SAWTRI TECHNICAL REPORT

NO 249

Scouring Conditions Part IV: The Effect of Liquor Temperature during Neutral Scouring on the Processing Performance of Fine Ciskei Fleeces

by

D. W. F. Turpie

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

P.O. BOX 1124
PORT ELIZABETH
REPUBLIC OF SOUTH AFRICA

ISBN 0 7988 0588 9

SCOURING CONDITIONS

PART IV
THE EFFECT OF LIQUOR TEMPERATURE DURING NEUTRAL SCOURING ON THE PROCESSING PERFORMANCE OF FINE CISKEI FLEECES

by D. W. F. TURPIE

ABSTRACT

Experiments were carried out to determine the effect of a restricted number of temperature variations in the liquors of the first, second and fourth bowls during neutral scouring on subsequent processing performance up to the top stage of Fine Ciskei fleeces. The temperatures selected were 60° and 65°C in the first bowl, 55°, 60° and 65° in the second bowl, and 45° and 50° in the fourth bowl. A mass of 100 kg greasy wool was scoured during each experiment.

It appeared from the results obtained that the wool selected was particularly difficult to scour. Nevertheless, satisfactory neutral scouring, carding and combing of this particular lot of wool could be achieved at temperatures of the liquors in the bowls of 65°, 60°, 50° and 45°C, initial charges of detergent to the first three bowls of about 0,1 0,02 and 0,02% m/v respectively, and subsequent additions to the first three bowls of about 0,40 0,15 and 0,05 (total 0,60) kg per 100 kg greasy wool.

KEY WORDS

Neutral scouring – greasy wool – temperature of the liquor – detergent – neps – percentage noil.

INTRODUCTION

This paper is the fourth of a series[1,2,3] in which the objective is to arrive at a set of scouring conditions which will affect subsequent mechanical processing most favourably.

In part III of this series[3] a preliminary study was made to determine the effect of liquor pH (using soda ash) and temperature on neps and percentage noil during conventional grease wool scouring to a residual grease content of 0,4 *per cent.* The amounts of wool used were small and no repeat experiments were undertaken. Unavoidable differences in scouring efficiencies placed certain restrictions on the conclusions. It was reported that when soda ash was used in the first bowl only, results favoured a pH of the liquor preferably not exceeding 9,5 and a temperature below 60°C. Where the resulting pH values of the aqueous extract of the scoured wool were too low, however, the results favoured pH adjustment of the liquor in the second bowl, which was considerably more economical. When no soda ash was used the results favoured a liquor temperature of 60/65°C.

As an extension of the work reported above it was decided to conduct further experiments on high temperature "neutral" scouring. Scouring with the aid of non-ionic detergents but *without the use of an alkali* is commonly referred to as "neutral" scouring. The pH of the scouring medium is not neutral to the fibre (isoelectric scouring[4]), nor is it frequently at pH 7, but will depend upon the pH of the suint salts contained on the wool. In one of the early neutral scourings a synthetic non-ionic detergent was used in conjunction with sodium chloride at a scouring temperature of about 70°C[5]. This high temperature gave rise to fairly unpleasant working conditions. Modified versions of this type of scouring followed, in which sodium carbonate or another alkali was added to the first scouring bowl and sodium chloride or other electrolytes were added to the subsequent scouring bowls together with the synthetic detergent[5,6]. These were actually modified versions of the conventional detergent-soda ash process. It was subsequently found that when a non-ionic detergent was used alone in a counterflowing system at 60° – 63°C it functioned more efficiently from the point of view of grease and dirt removal than it did in a non-ionic-sodium chloride scour at 70°C. It was claimed that the product was of superior appearance and its mechanical processing performance during its subsequent manufacture into tops was superior.

Broadly speaking, it has been claimed that scouring of raw wool in a neutral or acid medium requires from 50 to 100 *per cent* more detergent than scouring in an alkaline medium[7]. On the other hand, since recommended scouring temperatures are considerably lower (about 55°C) when alkali is present than when neutral scouring using a neutral salt (about 65°C), it has been claimed that approximately the same amount of detergent is normally required[8,9]. In certain cases (at temperatures below 60°C) neutral builders such as sodium chloride and sodium sulphate have little effect[5] but, in general, small additions of a neutral salt may be made with useful effect. The use of detergent alone, however, simplifies the process and reduces the possibility of corrosion of equipment. In the case of certain detergents it is claimed that, at little or no extra cost, the same effect may be produced simply by increasing the quantity of detergent[10].

Some interesting observations were made during studies on aqueous *jet scouring* with non-ionic detergents in neutral liquors, both with and without neutral builders, and using alkaline-soap liquors[11]. All systems reached maximum efficiency at treatment times of 1,5 to 3 minutes. The effects of temperature appeared to be greater than is generally recognised in industry and it was claimed that significantly more could probably be gained in existing plants by operating at higher temperatures. It was suggested that 65°C probably represented the maximum practical scouring temperature in ordinary scouring machines since heat losses are too great at higher temperatures. It was claimed that detergent efficiency was not reduced by a high level of contamination of the liquor and detergent consumption remained directly proportional to the mass of wool scoured. This was so even in cases where the grease concentration of the liquor had been allowed to build up to 10% and the detergent concentration to 0,5%[11]. It was suggested that the well-known improvement with time in the efficiency of soap liquors during the early part of a run, traditionally explained in terms of a build-up of suint, may possibly be attributed simply to an increase in the concentrations of soap and alkali[11]. Non-ionic detergent concentrations recommended for the scouring of high grease content wools in a four bowl scour may be around 0,3 g/*l* in the first bowl, 0,8 to 0,9 g/*l* in the second, and 0,1 to 0,2 g/*l* in the third bowl at liquor temperatures of 65°, 65° and 60 °C respectively[9,10] but will vary from one product to another. The *second* bowl is frequently regarded as the main scouring bowl and usually contains liquor of the highest detergent concentration.

In the present report the effect of certain temperature variations in bowls 1, 2 and 4 on the processing performance, up to the top stage, of Fine Native fleeces is discussed. As previously, it was possible to carry out only a limited number of experiments within the available budget.

EXPERIMENTAL

(a) Raw materials:

A twenty-two bale lot of 9/11 months Fine Ciskei fleece wool was selected for this investigation. The wool could be described as a type 169/A91 – in other words it had a character which might have enabled it to be shipped as a wool of average merino style. It appeared to be of excellent fineness, but it fact was over-crimped. The wool was relatively low yielding, the estimated yield being 48 *per cent* on a drycombed top and noil basis. The wool was carefully layer-blended, and vertical slices, each of mass 100 kg, were taken from the blend for each experiment. Altogether ten experiments were undertaken, and the remainder of the lot used for another project.

(b) Scouring:

The wool was scoured in a one-foot wide four-bowl Petrie & McNaught pilot scale scouring plant equipped with an automatic feed and a suction drum drier. Since publication of the previous three reports in this series, however, some modifications to the design of the first scouring bowl have been made. These permit liquor to be continuously removed from the bottom of the bowl through suitably placed valves. The liquor is pumped by means of a centrifugal pump to a small elevated tank, which acts as a "sludge catcher", overflows by gravity to the squeeze roller tank from where it is again circulated to the bowl. The modifications effectively prevent the accumulation of sludge at the bottom of the scouring bowl, and the sludge is "washed" during its passage to the sludge catcher. The effective capacity of the first bowl was 825 litres. A side settling tank was used in conjunction with the second scouring bowl, the total capacity being 1 300 litres. The capacities of the third and fourth bowls were 455 litres each. All squeeze rollers (each 300 mm wide) were set at a load of 2 000 kg . The speeds of all squeeze rollers and rakes were 6 r/min and 11 cycles/min, respectively. The temperature of the drier was thermostatically controlled at 70°C. The greasy wool was fed to the scouring train at a controlled rate of 80 kg/hr. During each experiment the feed was interrupted four times at specific intervals to await the results of grease tests and to make appropriate adjustments to the rates of addition of detergent.

All scouring bowls were fitted with industrial dip electrode systems and pH transmitters connected to a multipoint recorder, thus enabling the pH of the liquor in all the bowls to be monitored and recorded continuously. Bowls 1, 2 and 3 were also fitted with detergent reservoir tanks and automatic diaphragm metering pumps which enabled detergent to be added continuously to each of these bowls at predetermined rates.

The selected temperatures of the liquors in the various experiments were either 60° or 65°C in bowl 1 and 55°, 60° or 65°C in bowl 2; while that of the liquor in bowl 3 was constant in all experiments, *viz*. 50°C. A full set of experiments was carried out at a rinse liquor temperature of 45°C in bowl 4. A further four experiments at a rinse liquor temperature of 50°C, brought the total to ten.

The bowls were thoroughly cleaned and made up with fresh liquor for each experiment. The initial charges and supplementary additions of detergent will be referred to in the discussion of results. The detergent used was Berol Lanco (Berol Aktiebolag), a detergent of the non-ionic type. No auxiliary chemicals were used. The fourth bowl was used as a rinse bowl, fresh water being introduced at 400 *l*/hr during the scouring period and displacing an equivalent amount to waste. No backflow was used.

(c) Carding and combing:

Each lot of scoured wool was sprayed with 0,3% Topsol T40 (Price Ltd.) plus 0,02% Lissapol NX (I.C.I.) and sufficient water to increase the regain of the fibres to about 14 *per cent*. The wool was then allowed to condition at a relative humidity of 70 *per cent* and a temperature of 21°C for seven days before carding.

Carding was carried out on a double swift continental worsted card equipped with a breastworks, single morel and burr beater. The swifts and doffers were clothed with metallic wire and the auxiliary rollers with flexible clothing. Worker settings were increased progressively from 18 to 28 B.W.G. The card production rate was 15 kg/hr at a swift speed of 78 r/min.

Three gilling operations on an N.S.C. intersecting gill box followed carding. During the first operation the slivers were sprayed with water to increase the regain for combing to approximately 21 *per cent*. Successive drafts used were approximately 6, 6½ and 7 with the ratch set at 35 mm in each case.

Combing was carried out on a Schlumberger PB 26 comb at a gauge setting of 28 mm. A top comb of pin density 28 pins/cm and a segment of the Nitto Unicomb type suitable for use with 64's wool were used. Seven tests were performed to determine the percentage noil in each case.

(d) Testing:

Residual grease determinations were carried out on samples of the wool emerging from all four bowls of the scouring set. The samples were dried in "g" type cans of a C.S.I.R.O. Direct Reading Regain Tester until bone dry and their regain calculated. The hot, bone dry samples were each transferred into a small plastic bag and sealed. As soon as possible after this these samples were sub-sampled for the residual grease test. No correction was made for any slight change in mass of the samples due to exposure to the atmosphere during weighing. The test method used was the rapid column-and-tray method, using dichloromethane as solvent.

The mean fibre lengths of the tops were measured on an Almeter. Neps and vegetable particles were counted visually on a Toenniessen top testing machine using transmitted light. Three tests, each terminated after 150 total faults had been counted, were carried out on the card slivers. The same operator counted all the faults.

RESULTS AND DISCUSSION

The scouring conditions relevant to the *first* scouring bowl, together with the residual grease results obtained from the wool emerging from the squeeze rollers of the first bowl are given in Table I. Details of the temperature of the liquor, initial charge and subsequent additions of detergent are given.

TABLE I

SCOURING CONDITIONS IN THE *FIRST* SCOURING BOWL TOGETHER WITH RESIDUAL GREASE RESULTS PERTAINING TO THE WOOL EMERGING FROM THE FIRST BOWL SQUEEZE ROLLERS

Experiment No.	Temperature of liquor in Bowl 1	Initial charge of detergent to Bowl 1 (g)	Detergent addition to Bowl 1 during the scouring of 100 kg greasy (g)	Residual grease on wool emerging from Bowl 1 (%)
2	60°C	230	850	6,0
9		230	840	5,0
6		230	860	5,8
10		230	870	5,5
		230	860	5,6
4	65°C	230	770	6,4
8		230	770	5,0
12		230	750	6,1
13		230	750	5,6
		230	760	5,8
18	65°C	520	410	3,5
7	65°C	1040	350	2,1
14		1040	320	2,7
		1040	340	2,4

When the initial charge of detergent to the first scouring bowl was 230 g (0,028% m/v), the temperature of the liquor was 60°C, and additions of detergent made amounting to 860 g, the wool emerged from the squeeze rollers with an average residual grease content of 5,6 *per cent.* This rate of addition to the *first bowl only* was considered high (0,86 kg per 100 kg greasy wool). Even so, the residual grease content on the wool appeared to be unsatisfactorily high. When the temperature of the liquor was 65°C, and the initial charge of detergent was maintained constant at 230 g there appeared to be little improvement in the amount of detergent addition required to produce a similar residual grease level on the wool

TABLE II

SCOURING CONDITIONS IN THE *SECOND* AND *THIRD* SCOURING BOWLS TOGETHER WITH RESIDUAL GREASE RESULTS PERTAINING TO THE WOOL EMERGING FROM THE SQUEEZE ROLLLERS OF THE SECOND, THIRD AND FOURTH BOWLS

Range of residual grease on wool emerging from Bowl 1 (%)	Experiment No.	Temperature of liquor in Bowl 2 (°C)	Initial charge of detergent to Bowl 2 (g)	Detergent additions to Bowl 2 during the scouring of 100 kg greasy (g)	Residual grease on wool emerging from Bowl 2 (%)	Temperature of liquor in Bowl 3 (°C)	Initial charge of detergent to Bowl 3 (g)	Detergent additions to Bowl 3 during the scouring of 100 kg greasy (g)	Residual grease on wool emerging from Bowl 3 (%)	Residual grease on wool emerging from Bowl 4 (%)
5,0 to 6,4	2*	55	210	330	1,4	50	78	60	0,90	0,83
	9*		210	350	1,1			60	0,60	0,67**
	4		210	400	1,1			60	0,80	0,64
	8		210	330	1,0			60	0,57	0,43**
		Average	210	350	1,2		Average	60	0,72	0,64
	6*	60	210	270	1,3	50	78	60	0,86	0,64
	10*		210	280	1,0			60	0,57	0,44**
	12		210	230	1,1			60	0,62	0,53
		Average	210	260	1,1		Average	60	0,68	0,54
	13	65	210	100	1,3	50	78	50	0,53	0,41
3,5	18	60	210	120	1,0	50	78	60	0,52	0,42
2,1 to 2,7	7	55	210	120	0,8	50	78	20	0,56	0,43
	14	60	210	100	1,0			60	0,46	0,53

*Liquor temperature in first bowl 60°C. (All others 65°C).

**Rinsed at 50°C. (All others 45°C).

as before. This was clearly an exceptionally difficult wool to scour and it was, therefore, decided to try increasing the *initial* concentration of detergent while maintaining the liquor temperature at 65°C. The results show that when the initial charge of detergent was increased to 520 g (0,063% m/v) the residual grease on the wool emerging from the squeeze rollers of the first bowl was significantly reduced to 3,5 *per cent* in spite of the additions being almost halved (0,41 kg per 100 kg grease wool). Furthermore, when the initial charge of detergent was increased to 1 040 g (approx. 0,13% m/v) a further significant improvement in the residual grease content of the wool to 2,4 *per cent* took place and additions were again slightly lower (approx. 0,34 kg per 100 kg grease wool).

It is clearly important for the residual grease content of the wool emerging from the first bowl not to be too high so that the liquor in the second bowl does not become too contaminated. Ideally, the wool should be scoured progressively without underscouring or overscouring in any one bowl. As far as the *first* scouring bowl is concerned it would appear that an initial charge of detergent of somewhere between 0,06 and 0,13 *per cent* m/v together with additions amounting to about 0,37 kg per 100 kg greasy would have produced and acceptable level of scouring in this particular case at 65°C. It should be pointed out, however, that such a high initial concentration of detergent in the *first* bowl liquor of a four bowl set is unusual.

The scouring conditions relevant to the subsequent scouring bowls, together with the residual grease results obtained from the wool emerging from the squeeze rollers of the various bowls, are given in Table II. Details are given of the temperature of the liquors, initial charges and subsequent additions of detergent. It should be noted from the table that in all cases the initial charge of detergent to the *second* bowl was 210 g (0,016% m/v) and that the detergent additions were made at a rate which would produce a residual grease content of the wool emerging from the squeeze rollers of about one *per cent.* It should also be noted that in *all* cases the initial charge of detergent to the *third* bowl was 78 g (0,017% m/v) and that in *most* cases the additions were held constant.

The effect of the temperature of the liquor in the second bowl on the amount of detergent addition required to produce a similar residual grease level on the wool is clearly evident from the results shown in the table. For wool entering the second bowl with a residual grease content in the range 5,0 to 6,4 *per cent,* detergent additions could be reduced from approximately 0,35 kg/100 kg greasy at a liquor temperature of 55°C to approximately 0,26 kg/100 kg greasy at a liquor temperature of 60°C and 0,10 kg/100 kg greasy at a liquor temperature of 65°C. For wool having a residual grease content in the range 2,1 to 3,5 *per cent* on entering the second bowl the detergent additions required were significantly lower than that required at similar temperatures when the residual grease content of the wool entering the bowl was in the range 5,0 to 6,4 *per cent.* From a practical point of view, however, it did not seem to make much difference

TABLE III

CARDING AND COMBING RESULTS

Range of residual grease on wool emerging from Bowl 1 (%)	Experiment No.	Temperature of liquor in Bowl 2 (°C)	Percentage Noil	Mean fibre length of top (mm)	Percentage of short fibre in top (<25 mm)	Neps/20 g after carding	Vegetable particles/20 g after 3 gillings
5,0 to 6,4	2*	55	8,4	62,3	5,3	78	254
	9*		9,1**	61,8	5,3	89	296
	4		9,2	61,7	5,1	80	244
	8		9,0**	62,0	5,7	89	243
		AVERAGE	8,9	62,0	5,4	84	259
	6*	60	8,9	62,8	4,6	85	257
	10*		8,8**	62,1	5,2	79	299
	12		9,7	62,6	4,7	139	265
		AVERAGE	9,1	62,5	4,8	101	274
	13	65	9,3	63,4	3,9	96	222
3,5	18	60	9,5	64,2	3,3	121	269
2,1 to 2,7	7	55	9,3	61,7	5,2	71	245
	14	60	9,5	65,7	3,1	109	248

*Liquor temperature in first bowl 60°C. (All others 65°C)
**Rinsed at 50°C. (All others 45°C)

whether the temperature of the liquor was 55° or 60°C. Detergent additions in these cases were made at a rate varying from 0,1 to 0,12 kg/100 kg greasy wool.

Taken in pairs, experiments 9, 8 and 10 were similar to experiments 2, 4 and 6 respectively in every respect except that for the former the rinsing temperature was 50°C instead of 45°C. It will also be seen from the table, however, that by coincidence the residual grease contents of the wools emerging from the squeeze rollers of bowls 1, 2 and 3 were *all* lower in the former case than in the latter. This coincidence makes it impossible to asses the effect of a higher rinsing temperature on residual grease levels of the wool emerging from the squeeze rollers of the fourth bowl.

Carding and combing results are given in Table III. The influence of the temperature of the liquor in the *first* bowl can be seen by comparing the results with and without an asterisk in the first two blocks of results in Table III. These show that both the nep count after carding and the percentage noil were marginally lower when the temperature of the liquor in the first bowl was at 60°C than it was at 65°C. There was, however, no apparent change in the mean fibre length of the top or the percentage of short fibre. The influence of the temperature of the liquor in the *second* bowl can be seen by comparing the results in the ranges of residual grease on the wool emerging from bowl 1 of 5,0 to 6,4% and 2,1 to 2,7%. It appears from these results that higher temperatures of the liquor in the second bowl caused marginal increases in the nep count after carding and in the percentages of noil obtained. These results were accompanied by better results for mean fibre length and percentage of short fibre in the top. Such marginal changes in neps, percentage noil, mean fibre length of the top and percentage short fibre in the top were probably the result of marginal changes in combing efficiency due to, for example, the differences in residual grease content of the different lots. Had the comb been set for say, 5 *per cent* of short fibre to remain, it is clear that the marginal trends for percentage noil and mean fibre length of the top would then most probably have been of no significance. It is, therefore, not possible from these results to conclude that the use of higher temperatures, in the range 60° to 65°C in the first bowl and 55° to 65°C in the second bowl is detrimental to the combing performance of the wool. The temperature of rinsing i.e. 45° or 50°C had no apparent effect on subsequent carding and combing performance.

The pH of the liquor in the bowls was between 8,0 and 8,5 at the commencement of each experiment. These values drifted slowly towards approximately 7,4 in the first bowl, 7,7 in the second bowl, 7,8 in the third bowl and 8,0 in the fourth bowl during the course of each experiment. These results indicated that the suint was acidic, and may have accounted partly for the difficulty encountered in the first scouring bowl although it is also possible that this particular type of wool contained a high proportion of 'oxidised' grease.

SUMMARY AND CONCLUSIONS

Experiments were carried out to determine the effect of a restricted number of temperature variations in the liquors of the first, second and fourth bowls during neutral scouring on subsequent processing performance up to the top stage of Fine Ciskei fleeces. The temperatures selected were 60° and 65°C in the first bowl, 55° 60° and 65°C in the second bowl and 45°and 50° C in the fourth bowl. A mass of 100 kg greasy wool was scoured during each experiment.

It was found that an initial charge of detergent to the first bowl of about 0,03 *per cent* m/v together with subsequent additions of about 0,9 kg/100 kg greasy wool produced an unsatisfactorily high residual grease level. There did not appear to be much improvement by increasing the temperature of the liquor from 60° to 65°C. Further results showed that acceptable scouring could result from using an unusually high initial detergent concentration of between 0,06 and 0,13% m/v, and a liquor temperature of 65°C. Furthermore, additions could be reduced to about 0,4 kg/100 kg greasy wool.

An initial charge of detergent to the *second* bowl of about 0,02 *per cent* m/v together with subsequent additions of from 0,1 to 0,35 kg/100 kg greasy wool resulted in satisfactory scouring in all cases. The amount of the addition was dependent on the range of the residual grease content of the wool entering the second bowl, and on the temperature of the liquor. When the residual grease content of the wool was in the range of about 5 to 6 *per cent* detergent additions were as high as 0,35 kg/100 kg greasy at a liquor temperature of 55°C but decreased sharply to 0,1 kg/100 kg greasy when the liquor temperature was increased to 65°C. When the residual grease content of the wool was in the range of about 2 to 3 *per cent* the additions were insensitive as to whether the liquor temperature was 55° or 60°C, and were significantly lower than when the residual grease on the wool was in the higher range for similar liquor temperatures.

The initial charge of detergent to the *third* bowl was about 0,02 *per cent* m/v in all experiments and subsequent additions were made at the rate of about 0,05 kg/100 kg greasy. Under those conditions scouring was satisfactory, and after rinsing in the fourth and final bowl the various lots emerged with an average residual grease level of around 0,5 *per cent.*

Marginal differences in neps, percentage noil, mean fibre length of the top and percentage of short fibre in the top were observed in the various experiments. These were probably the result of marginal changes in combing efficiency due, for example, to the unavoidable slight differences in residual grease content of the different lots. It was, therefore, not possible to conclude that the use of higher temperatures in the first and second bowls (65°C and 60°C respectively) was detrimental to the combing performance of the wool. Furthermore, the temperature of rinsing i.e. 45° or 50°C had no apparent effect.

It appeared that satisfactory neutral scouring, carding and combing of the particular Fine Ciskei fleeces investigated could be achieved with temperatures of the liquors in the four bowls of 65°, 60°, 50° and 45°C, initial charges of detergent to the first three bowls of about 0,10 0,02 and 0,02% m/v respectively, and subsequent additions to the first three bowls of about 0,4 0,15 and 0,05 (total 0,60) kg/100 kg greasy wool respectively.

ACKNOWLEDGEMENTS

The author wishes to thank the staff of the Departments of Scouring, Carding and Combing for technical assistance. Thanks are also due to the National Association of Woolwashers and Carbonisers of South Africa and the S.A. Wool Combers' Trade Association for authorising the publication of this report.

THE USE OF PROPRIETARY NAMES

The fact that proprietary names have been mentioned in this report does not in any way imply that SAWTRI recommends them or that there are not substitutes which may be of equal value or better.

REFERENCES

1. Turpie, D. W. F., Scouring Conditions, Part I: The Effect of Liquor pH during Backwashing on the Subsequent Combing Performance of Neutral Scoured Wool, *S. African Wool & Text. Res. Inst.* Techn. Rep. No. 191 (1973).
2. Turpie, D. W. F., Scouring Conditions: Part II: The Effect of Rinsing at Different Liquor pH Values during Scouring on the Subsequent Combing Performance of Wool, *S. African Wool & Text. Res. Inst.* Techn. Rep. No. 193 (1973).
3. Turpie, D. W. F., Scouring Conditions, Part III: A Preliminary Study on the Effect of pH and Temperature during Grease Wool Scouring on Neps and Percentage Noil, *S. African Wool & Text. Res. Inst.* Techn. Rep. No. 224 (1974).
4. Borghetty, H. C., Wool Scouring Procedures, *Am. Dyestuff Reporter* **44**, 21, p.726 (1955).
5. McNamara, E. J., Jr., The Practical Aspects of Neutral Grease Wool Scouring, *Am. Dyestuff Reporter* **46**, p731 (1957).
6. Hepworth, J. A., The Scouring of Wool with Synthetic Detergents, *J. Soc. Dyers & Col.* **66**, 101 (1950).
7. Rösch, M., Raw Wool Scouring Agents, "Interwool 71". First Int. Conf. on Wool Scouring, Brno, p110 (1971).
8. Shell Chemicals Technical Bulletin ICS(X)/67/18.
9. Shell Chemicals Technical Bulletin CMKS(X)/72/1.
10. Shell Chemicals Technical Bulletin IC:63:34.
11. Anderson, C. A. and Wood, G. F., Aqueous Jet Scouring of Raw Wool, Part IV: Time, Temperature, and Concentration Effects with Various Detergent Systems, *J. Text. Inst.* **57**, T545 (1966).

Published by
The South African Wool and Textile Research Institute
P.O. Box 1124, Port Elizabeth, South Africa,
and printed in the Republic of South Africa
by Nasionale Koerante Beperk, P.O. Box 525, Port Elizabeth.

ISBN 0 7988 0588 9