SAWTRI BULLETIN

WU4/F1113

SOUTH AFRICAN
WOOL TEXTILE RESEARCH INSTITUTE
OF THE CSIR

P.O. BOX 1124
PORT ELIZABETH

INSTITUTE NEWS

New Processing Tariffs

Recently new tariffs for the processing of special lots of wool for the industry were introduced.

The new tariffs which came into effect on January 1st are as follows:

Washing, Carding and Combing		40c per Kg
Recombing		20c per Kg
	90 tex	28 tex
Drawing and Spinning	30 c per Kg	55c per Kg
Spinning only	20c per Kg	40c per Kg
Folding	8c per Kg	12c per Kg
Spinning (lots smaller than 3 Kg)	25c per Kg	50c per Kg

The cost of processing yarns of linear densities between 90 tex and 28 tex will be calculated at an approximately proportional rate.

Further Developments on Solvent Dyeing at SAWTRI

Following the publication of a preliminary report on the dyeing of wool from a charged solvent system (SAWTRI TECHNICAL REPORT NO. 137) satisfactory progress has been made in this field.

Initially, some 60% of the conventional dyestuffs used in the new solvent dyeing process could be applied successfully. This percentage, in the case of reactive dyes, has now been appreciably increased. Whereas, at the beginning of the project, the achievements were limited to pastel and medium shades, it is now possible to dye to heavy shades.

As a result of the work carried out at SAWTRI, the I.W.S. requested the Institute to send one of its senior scientists, Mr. J. P. van der Merwe, Head of the Dyeing and Finishing Division, to Augsburg, Germany to participate in discussions on further developments of this new process with IWS officials, Messrs. Böhler and Weber and representatives of the Deutsches Wollforschungsinstitut in Aachen. Certain aspects of research in this field were discussed. During his stay in Germany Mr. van der Merwe also carried out dyeing trials using a prototype solvent dyeing machine, developed by Messrs. Böhler and Weber. This machine is equipped with heating facilities and a high speed emulsifier which, it is hoped, will reduce the quantities of emulsifier at present being used in the new process. SAWTRI has placed an order for one of these machines and delivery is expected in June.

While abroad, Mr. van der Merwe also had talks with scientists at the IWS technical centre, Ilkley, United Kingdom, on various aspects of Dyeing and Finishing.

"Sympotex '71"

The South African Dyers' and Finishers' Association are organizing a symposium, "Sympotex '71", to be held in Port Elizabeth on September 24th and 25th. The venue for "Sympotex '71" is the Auditorium of the University of Port Elizabeth.

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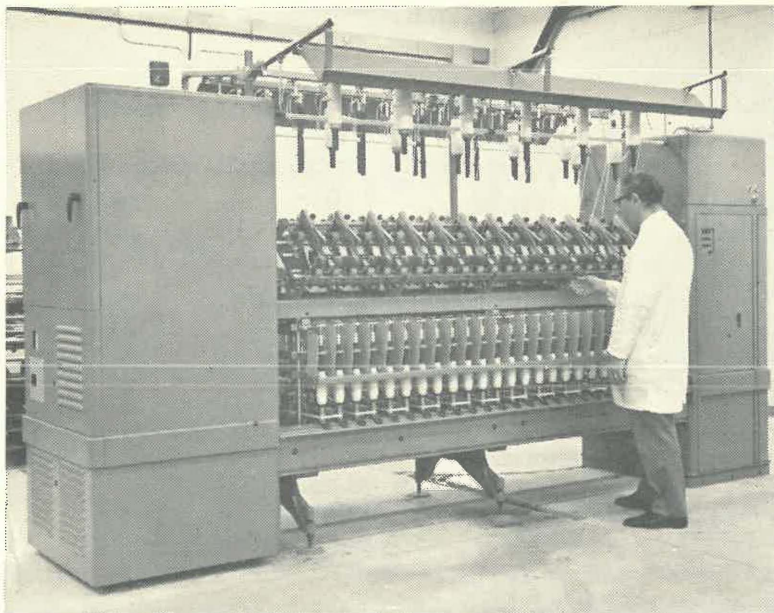
SAWTRI'S new Riter Ring Spinner with Mr. S. Marsland, Technical Officer in charge of Spinning looking on.

The Symposium is to be a follow-up of the International Textile Machinery Exhibition (ITMA) taking place in Paris during June of this year. This is a four-yearly event. It is important that South African dyeing and finishing technicians be informed of the latest developments in machinery and processing trends but, unfortunately, only a limited number of them are able to view overseas exhibitions. It is the purpose of "Sympotex '71" to supply these technicians with the latest, first-hand information.

Overseas as well as South African authorities on dyeing and finishing will read papers and lead discussions. Should "Sympotex '71" prove to be a success, it will become a regular South African event after each ITMA in Europe.

The symposium fee is R20.00 per person. Further details are obtainable from the Secretary, "Sympotex '71", P.O. Box 272, Bellville, C.P.

Director for the Far East

Professor D. P. Veldsman, Director of SAWTRI and Head of the Department of Textile Science of the University of Port Elizabeth, left for Japan on the 10th of March to study any problems the Japanese Wool Textile Industry may encounter with South African wool. Japan is one of the most important buyers of South

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African wool and it is therefore of national importance that where the South African Wool Textile Research Institute is able to be of service to the Japanese textile industry it must be effected as soon as possible.

While in Japan, Dr. Veldsman will visit the Product Development and Technical Departments of the International Wool Secretariat as well as wool processing factories. He will, on certain of these occasions, give lectures on the most important research achievements at SAWTRI.

On his return journey Dr. Veldsman will attend the first 1971 meeting of the Research and Development Committee of the IWS in Sydney, Australia.

The SAWTRI/Wool Board Coordinating Committee met at the CSIR in Pretoria on March 5th.

The Research Advisory Committee meets at SAWTRI on April 7th to discuss the 1971/72 budget and the Director's Research Progress Report. The Director will also report on decisions taken at the Sydney meeting of the I.W.S. Research and Development Committee and which are relevant to SAWTRI's research activities. The April meeting of the R.A.C. will be the last to be attended by Dr. E. G. Carter, Director of Research of the International Wool Secretariat due to his retirement from this position. Dr. G. Laxer has been nominated to succeed Dr. Carter on the Research Advisory Committee.

Meetings and Addresses

At the annual convention of the Chemical Institute in Grahamstown the Director read a paper on "New developments in the dyeing and finishing of keratin fibres" and acted as chairman for the fibre seminar on the morning of February 4th. He also read a paper at a Symposium at the Döhne Research Station near Stutterheim on February 23rd.

Dr. P. J. Kruger attended a meeting of the Advisory Committee on Wool Production of the Department of Agricultural Technical Services in Middelburg on February 23rd.

On February 17th, the Director presented his Annual Report to the Council for Scientific and Industrial Research in Pretoria.

Mr. G. B. Moore, General Secretary of the Textile Institute paid a visit to the Institute on December 9th, 1970, and addressed the staff on the work of the Textile Institute outlining the requirements for membership. On the same occasion, Mr. Moore presented Dr. P. J. Kruger with his certificate of Fellowship of the Textile Institute. After detailed discussions with Mr. Moore, it was decided to apply to the Textile Institute Council to exempt textile students at the University of Port Elizabeth who have passed their B.Sc. (Textiles) examination, from writing the examinations required to become Associate Members of the Textile Institute.

The Director made his annual round of members in the Eastern Cape paying visits to Messrs. Cyril Lord, Marine Knitting Mills and Esludo Mills in East London and wool washing factories at Toise River and Kubusie.

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Dr. P. J. Kruger (right) receiving his Certificate of Fellowship
of the Textile Institute from Mr. G. B. Moore

During February, Dr. P. J. Kruger paid visits to a number of manufacturers of synthetic fibres and subsequently addressed SAWTRI staff members on his impressions.

Director to serve on Wool Board for a further two year period
The State President has appointed Dr. Veldsman to the Wool Board for a further two years representing the following organisations:

The South African Wool Textile Council;
The South African Wool Washers and Carbonizers Trade Association;
The South African Worsted Manufacturers Trade Association;
The South African Wool Combers Association; and
The National Textile Manufacturers Association.

Visits and Visitors
During the period following the previous issue of the "Bulletin" SAWTRI received visits from a number of persons. On February 3rd, Mr. Alexander D. Forbes, a wool farmer from Scotland and a Nuffield Farming Scholar was shown around the Institute.

Prof. K. Kuhn of the Max Planck Institute in Germany, while in South Africa for the Chemical Convention in Grahamstown, paid a brief visit to SAWTRI discussing matters of mutual interest with Drs. van Rensburg and Hanekom on February 5th.

Mr. Walter Willich of Messrs. Kulenkampff and Kotinzky in Bremen, Germany visited the Institute on February 17th. Mr. Willich, whose firm is engaged in top making showed a keen interest in the Carding and Combing Department.

The Scientific and Geographical Society of the Alexander Road High School organised a visit by thirty scholars to the Institute on February 18th.

Two members on the Mohair Council of the United States of America, Messrs. Walter Pfleuger and Noel Fry, accompanied by Mr. David Uys of the Mohair Board were taken through the Institute on February 24th. They spent some time discussing the use of mohair in co-we-nit fabric construction with Mr. Alan Robinson, Head of the Weaving Department.

Staff Matters

The following staff members were promoted at the beginning of 1971: Dr. T. Haylett — Senior Chief Research Officer; Drs. N. J. J. van Rensburg and L. S. Swart — Chief Research Officers; Dr. E. C. Hanekom and Messrs. I. M. Hunter and E. Weideman — Senior Research Officers; Mr. S. Smuts — Research Officer; Mr. K. Schröder — Chief Technician; Mr. J. A. Benecke — Principal Technician. Mr. J. Klazar has been promoted to Head of Machine Development as from March 1st.

A number of new appointments have been made. Two of the first three textile students to graduate in Textile Science from the University of Port Elizabeth at the end of 1970, Messrs. G. Buys and H. Silver who has received a merit award from the University of Port Elizabeth, have been appointed to the staff in the departments of Knitting, and Dyeing and Finishing respectively. The third graduate, Mr. G. van der Walt is employed by the Wool Board in their Technical Services Department.

In the Textile Physics Division three new appointments have been made. They are Mr. R. N. Taylor, a textile engineer, Senior Research Officer, and Messrs. G. L. Anderson and R. W. van Heerden, Technician and assistant technician, respectively. Messrs. P. C. Coleman and G. W. P. de Mattos, CSIR bursars, have joined the staff of Protein Chemistry as Assistant Research Officers. Mr. D. B. van Rooyen, formerly of the College of Advanced Technical Education has been appointed Assistant Research Officer (Statistics). Messrs. A. L. W. Jonas and B. C. Fisher, Senior Technicians, have joined the workshop staff.

Mrs. H. Minderon, a former staff member in the typing office has returned to assume duties as receptionist/telephonist.

Mr. R. I. Slinger, Chief Research Officer, has successfully submitted a thesis: "The Influence of Fabric Geometry and certain Fibre Parameters on the Mechanical Properties of Wool Worsted Fabrics" to the University of Port Elizabeth and will receive his Ph.D. on April 1st.

Mr. G. A. Robinson, Chief Technical Officer, will receive an M.Sc. degree from the University of Port Elizabeth on April 1st having successfully completed a thesis: "A Study of Weft Skewing in Wool/Worsted Fabrics."

The SAWTRI/Wool Board Coordinating Committee met at the CSIR in Pretoria on March 5th.

SAWTRI PUBLICATIONS

The following publications have appeared since the December issue of the "Bulletin":

Technical Reports:
No. 145 : Aldrich, de V.: The Combing Performance of Different Types of Comb Cylinders for Rectilinear Combs.

Papers published in Local and Overseas Journals:
King, N. and Kruger, P. J.: Preliminary Results on the Elastic Moduli of Wool, Mohair and Kemp Fibres by Ultrasonic Pulse Techniques, *Text. Res. J.* **40** (10) 865–872 (Oct. 1970).

Slinger, R. I.: The Evaluation of Yarn and Fabric Quality, S.A. *Textiles,* **20** (1) 35–39 (Jan. 1971).

Kruger, P. J.: The Measurement of Fibre Entanglement in Scoured Wool, *J. Text. Inst.* **62**, 1, (January, 1971).

Accepted for Publication
The following papers have been accepted for inclusion in the Proceedings of the Fourth Quinquennial Wool Textile Research Conference, California, August 1970 in *J. of Polymer Science:*

Kruger, P. J. and Aldrich, de V.: Rectilinear Combing of Wool;

Haylett, T., Swart, L. S., Parris, D. and Joubert, F. J.*: The Primary Structure of some High Sulphur Proteins of Reduced Wool.

Veldsman, D. P., and Swanepoel, O. A.: The Effect of Reaction Rate on the Shrinkproofing of Wool with DCCA.

Swanepoel, O. A.: Reaction between Reactive Dyestuffs and Urea during Wool Dyeing.

Boshoff, M. C.**, and Kruger, P. J.: The Mikronmeter — An Instrument for the Rapid Determination of Mean Fibre Diameter, *Text. J.*

*National Chemical Research Laboratory, Pretoria.
** National Physical Research Laboratory, Pretoria

A STUDY OF THE VARIATION IN DOUBLING TWIST OF WOOL WORSTED HOSIERY YARNS

by I. M. HUNTER

ABSTRACT

The variation in doubling twist, at different gauge lengths, of a range of commercial twofold wool worsted hosiery yarns has been determined and average values for the Coefficient of Variation of doubling twist have been obtained.

KEY WORDS

doubling twist, variation, average values, hosiery yarns.

INTRODUCTION

On several occasions enquiries have been received from the knitting and spinning industries concerning the twist characteristics, and especially the variation in doubling twist, of twofold hosiery yarns. Since no data of "normal" or "average" values were available with which the values obtained for the coefficient of variation (C.V.) of doubling twist could be compared and since it was felt that undue variation in twofold twist could have an adverse effect on the appearance of the knitted fabric, it was decided to conduct a survey of the doubling twist of a range of commercial twofold wool worsted hosiery yarns.

The aim of this investigation was, therefore, to determine the variation in doubling twist, at different gauge lengths, of a range of yarns obtained from industry, and to relate the C.V.'s so obtained to the mean doubling twist and yarn count. This would enable "normal" or average values for the C.V. of doubling twist to be established which could be used as a guide by the knitting and spinning industries.

EXPERIMENTAL

Forty-seven wool worsted hosiery yarns of various shades and ranging in count from R230 tex/2 to R30 tex/2 were used in this investigation.

The doubling twist of the yarns was determined on a Goodbrand manually operated twist tester at gauge lengths of 2.5 cm (50 tests per cone), 5 cm (50 tests per cone), and 25 cm (10 tests per cone), respectively. The doubling twist was also determined manually on a Zweigle Automatic Twist Tester at gauge lengths of 50 cm and 1 metre, respectively, 15 tests being carried out per cone in this case.

From the results so obtained the C.V. of doubling twist at each gauge length as well as the overall mean doubling twist, in turns per metre (t.p.m.) were calculated.

The yarn count, in tex units, was calculated from the weight of 100 metres of yarn.

RESULTS AND DISCUSSION

In Figs. 1 to 5 the C.V. of doubling twist has been plotted against mean doubling twist for the different gauge lengths.

At gauge lengths of 2.5 cm and 5 cm (Figs. 1 and 2) the C.V. of twist is a quadratic function of the mean doubling twist with a minimum at approximately 210 t.p.m. The scatter of the points is, however, so large that such a minimum is not immediately obvious. Quadratic curves, have been fitted to the points in Figs. 1
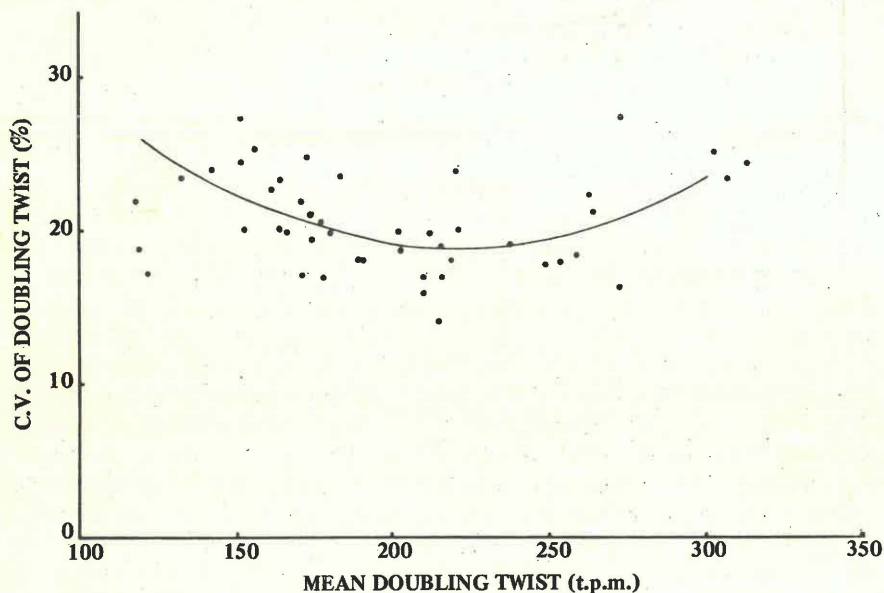

FIGURE 1

Relationship between C.V. of doubling twist and mean doubling twist
(Gauge length: 2.5 cm)

and 2. From Figs. 3 to 5 it is apparent that, at gauge lengths of 25 cm, 50 cm and 1 metre, respectively, the C.V. of doubling twist is independent of mean doubling twist. A straight line of zero slope, representing the average C.V., has therefore been superimposed onto the points plotted in these figures.

C.V. of doubling twist has been plotted against yarn count in Figs. 6 to 8 for gauge lengths of 2.5 cm, 25 cm and 50 cm, respectively, and it can be seen that, for all practical purposes, the C.V. of doubling twist can be regarded as independent of yarn count. Similar trends were obtained for the other gauge lengths. The average values given in Figs. 1 to 5 are, therefore, not affected by the yarn count.
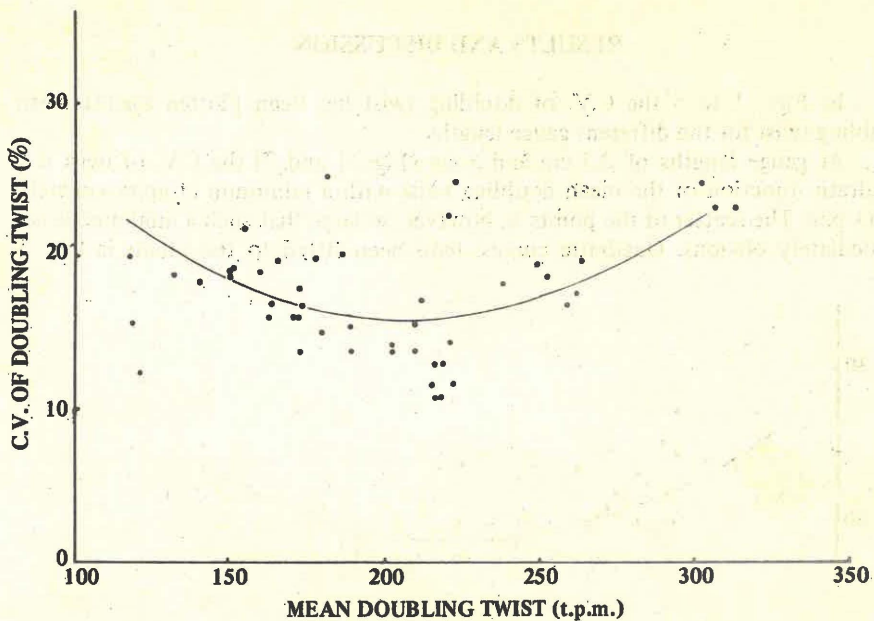
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FIGURE 2

Relationship between C.V. of doubling twist and mean doubling twist
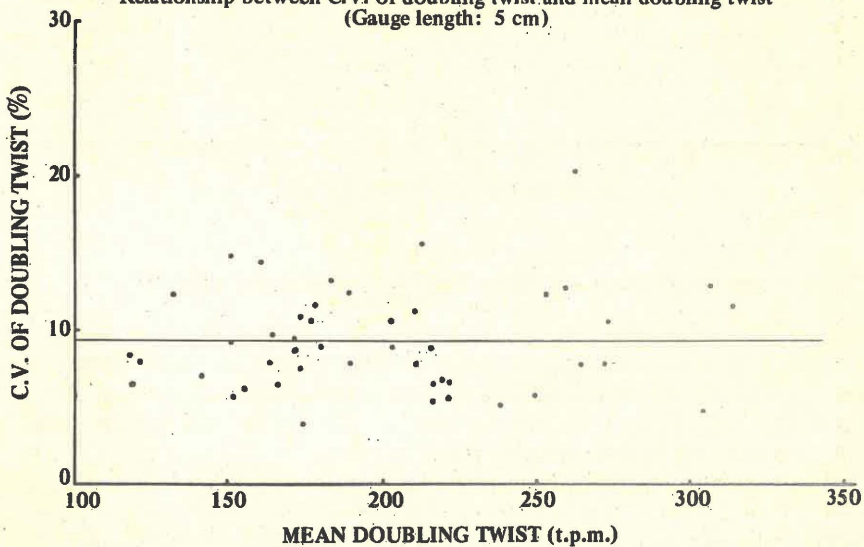(Gauge length: 5 cm)

FIGURE 3

Relationship between C.V. of doubling twist and mean doubling twist
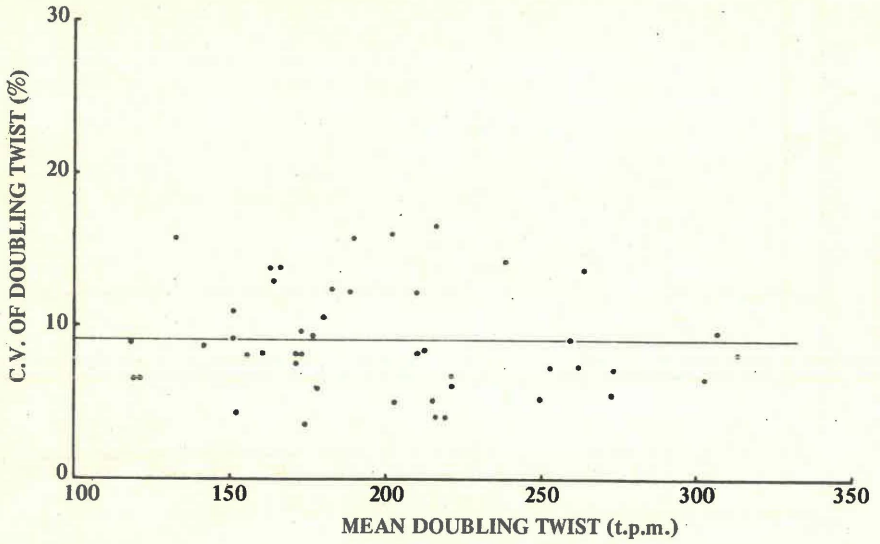(Gauge length: 25 cm)

FIGURE 4

Relationship between C.V. of doubling twist and mean doubling twist
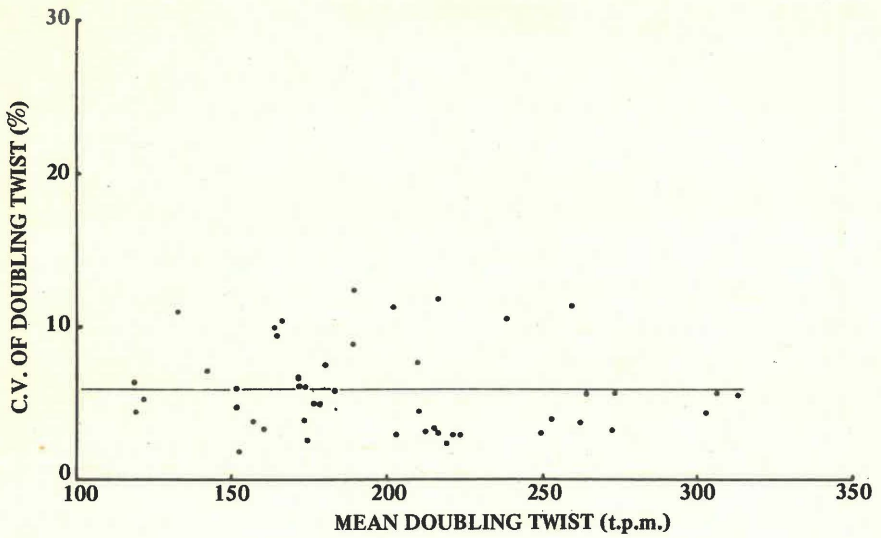(Gauge length: 50 cm)

FIGURE 5

Relationship between C.V. of doubling twist and mean doubling twist
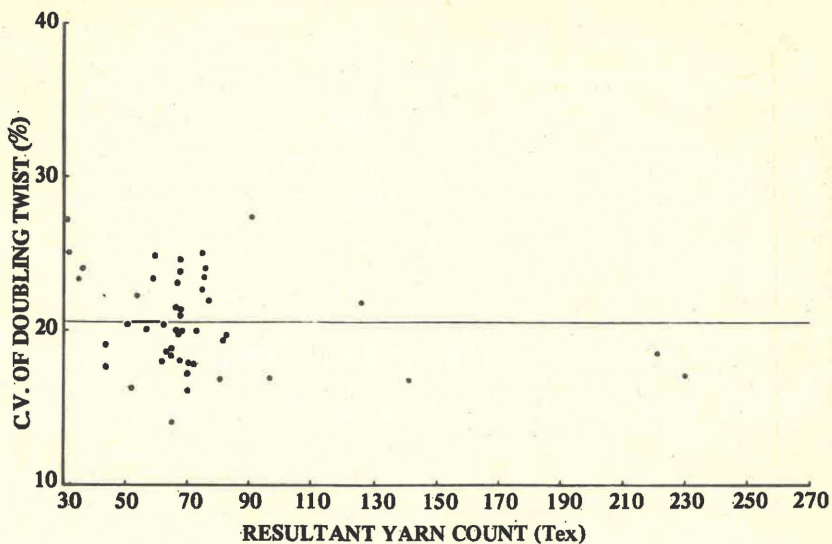(Gauge length: 1 metre)

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FIGURE 6

Relationship between C.V. of doubling twist and resultant yarn count
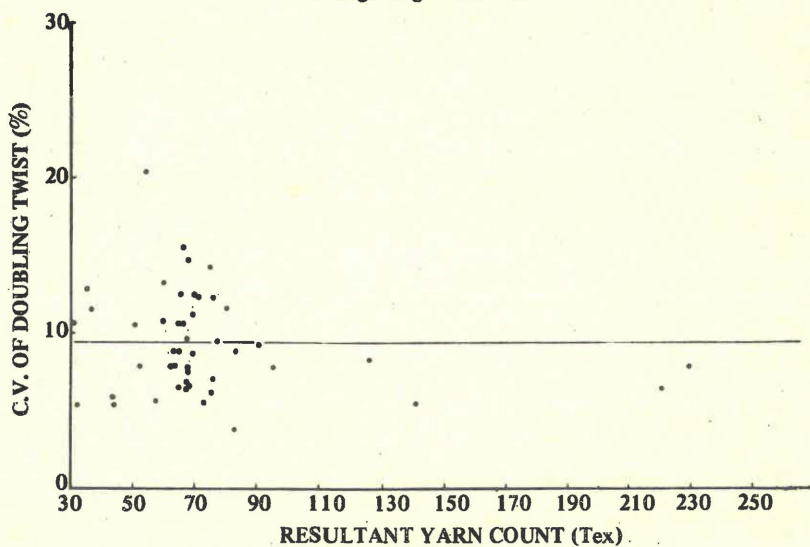(Gauge length: 2.5 cm)

FIGURE 7

Relationship between C.V. of doubling twist and resultant yarn count
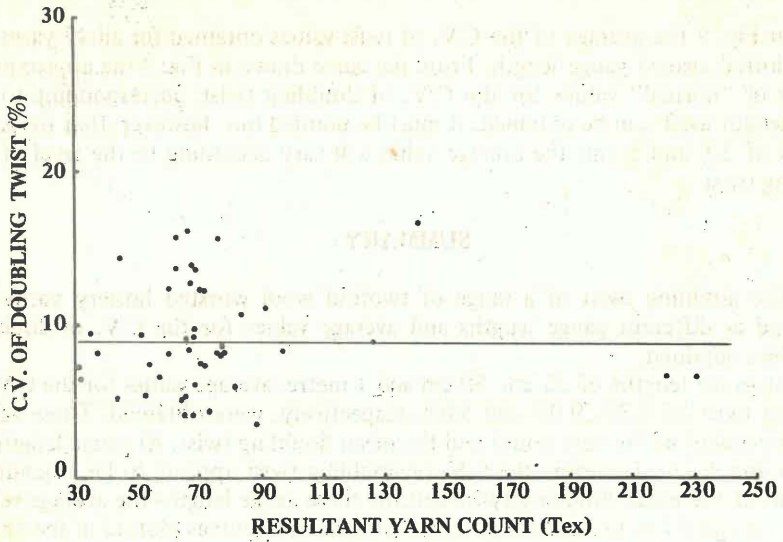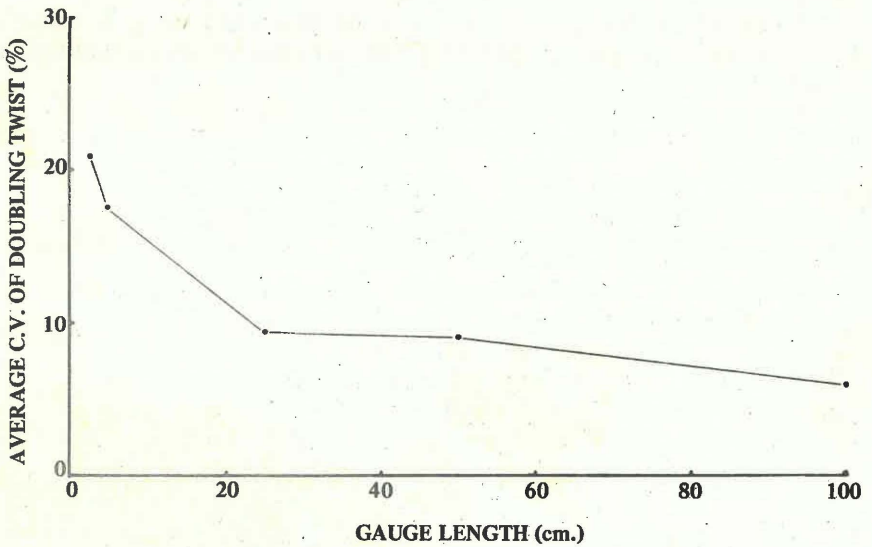(Gauge length: 25 cm)

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FIGURE 8

**Relationship between C.V. of doubling twist and resultant yarn count
(Gauge length: 50 cm)**

FIGURE 9

Relationship between average C.V. of doubling twist and gauge length

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In Fig. 9 the average of the C.V. of twist values obtained for all 47 yarns has been plotted against gauge length. From the curve drawn in Fig. 9 the approximate average or "normal" values for the C.V. of doubling twist, corresponding to the gauge length used, can be obtained. It must be pointed out, however, that for gauge lengths of 2.5 and 5 cms the average value will vary according to the level of the doubling twist.

SUMMARY

The doubling twist of a range of twofold wool worsted hosiery yarns was measured at different gauge lengths and average values for the C.V. of doubling twist were obtained.

At gauge lengths of 25 cm, 50 cm and 1 metre, average values for the C.V. of doubling twist of 9.3%, 9.0% and 5.8%, respectively, were obtained. These values are independent of the yarn count and the mean doubling twist. At gauge lengths of 2.5 cm and 5 cm, however, the C.V. of doubling twist appears to be a quadratic function of the mean doubling twist and for these gauge lengths the average values for C.V. of doubling twist are represented by quadratic curves plotted in the appropriate figures. Once again the variation in doubling twist was, for all practical purposes, independent of yarn count.

ACKNOWLEDGEMENTS

THE USE OF ORGANIC SOLVENTS AS A SUBSTITUTE FOR WATER IN TEXTILE PROCESSING*

(PAPER READ AT WATER CONVENTION, PRETORIA, 16/11/70)

by D. P. VELDSMAN

ABSTRACT

This paper presents some information on the physical/chemical properties of some organic solvents and how their properties fulfil the specific requirements of textile processing. Typical examples are quoted in which water has been replaced, partly or entirely, by organic solvents, viz. scouring of raw wool, solvent dyeing, solvent milling, achievement of the fully relaxed state of knitted fabrics, shrink-resist treatment of wool and the application of easy-care finishing agents.

Finally, some assessments are made of the saving in water which would be achieved by more efficient processing or a change-over to organic solvents in the local textile industry.

KEY WORDS

water conservation − pollution − scouring − dyeing − Kier boiling − milling − organic solvents.

Large volumes of water pass through the processing works of the local textile industry, at present the most important sector of our secondary industry. At the current growth rate, it is expected that the textile sector will maintain its present position in the country's economic growth.

Of the processing departments of any textile mill, the three main consumers of water are scouring (or Kier boiling), dyeing and wet finishing. It is also an indisputable fact that water is often wasted because of ignorance as to what the optimum amounts of water for specific processes should be. Furthermore, due to incomplete loading of machines (especially in dyeing), water is wasted.

Water will always be an important medium in the processing of textiles. Lately, however, **solvent** processing has become of increasing importance and in certain cases, water has been completely replaced by solvents as the processing medium. In other cases, both are being used. It is unlikely that water will be completely eliminated but much could be done to reduce water consumption, which in a country such as ours, is of vital importance in view of the emphasis on water conservation. The purpose of this paper is to describe possible avenues along which useful developments could take place.

The first important question which might be raised is, why, apart from the point of view of water conservation, water tends to be replaced by solvents?

*Permission for republication granted by The Department of Water Affairs.

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The following reasons for a diminishing water consumption in textile processing can be put forward[1, 2]:

(a) Industrial, and especially treated water, becomes dearer: This is a trend throughout industrial countries. Whereas industrial water used to be approximately 15 cents per 1 000 galls it has, in some cases, trebled in price.

(b) Effluent treatment has become compulsory and an expensive operation. For many years, the textile industry was permitted to release its effluents into public streams or sewers without any prior treatment. Pollution problems have compelled public authorities to take more stringent precautions as to the quality of the effluents which are released. This, in turn, has forced textile firms to apply more expensive purification treatments and at present the specifications for effluents in some industrial countries have become so severe that, for large volumes of heavily polluted effluent to be treated, the costs incurred make such treatment almost prohibitive.

(c) Water alone is not always the ideal medium for the removal of impurities: For example, to remove fats or waxes, water has to be used in conjunction with surface-active agents or solvents.

(d) The advent of synthetic fibres and the development of certain processing techniques for these fibres have placed the use of organic solvents in a new perspective. In addition, some chemicals used in these processes are not compatible with water.

(e) The thermo-economics of solvents (i.e. low specific heat and low heat of evaporation) are favourable.

WHAT PROPERTIES SHOULD ORGANIC SOLVENTS POSSESS TO BE SUITABLE FOR TEXTILE PROCESSING?

The organic solvent should be
(a) non-inflammable and should not form explosive mixtures with air — (this is a most important prerequisite),
(b) non-toxic,
(c) non-corrosive,
(d) relatively cheap, and
(e) easy to recover, and
(f) if at all possible, it should not pollute the air.

Where solvents which are immiscible with water, are used in conjunction with water, the separating funnel technique can be adopted for their separation. In the case of miscible solvents, fractional distillation can be applied.

In Table I a limited range of organic solvents and some of their most important physical properties are given.

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TABLE I

PHYSICAL PROPERTIES OF SOME ORGANIC SOLVENTS

Solvent	Dielectric const. (at specified temperatures)		Solubility in water (g/100 ml)	B.P. ($^{\circ}$C)	Ignition point ($^{\circ}$C)	Approx. price (R/100 Kg)
Water	78.5	$(25^{\circ}C)$	–	100	–	–
Methanol	32	$(25^{\circ}C)$	–	65	11	–
Ethanol	24.3	$(25^{\circ}C)$	–	78	12	14.4
Butanol-L	17.8	$(20^{\circ}C)$	7.90	118	29	29.0
Benzyl Alcohol	13.1	$(20^{\circ}C)$	4.00	206	101	–
Trichlorethylene	3.4	$(16^{\circ}C)$	0.11	87	Burns with difficulty	19.2
Perchlorethylene	2.3	$(25^{\circ}C)$	0.015	121	Burns with difficulty	22.2
Benzene	2.3	$(20^{\circ}C)$	0.08	80	11	15.6

The dielectric constant of an organic solvent is in direct relation to its water miscibility – as the polarity of the solvent decreases, so does its miscibility. Furthermore, a low ignition point infers easy inflammability and a tendency to form explosive mixtures with air.

Per- and trichlorethylene are almost non-inflammable and, in many respects the chlorinated hydrocarbons have advantages over other solvents (see Table II).

TABLE II

PHYSICAL PROPERTIES OF TRI-, PERCHLORETHYLENE AND WATER

Property	Perchlorethylene	Trichlorethylene	Water
Density (Kg/l)	1.62	1.46	1.00
B.P. ($^{\circ}$C)	120.80	86.70	100.00
Heat of Evaporation (Kcal/Kg)	50.10	57.30	584.90
Surface Tension (20°C, dyne/cm)	32.32	32.00	72.75
Specific Heat (Kcal/Kg degree)	0.205	0.227	1.00

The specific heat of perchlorethylene is only about 1/5 of that of water. This implies that to heat a bath to a certain temperature, a considerable heat saving can be accomplished if perchlorethylene is used instead of water. Its surface tension is

also lower and its heat of evaporation is about 1/10 of that of water which facilitates the drying process. The chlorinated hydrocarbons are also chemically unreactive, neutral, and do not degrade the textile fibre.

SOME CLASSICAL EXAMPLES OF THE USE OF ORGANIC SOLVENTS IN WOOL PROCESSING

(a) Scouring of raw wool or woven/knitted piece goods:

The scouring of greasy wool by means of an aqueous system, produces one of the most heavily polluted effluents and at the same time, one of the most difficult to purify. Furthermore, large volumes of water are involved in this system of scouring. Consequently, the possible use of organic solvents to remove wool grease has been investigated. Up to the present two lines of action were pursued, viz. the use of a Kier containing the greasy wools and the solvent or the use of solvent jets whereby the wool can be sprayed. In both cases the solvent is recovered under reduced pressure and the wool grease recovered as a by-product. White spirit and perchlorethylene can be used as solvents. In the Sover process in Belgium, the wool is sprayed successively with water, with a mixture of isopropyl alcohol and water and finally with hexane.

Piece scouring could also be done on a solvent basis and here continuous processing machines are available. The Spencer vibro-scour is a classical example.

(b) Solvent dyeing and bleaching:

For many years dyestuff manufacturers have been developing water soluble dyestuffs and the dyeing process took place after swelling of the fibre. For fibres such as polyester which do not swell in water, a swelling agent (or carrier), e.g. o-phenyl phenol was used.

Recent research has shown that chlorinated hydrocarbons, with additives if necessary, can be used successfully for the application of appropriate dyestuffs. Already certain disperse dyes can be applied to Tricel, nylon and polyester fibres from trichlorethylene solutions.

Recently, the S.A. Wool Textile Research Institute (SAWTRI) developed a technique[3] whereby a large proportion of conventional dyestuffs can be used to dye wool in a charged system of perchlorethylene at 80°C. This solvent technique was also used for the bleaching of wool and very promising results were obtained. For the same bleaching effect, the bleaching with Hydrogen peroxide in perchlorethylene consumes only 10% of the conventional amounts required in aqueous medium. Furthermore, the bleaching process in perchlor could be carried out in a quarter of the time required for conventional, aqueous bleaching.

(c) Solvent milling of wool knitwear:

In some cases, e.g. with double jersey all wool fabrics, a slight milling effect is desirable. This can be achieved by using a 'charged system' of dry-cleaning. In this system the solvent is charged with a suitable wetting/emulsifying agent and water, the latter varying from 4 *per cent* to 5 *per cent*, based on the volume of solvent. The

goods are tumbled in this medium, spun and tumble dried. The amount of water present determines the degree of milling – the higher the percentage of water, the greater the rate of milling.

(d) Achievement of the fully relaxed state in double jersey fabrics:

In knitwear there are two types of shrinkage, viz. relaxation shrinkage and felting shrinkage. The first phenomenon can mainly be ascribed to a change in loop configuration and the latter to a change in loop length. In double jersey knitted fabrics relaxation shrinkage can be of the order of 30 *per cent* area shrinkage. If this is not reduced to within reasonable limits of tolerance (say 6 *per cent* in area), such an end-commodity cannot be claimed to be machine washable, however effective the anti-felting treatment is. Recently, SAWTRI developed a commercially viable process for achieving the fully relaxed state with double jersey fabrics[4].

The already shrinkproofed fabrics (and this is a pre-requisite) are first decatised for one minute and then tumbled for 8 min in a dry-cleaning machine containing perchlorethylene solution, 27 *per cent* water and 13.5 *per cent* of a wetting agent (Aerosol OT), the latter two percentages being based on the weight of goods. The excess of liquor is drained off, the goods spun for 2 minutes and then tumble dried at 70°C for 12 minutes.

(e) Application of certain easy-care finishing agents:

Many easy-care finishing agents which are normally applied by means of aqueous systems, can be applied equally effectively in solvent-based systems.

There are several currently available shrink-resist treatments for wool involving the use of resins in organic solvents ("Zeset" of Messrs. du Pont, "Synthappret LKF" of Messrs. Bayer, "Braxan LFA" of Messrs. Pherses, etc.).

Similarly, for cotton many resin finishes applied in aqueous systems, could be applied equally well in solvents.

Solvent-based application of water repellents, such as fluorocarbons, moth-proofing agents, silicone polymers and durable-press resins are further examples.

POSSIBLE SAVINGS IN WATER:

(a) More effective processing:

On the average, to convert 10 000 lbs of raw wool into finished cloth will entail water costs of R120[5]. However, if the water is used to its full potential this cost could be halved at least. The following figures for current consumption of water and possible reductions for the various wool textile processes are worth noting:

1. Raw wool scouring:

By and large, about 2.0 gallons of water are used to scour 1 lb of raw wool. Through the use of hydrocyclones, sludge-dischargers and centrifugal wool grease recovery systems on the first scouring bowl, as well as the re-use of rinsing liquors, this figure could be reduced to approx. 1 gallon/lb wool. In view of the annual local consumption of apprixomately 200 million gallons of water for raw wool scouring, a saving of 1.0 gallon/lb wool is quite significant.

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2. Dyeing:

In this case the stage at which the wool is dyed, determines the water consumption. On the average, 4.5 gallons of water are used to dye 1 lb of wool up to the yarn stage (this includes rinsing). Another 5.0 lbs of steam/lb of wool are used for heating of the dyebath. By the re-use of rinsing water, and more efficient use of steam, this figure could easily be reduced from 5.0 gallons to 3.5 gallons.

3. Worsted piece scouring:

In this process there is a tremendous variation in water consumption between different finishing departments — a survey showed that anything from 5.0 gallons to 50 gallons per lb of wool can be used.

Again, by re-using rinsing liquors and applying proper liquor ratios, 2.0 gallons per lb of wool should not be exceeded.

4. Worsted piece dyeing:

On the average, 15 gallons of water (including steam) is used to dye one lb of wool (variation between 8.6 and 19.8 gallons). A well controlled dyeing will reduce this figure to 7.5 gallons/lb wool, made up as follows:

water	:	3 000 lb
steam	:	1 500 lb	per 100 lbs wool
rinse	:	3 000 lb

These are a few classical examples, showing how water consumption could be reduced effectively without loss in efficiency of the process itself.

The second possible saving in water can be accomplished by the

(b) Use of solvents as a substitute for water:

In charged systems of *solvent-based dyeing and finishing* the percentage of water (by volume) rarely exceeds 5 *per cent* and, therefore, in processes where solvents replace water, the saving in water is of the order of 95 *per cent*. In most cases the solvent system is operated on a closed system and the recovery of solvent is of the order of 98 *per cent*. For dyeing and finishing processes solvent-based processing sounds economically attractive.

In the case of raw wool scouring, the wool has still to be rinsed with water after grease removal with solvent. The saving of water may therefore be of the order of 80 *per cent*. On the other hand, if the grease removal does not take place in a closed system, the solvent loss may be high. The solvent is also fairly saturated with grease and other dispersed impurities and the recovery of clean solvent is not an easy matter. In the Republic of South Africa, current prices of those solvents which are suitable for raw wool scouring, the solvent loss during processing and the large volumes of solvent required at this stage, make the solvent scouring of raw wool economically unattractive.

In conclusion, I wish to make a plea to our local textile industry to become more conscious of the necessity for water conservation. Only then can a major reduction in water consumption be expected. There are ways and means whereby

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local authorities could enforce certain restrictive measures on the use of our water resources. However, before such a step is deemed necessary, a voluntary response to this plea would be a more satisfactory solution.

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THE INFLUENCE OF MILD ALKALI TREATMENT ON WOOL FOR SHORT PERIODS AND AT DIFFERENT TEMPERATURES

by E. WEIDEMAN and H. W. WEVERS

ABSTRACT

Wool was treated with 0.1 M sodium carbonate at temperatures ranging from 20°C to 75°C for periods of 5–300 minutes. The following determinations were made:

Alkali solubility, urea-bisulphite solubility, dye-exhaustion and the amino acids: cystine + cysteine, dl-lanthionine, meso-lanthionine, lysine, lysinoalanine, arginine and ornithine.

The relative importance and usefulness of these tests are discussed.

KEY WORDS

Alkali-solubility, urea-bisulphite solubility, dye-exhaustion, cystine, lanthionine, lysine, lysinoalanine, arginine, ornithine, alkali modification.

INTRODUCTION

The identification of alkali-modified wool by chemical means is extremely important to the textile industry, since wool may become damaged during improperly controlled scouring and alkaline finishing processes. The wool protein is attacked by alkali and from the disulphide bonds lanthionine and other products can be formed[1,2].

Zahn *et al*[3] pointed out that a lanthionine content higher than 0.3% (14.4 micromoles per gram) is a sign of chemical modification of the wool. Lanthionine determination is unfortunately too cumbersome for routine quality control[4], but an inverse relationship was found between the urea-bisulphite solubility (U.B.S.), which can easily be determined in Industry, and lanthionine content of wool modified by alkali[5]. There is, however, no correlation between the U.B.S. and lanthionine content of reduced wool[6], which indicates that other chemical degradative treatments also influence U.B.S. A low U.B.S. therefore does not necessarily indicate alkali modification.

Most authors studied the influence of long periods of treatment or relatively high temperatures[7-11]. Von Bergen[7] noted that for the wool scourer it would be valuable to know the effects of 0.05 M sodium carbonate on wool treated for short periods (1–10 minutes) at different temperatures. These are less drastic conditions than normally studied and therefore closer to those encountered in the industrial processing conditions.

Kriel[1 2] studied the U.B.S. of wool and mohair fibres treated with 0.014 M and 0.05 M sodium carbonate solutions for short periods (1–5 minutes) at temperatures that simulated or nearly simulated practical mill conditions. He concluded that scouring at temperatures not exceeding 60°C in a 0.15% sodium carbonate solution, will have a negligibly detrimental effect on the wool.

Kunitz treated wool with 0.05 M. sodium carbonate and 0.05 M sodium hydroxide at 45°C for periods of 10 minutes to 4 hours[5]. From his work it is evident that to obtain wool with a lanthionine content of less than 0.3%, the time of treatment is important only for high pH (or alkaline solutions stronger than 0.05 M Na_2CO_3) and temperatures higher than 50°C.

In this paper the relative importance of the different tests for chemical modifications was studied for wools treated with mild alkali for various times.

EXPERIMENTAL

Material:

Unscoured raw wool (64's Merino, 9–11 months) and undyed normally finished woven wool fabric (255 grams m^{-2}) were used. The tips and roots of the raw wool were removed and the middle portions and tips cleaned separately by washing for 3 minutes in diethyl ether followed by 3 minutes in ethanol. They were finally rinsed in running tap water (pH 8.0) for 10 minutes and dried at room temperature, and the cleaning procedure repeated once more.

Treatment with Alkali:

1(a) Samples of wool each weighing 15 g and with the tips and roots removed, were treated for 15 minutes in 800 ml 0.1 M sodium carbonate solution containing 0.1% Tergitol Speedwet (nonionic detergent) at different temperatures (20°, 40°, 60° and 75°C).

(b) Wool as in (a), was treated at 40°C and 75°C for 5, 15 and 30 minutes.

2. The cleaned wool tips were treated with 0.1 M sodium carbonate solution containing 0.1% Tergitol Speedwet at 40° and 75°C for 5, 15 and 30 minutes.

3. 2.5 g of the woven material was treated in 133 ml 0.1 M sodium carbonate solution containing 0.1% of Tergitol Speedwet at 40°C for 45 to 300 minutes.

In all the experiments the samples were rinsed for 5 minutes and dried at room temperature after having been treated with alkali. All the samples were conditioned at 20°C and 65% R.H. before testing.

Method of Analyses:

Alkali solubility and U.B.S. were determined according to the I.W.S. methods[13, 14].

The dye-exhaustion curve was determined in the following manner:
Each sample (9 g) was dyed in a solution of 2% Lanasol Red G, 4% ammonium

sulphate, 1.5% acetic acid (80%), and 1% Albegal B (all percentages on weight of wool). The wool-liquor ratio was 1:50. The solution was brought to a temperature of 40°C and the wool added. The temperature was increased at a rate of 2°C per

TABLE I

LOOSE WOOL TREATED WITH 0.1 M Na_2CO_3 FOR 15 MINUTES AT DIFFERENT TEMPERATURES

(Results in micromoles per gram of wool)

Solubility or amino acid	Control	Reaction temperature °C			
		20	40	60	75
U.B.S. (%)	64.4	59.6	55.5	11.3	0
Alkali solubility (%)	14.6	14.6	14.1	11.0	8.9
Lysine	249	243	236	230	204
SS + SH	497	497	472	433	253
Lysinoalanine	0	0	< 1	< 1	19
dl-lanthionine	< 1	< 1	< 5	18	49
meso-lanthionine	< 1	< 1	< 5	23	78

minute to the boil and the wool boiled for one hour. Samples (0.25 ml) were taken every 3 minutes during the first 24 minutes and then at longer intervals.

Amino acid determinations: A sample of wool (5–6 mg) was added to 0.5 ml of constant boiling point hydrochloric acid in a long necked tube. The tube was evacuated, sealed off and the sample hydrolysed for 24 hours at 110°C. The solution was evaporated, using a vacuum pump, and the residue finally dissolved in 2.2 ml of buffer (pH 2.2); 0.5 ml was analysed on a Beckman automatic amino-acid analyser (4 hour system). All the amino acids were determined on the analyser except cystine which was determined according to the method of Leach[15]. Lysinoalanine, lysine and arginine were determined on the 5.5 cm column using a buffer of pH 5.28. Ornithine was determined on a 50 cm column using a buffer of pH 4.26 and column temperature of 30°C with a temperature change to 55.5°C after 110 mins (flow speed 30 ml/hr).

The method of Mellet and Swanepoel[16] was used for the determination of lanthionine. However, as this method was based on a 16 hour column run the method was adapted for a four hour system used in the present amino acid analyser. Inglis and Nicholls[17] used a buffer of pH 3.07 with a column temperature of 52°C and a buffer flow rate of 68 ml per hour. Under these conditions they succeeded in obtaining a good resolution of all amino acids usually determined on such a column.

TABLE II

LOOSE WOOL TREATED WITH 0.1 M Na_2CO_3 AT 40°C AND 75°C FOR DIFFERENT TIMES
(Results in micromoles per gram of wool)

Amino acid	Control	40°C		75°C		
		15 min	30 min	5 min	15 min	30 min
Lysine	249	237	237	213	206	199
SS + SH	497	472	468	362	253	185
Lysinoalanine	0	< 1	< 1	6	24	44
dl-lanthionine	< 1	< 5	< 5	26	49	66
meso-lanthionine	< 1	< 5	< 5	40	69	89

Because it was preferable not to change the normal column temperature (55.5°C) of the analyser, buffers of different pH's were tried and it was found that using a buffer of pH 3.03 at 55.5°C gave an excellent separation between dl- and meso-lanthionine (retention times of 112 and 121 mins respectively) and the adjacent amino acids proline and glycine.
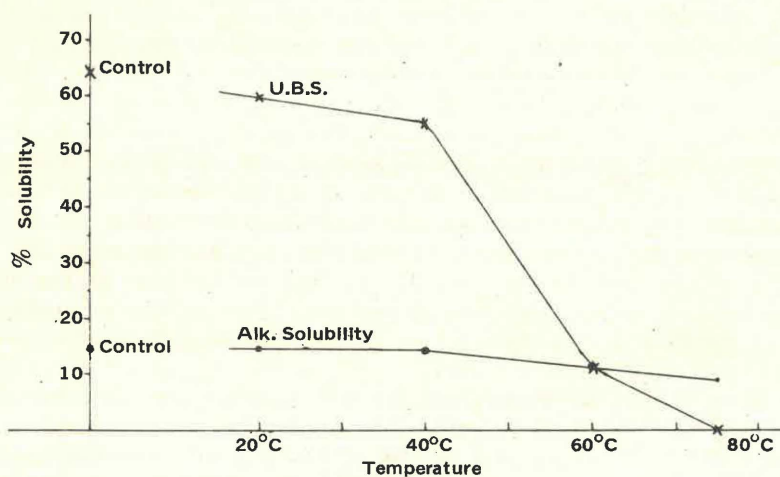

Figure 1
Alkali- and Urea-bisulphite-solubility
Loose Wool treated with 0.1 M Na_2CO_3 for 15 minutes

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RESULTS AND DISCUSSION

All the results are given in micromoles per gram of dry wool.

Table I and Fig. 1 summarise certain of the results obtained on loose wool. Dye-exhaustion curves of loose wool treated with 0.1 M sodium carbonate for 15 minutes at different temperatures are shown in Figure 2. Values for lysine, cystine and cysteine, lysinoalanine, dl-lanthionine and meso-lanthionine of loose wool are given in tables I and II; the equivalent values for wool tips are given in table III and for fabric in figures 3 and 4.

TABLE III

TIPS OF WOOL TREATED WITH 0.1 M Na_2CO_3 AT 40°C AND 75°C FOR DIFFERENT TIMES
(Results in micromoles per gram of wool)

Amino acid	Control	40°C			75°C		
		5 min	15 min	30 min	5 min	15 min	30 min
Lysine	207	193	192	186	203	188	168
Lysinoalanine	0	0	3.5	6	13	24	45
SS + SH	449	403	402	408	298	193	122
dl-lanthionine	<5	<5	<5	<5	47	58	67
meso-lanthionine	<5	<5	<5	<5	54	95	106

The results from all the tests carried out here were, with only a few exceptions, correlated to a high level of significance (the correlation coefficients were generally of the order of 0.95 usually with 3 degrees of freedom). Therefore, for the case of alkali modification, it appears that carrying out more than one test is not worthwhile since the second test will provide hardly any new information. The choice of test or tests therefore now revolves around other factors such as sensitivity of the test method to alkaline modification or the ease with which the test can be carried out.

From Table I and Figures 1 and 2 it follows that, for treatment up to 15 minutes at 40°C the U.B.S. and rate of dye-uptake are the most sensitive methods, and therefore more suitable than any one of the other tests to indicate mild alkali modified wool. It is only on slightly more modified wool that the other values all show a significant reduction (lysine, cystine plus cysteine) or increase (lysinoalanine and dl- and meso-lanthionine).
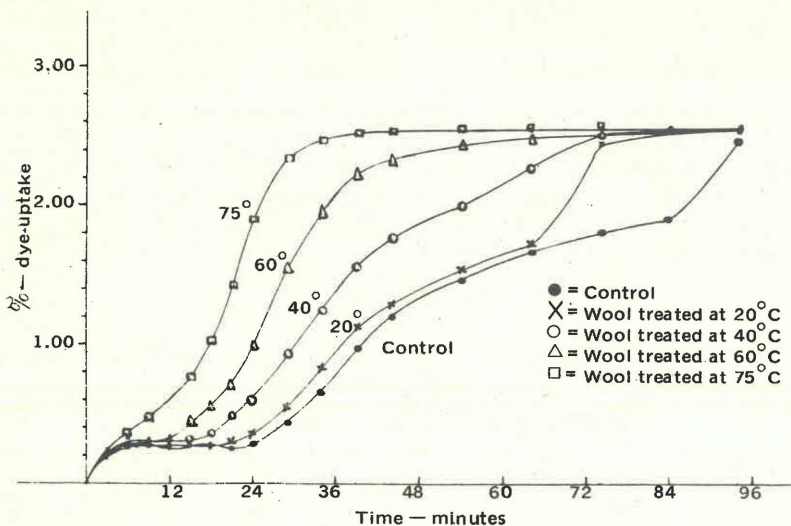
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Figure 2

Dye-exhaustion of Loose Wool treated with 0.1 M Na_2CO_3 for 15 minutes

From tables I and II it is evident that lanthionine increased more rapidly than lysinoalanine, with increasing temperature and treatment time. However, in the case of the wool tips, treated up to 30 minutes at $40°C$, lysinoalanine increased more rapidly than lanthionine (table III).

The cystine plus cysteine value for the woven wool control sample was relatively low when compared with the value of the loose wool control (Fig. 4). The lanthionine and cystine plus cysteine values, however, followed approximately the same pattern as for the loose wool. Figures 3 and 4 show that the lysinoalanine content of woven wool also seemed to increase more rapidly in the beginning than the lanthionine when compared with the loose wool (6 micromoles lysinoalanine and 44 micromoles total lanthionine for woven wool as compared with less than 1 micromole lysinoalanine and 41 micromoles lanthionine in the case of the loose wool).

In general, the untreated samples which were used, contained very little lanthionine [less than 2 micromoles per gram (0.04%)] and the wool tips less than 10 micromoles per gram. More than 10 micromoles per gram of lanthionine was found only in samples which had been treated for longer than 45 minutes at $40°C$.

The arginine values for all treated wools did not change significantly and no ornithine was found (see, however, accuracy of results). The maximum ornithine value found for wool treated with 2.5 N ammonia for 5 hours at $40°C$ was ca 5 micromoles per gram[18].
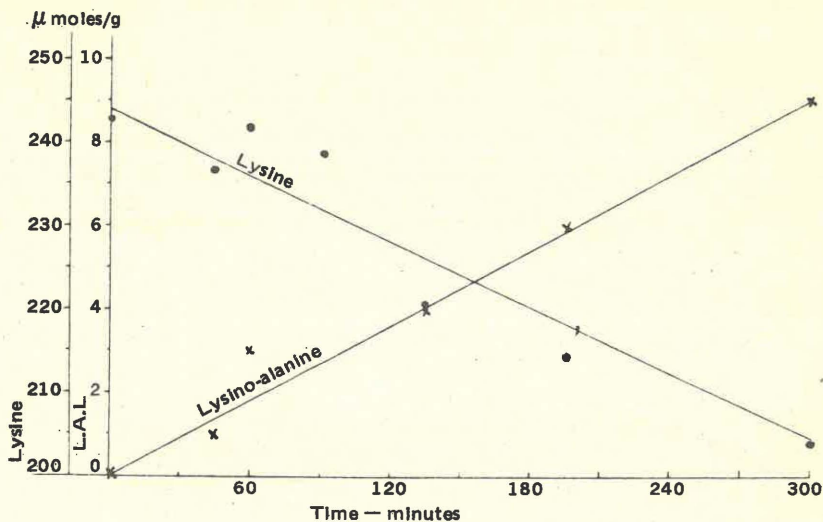
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Figure 3
Woven Cloth treated with 0.1 M Na_2CO_3 at $40^{\circ}C$

ACCURACY OF RESULTS

(a) Lanthionine:

A hydrolysed wool sample which had been treated with alkali and found to contain 8 micrograms of lanthionine (total) by the column chromatography method, was analysed by using Dowling and Crewther's method[19]. The presence of 7.5 micrograms confirmed the comparison made previously[17].

Five samples having different lanthionine values were obtained from Prof. Zahn and the comparative values, found by Zahn and SAWTRI are as follows:

	Column chromatographic Method (SAWTRI)	Paper chromatography Method (Zahn)
1.	13	12 – 13.5
2.	21	21
3.	25	22
4.	>5 < 10	7.2
5.	14	16

(Results in micromoles per gram)

This shows that the results obtained with the ion exchange method compare reasonably well with those determined with the paper chromatography method. Inglis and Nicholls[17] also found a satisfactory agreement between results using the two methods. They obtained 18 and 29 μ moles with the ion exchange method
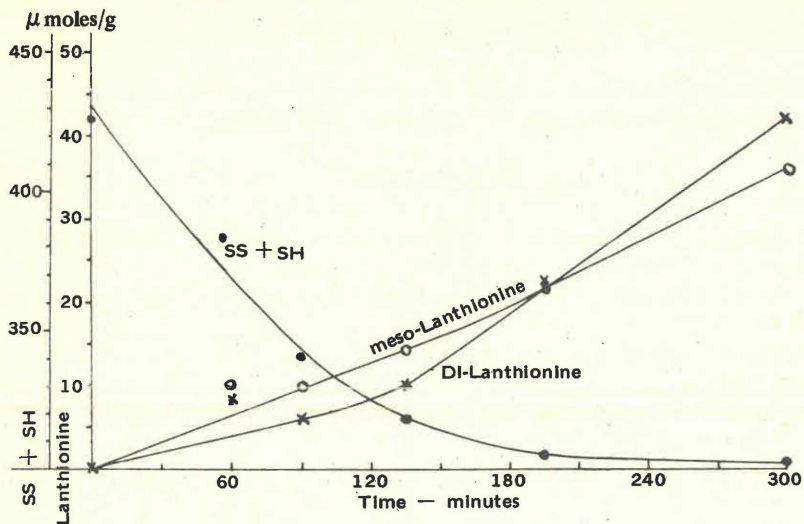
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Figure 4
Woven Cloth treated with 0.1 M Na_2CO_3 at 40°C

whereas 16 and 28 μ moles were obtained with the method of Dowling and Crewther.

By slightly overloading the columns it was found in agreement with Inglis and Nicholls, that the lower limit for accurate determination of lanthionine (dl+ meso) was approximately 15 μ moles per gram.

(b) Lysine and Ornithine:

On the 5.5 cm column, lysine and ornithine elute at the same position and because the lower limit for determination of ornithine was ca 40 micromoles per gram on the physiological fluid column we could not make a correction for the lysine content. No ornithine was found in any of the samples.

CONCLUSIONS

Alkali modification of wool can be detected by determining its urea-bisulphite or alkali-solubility, the dye-exhaustion curves, or by its cystine, lanthionine, lysine or lysinoalanine content.

As far as the sensitivity of these tests is concerned, U.B.S., rate of dye-exhaustion and cystine values are the most sensitive parameters to indicate mild modification of wool. The U.B.S. test would be the easiest determination and therefore the first choice to indicate mild modification.

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THE USE OF PROPRIETARY NAMES