the nep content decreases with increasing gauge setting.

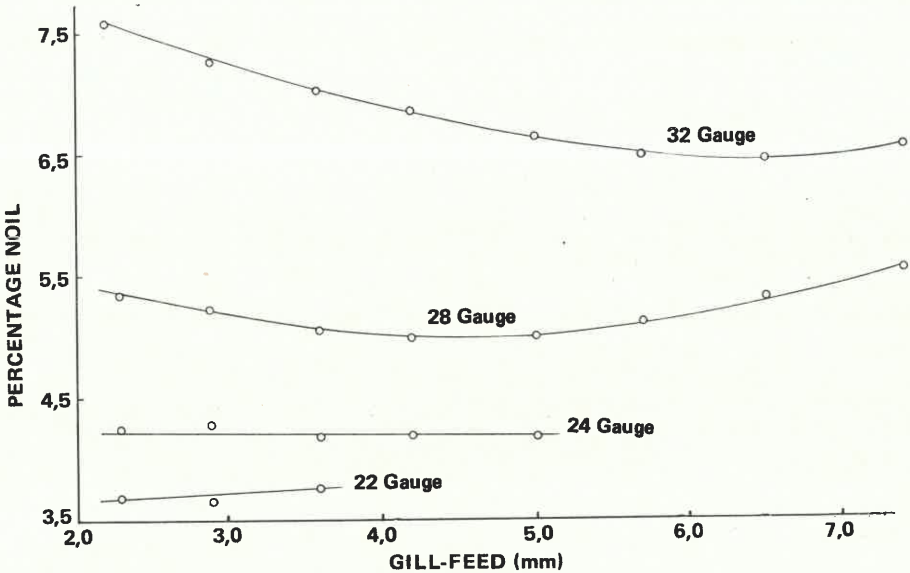

FIGURE 9

Percentage Noil versus Gill-feed for different Gauge Settings (Wool C)

For gauge settings of above 28 mm the improvement in the cleanliness of the top was relatively small and it is doubtful whether much is to be gained in this respect by the use of gauge settings above 30 mm. The slight improvement in cleanliness above 30 mm gauge will be more than counteracted by the increase in percentage noil and fibre breakage[6].

Considering the effect of gill-feed on the efficiency with which the comb removes impurities one must distinguish between neps and vegetable particles. It was only at very small gauge settings (22 and 23 mm) that the number of neps in the top increased with increasing gill-feed. For all other gauge settings the number of neps showed a tendency to decrease with increasing gill-feed. In the case of vegetable particles the tendency was to increase with gill-feed at all gauge settings. At gauge settings above 28 mm the effect of gill-feed on the number of vegetable particles in the top was, however, very small and can most probably be ignored.

The influence of gill-feed on the efficiency with which the comb removes impurities can, therefore, be divided into two categories – above 28 mm and below 28 mm gauge setting. At gauge settings above 28 mm the influence of gill-feed on the vegetable particles in the top was small and the neps tend to decrease with increasing gill-feed. In this range of gauge settings, it was, therefore, possible to use relatively large gill-feeds (5,5 to 7,0 mm) without deterioration of the cleanliness of the top, and which favours minimum noil[7] and higher production rates. At large gill-feeds it was, however, necessary to reduce the sliver mass per unit length to avoid overloading of the comb.

At small gauge settings (22 to 26 mm), large gill-feeds can have disastrous effects on the cleanliness of the top. For gauge settings in this range the results favoured the use of small gill-feeds. To maintain an adequate production rate and to compensate for the small gill-feeds, it was necessary to use slivers with a higher linear density.

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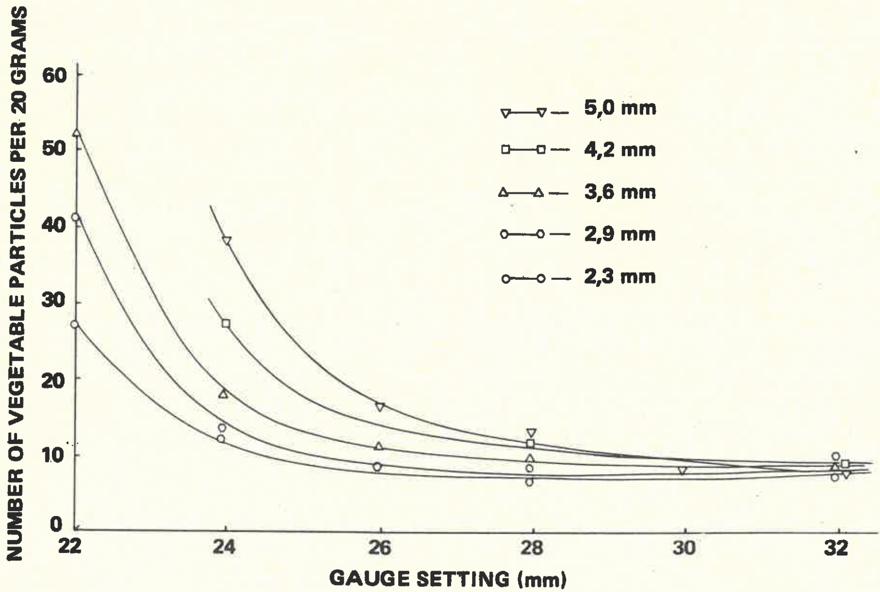

FIGURE 10

Number of Vegetable Particles per 20 grams versus Gauge Settings for different Gill-feeds (Wool C)

THE USE OF PROPRIETARY NAMES

The fact that chemicals and machines with proprietary names have been mentioned in this report, does not in any way imply that SAWTRI recommends them or that there are no substitutes which may be of equal value or even better.

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