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SAWTRI BULLETIN

WU4/F/113

SOUTH AFRICAN
WOOL TEXTILE RESEARCH INSTITUTE
OF THE CSIR

P.O. BOX 1124
PORT ELIZABETH

VOL. 10 SEPTEMBER, 1976 NO. 3

SAWTRI BULLETIN

Editor: M. A. Strydom, M.Sc.

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SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH INSTITUTE
OF THE CSIR

P.O. Box 1124
Port Elizabeth

SA ISSN 0036-1003

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N. J. J. van Rensburg, D.Sc.
L. Hunter, Ph.D.
D. W. F. Turpie, Ph.D.
M. A. Strydom, M.Sc.

INSTITUTE NEWS

Sulzer Weaving Machine Instruction Course

The Textile Machinery Department of Sulzer Bros (S.A.) Limited in collaboration with SAWTRI, offers a weaving course from 25th October to 19th November, 1976 at the Institute. This course will be the first of its kind to be held in South Africa by Sulzer Switzerland and is intended to provide participants with tuition, and the basic training to:

- operate and service Sulzer weaving machines;
- carry out article changes;
- carry out the six-monthly, monthly (or at article change) and daily machine revisions;
- carry out basic machine settings.

The course will be restricted to mill personnel whose task is to operate Sulzer weaving machines.

The course fee is R300 which includes lunch, tea, transportation from hotel to SAWTRI and back every day as well as the instruction material. All participants are recommended to stay at the Edward Hotel which has international status. The course is open to all races.

Unisa Seminar : Utilising Research and Development Opportunities

The Director, Dr D. P. Veldsman, attended a one-day seminar offered by the School of Business Leadership of the University of South Africa on 29th July which was led by Prof. A. Shapero of the University of Texas at Austin.

The seminar included discussions on how to improve an organisation's ability to utilise research and development opportunities with special reference to the creative output from the R and D function and improving the ability to obtain the acceptance and successful diffusion of its products.

Symposium on the Interdependence of the Textiles and Clothing Industries

The SABS is currently engaged on arrangements for a symposium to be held at Durban on 25th and 26th November on the above subject.

The importance of the textiles and clothing industries can be seen from the fact that together they employed approximately 205 000 workers in 1975. Dr L. Hunter, Chief Research Officer at SAWTRI, who has been very active over the past years in the field of barré and streakiness in knitted fabrics, has been asked to read a paper on this subject.

Dr D. P. Veldsman who is a member of the Sectoral Advisory Committee for Textiles of the Economic Advisory Committee to the Prime Minister, will also attend the symposium.

Uster Training Course

Messrs Texmaco (Pty) Limited, official agents for Zellweger Uster Limited of

Switzerland will present courses on Uster instruments at SAWTRI from 20th to 24th September.

Instruction courses will be provided on the use of Uster testing installations, automatic electronic yarn clearing, Monitex data collection and automatic card autoleveller control.

Research Advisory Committee

We have pleasure in welcoming two new members of the Research Advisory Committee. They are Mr P. S. Rautenbach of the Industrial Development Corporation who has been appointed in the place of Dr J. S. Starke; and Mr D. S. Uys, Manager of the S.A. Mohair Board who takes the place of Mr D. A. Hobson.

With the appointment of these two members and the re-appointment of Messrs A. E. Nilsen and J. Z. Moolman who were available for a further term of office, all vacancies resulting from the three-yearly rotation of members have been filled.

The next meeting of the Committee takes place at the Institute on 24th November.

Productivity in the Textile Industry

The National Productivity Institute has gone further ahead with its plans to increase productivity in the textile processing industry and implement its earlier findings on the spinning, knitting and weaving industries. The Board of the National Productivity Institute, at a meeting held in Johannesburg on 16th June, appointed Mr C. Wolfaardt as head of the organisation to be established in conjunction with the industry.

Dr Veldsman, Director of SAWTRI, is a member of the NPI Board.

Science and Industry

We welcome as a new contributor to SAWTRI, Messrs Hans G. L. Krijger & Co. (Pty) Limited, of Durban.

The Institute is grateful for the growing support from the textile industry and looks forward to the day when every mill recognises the value of closer co-operation with research.

It is a sore point with the Institute that technological innovations made by SAWTRI are lost to the local industry because of failure to take the initiative in the competitive market of applying first hand information before it reaches the overseas market. Dr Veldsman remarked on this during his address before the combined meeting of the Natal branches of the S.A. Dyers and Finishers Association and the Textile Institute which recently took place in Durban. He said processes developed locally were quite often 'exported' only to be 'imported' afterwards at a premium.

The Primary Industry and Research

The Australian Wool Growers Study Tour of 1976 included a visit to the Institute on 17th May. The photo on the opposite page was taken on that occasion.

The wool classing standards of the NWGA were discussed on 16th July by various interested bodies including the National Wool Growers, Grootfontein Agricultural College and SAWTRI.

The S.A. Mohair Board has increased its annual research contribution by 25% as from April 1976. SAWTRI is much indebted to the mohair industry for its support and goodwill, especially in the present state of inflation and increased research costs.

History was made when for the first time, the International Mohair Association met in South Africa from 10th to 14th May. The programme of the delegates included a visit to SAWTRI. In the photo below Mr D. S. Uys, Manager of the S.A. Mohair Board (right) is seen in conversation with the delegate from Lesotho during a lunch at SAWTRI.

Much interest was shown in the tour of the laboratories. In the photo below, a demonstration is given of mohair spinning on the Repco while in the following photo, Dr Veldsman shows Mr Tom Hibbert, Chairman of the International Mohair Association (extreme right) and other delegates the Sulzer weaving machine producing fine mohair suitings from Repco spun yarns.

Another group of farmers from Australia, who are members of the Australian Merino Society, visited SAWTRI on 2nd August. This society represents a very large and highly successful ram breeding group in Western Australia. The visitors were addressed by Dr Veldsman on the effect of the coefficient of variation of diameter on the spinning performance of wool.

News in Brief

The photograph below was taken on the occasion of the signing of the contract for building extensions at SAWTRI. Mr A. Krüger, Manager of the Estates Department of the CSIR, presided at this meeting which was held at the Institute on 7th June, 1976.

From left to right (seated): A. Sandison-Smith, J. A. Rautenbach, P. A. Gouws, J. B. Waugh, M. N. Landale.
(Standing): K. Schröder, A. S. Milne, C. Snyman, R. A. Osborne, M. K. Wait, J. van der Merwe, C. White, N. Timmermans, A. Krüger, N. J. Vogt, E. F. Calitz.

The Director officially opened the S.A. Mathematical Association's congress which was held on 5th July at the College for Advanced Technical Education in Port Elizabeth.

SAWTRI was represented at the annual general meeting of the Leather Industries Research Institute (LIRI) in Grahamstown by Mr N. J. Vogt.

Mr Cyril Hide, Scientific Counsellor of the CSIR in London arrived in South Africa on six weeks home leave. He visited SAWTRI on 1st September before his return to London. He also visited the University of Port Elizabeth.

Mr G. A. Harvey of the Scientific Liaison Office in Tehran, visited the Institute on 31st August.

Dr M. B. Roberts, Group Leader for Dyeing and Finishing at SAWTRI

addressed members of the Eastern Cape branch of the South African Dyers and Finishers Association (SADFA) on Friday, 27th August in Port Elizabeth.

The lecture covered the Institute's research in the dyeing and finishing fields, which includes transfer printing of natural fibres and solvent dyeing.

The Institute was also honoured by visits from touring groups and other distinguished persons during the past three months –

Mr E. R. Leeman, Assistant Director of the National Mechanical Engineering Research Institute in Pretoria, paid one of his regular annual visits of inspection to SAWTRI on 4th August. Mr Leeman is the adviser to the Research Advisory Committee on textile engineering and development activities at the Institute.

Messrs Heicke and Van den Heuvel of Hebox Textiles Limited visited SAWTRI on 3rd August to take a closer look at textile research, particularly concerning cotton and cotton blends.

Mr Iain Clegg of the International Wool Secretariat's office in London paid a visit to the Institute on 7th and 8th September during his brief visit to South Africa as part of his tour of wool growing countries. The purpose of his visit was to look at research operations and in particular, to have discussions on yarn developments and dyeing aspects.

Mr R. Howarth, Technical Director and General Manager of Messrs Nortex Limited, a subsidiary of the Frame Group of Companies, visited SAWTRI on 27th July to discuss the facilities which the Institute can offer in helping his mill to solve technical problems. He also discussed the processing of mohair with senior staff members.

New Staff Member

Dr A. Scheffer assumed duty as research officer on 1st August, 1976.

Dr Scheffer obtained his Ph.D. degree at the University of Port Elizabeth in March 1974. He was subsequently awarded a post-doctoral fellowship by the British Research Council for one year which was extended for a further year. He returned to South Africa in April 1976 after completion of his studies at Chelsea College, University of London under the direction of Prof. M. J. Perkins.

Dr Scheffer has joined the Protein and Cotton Chemistry Department.

SAWTRI PUBLICATIONS

Technical Reports

No. 303 : Turpie, D. W. F., Processing Characteristics of S.A. Wools, Part X: Influence of Relatively Large Variations in Diameter on the Processing Performance of S.A. Long Wools up to Spinning, (May, 1976).

No. 304 : Horn, R. E., The Simultaneous Dyeing and Crease-Resist Finishing of Cotton Fabrics with Acid Dyes and Resin Precondensates, Part II, (June, 1976).

No. 305 : Smuts, S. and Hunter, L., Studies of Some Wool/Acrylic Woven Fabrics, Part I: Untreated Plain and 2/2 Twill Weave Fabrics from Wool Blended with Regular Acrylic, (June, 1976).

No. 306 : Schmidt, H. E. and Turpie, D. W. F., The Processing of Wool/Cotton Blends on the Worsted System, Part II: The Effect of Various Carding Conditions, (June, 1976).

No. 307 : Hunter, L., Dobson, D. A. and Cawood, M. P., Effect of Atmospheric Conditions on the Knitting Performance of Wool Worsted Yarns, (June, 1976).

No. 308 : Cawood, M. P., Robinson, G. A. and Dobson, D. A., Single Jersey Knitting Performance, Part II: The Influence of Machine Speed, Yarn Input Tension and Yarn Linear Density on the Knitting Performance of Fine Worsted Yarns Knitted on a 28 gauge Single Jersey Machine, (July, 1976).

No. 309 : Van Rensburg, N. J. J. and Michau, Marilyn, An Evaluation of Various Methods of Reducing the Degradation of Cotton by Light, (June, 1976).

No. 310 : Hunter, L., Processing Characteristics of S.A. Wools, Part XI: Influence of Limited Variations in Length and Large Variations in Diameter on the Physical Properties of Yarns Produced from Mixtures of S.A. Wools, (July, 1976).

No. 311 : Barkhuysen, F. A., Liquid Ammonia Mercerisation of Cotton, Part V: The Influence of Anhydrous Liquid Ammonia on Certain Chemical Properties of Cotton, (June, 1976).

No. 312 : Aldrich, De V., Some Spinning and Weaving Trials on Existing and New S.A. Cotton Cultivars, (July, 1976).

No. 313 : Roberts, M. B., A Laboratory Process for Dyeing Wool/Orlon 42 Blends from a Charged Solvent System, (July, 1976).

No. 314 : Van Rensburg, N. J. J., The Flame-Retardant Treatment of 55/45 Wool/Cotton Fabrics with THPOH-Ammonia and a Vinyl Phosphonate Oligomer, (July, 1976).

No. 315 : Turpie, D. W. F. and Musmeci, S. A., The Effect of Different Detergents on the Primary Centrifugal Performance of Wool Scouring Liquors, (July, 1976).

No. 316 : Gee, E., Core Yield as a Theoretical Estimate of Bale Yield in a Changing Regain Situation, (July, 1976).

No. 317 : Gee, E. and Turpie, D. W. F., A Statistical Assessment of the Accuracy of the Measurement of Spinning Potential by the "MSS at Break" Technique, (July, 1976).

No. 318 : Gee, E., Objective measurement of the South African wool clip, part II: Sampling by model T coring equipment in Durban, East London and Port Elizabeth ports.

No. 319 : Gee, E., Hunter, L. and Aldrich, De V., The between bale and between lot variation of South African grown cottons, part I: Micronaire, maturity ratio, fineness, 2,5% span length, uniformity ratio and trash content.

Papers Appearing in Local and Overseas Journals

Veldsman, D. P., SAWTRI – Forschungsarbeit zum diskontinuierlichen und kontinuierlichen Filzfreimachen und Färben von Wolle, *Textil Praxis,* **31**, No. 2, 152 (Feb., 1976).

Veldsman, D. P., The Medical Application of Textile Fibres, *S.A. Textiles* **24** No. 7, 17 (July, 1976).

Veldsman, D. P., Cotton in Modern Textile Technology, *Cotton Boll* (July, 1976).

Strydom, M. A., Cotton Research at SAWTRI, *Cotton Boll,* **6**, No. 2, 3 (May, 1976).

Van Rensburg, N. J. J., Observations on Some Flame-Retardant Treatments of Cotton/Polyester Blended Fabrics, *J. Fire & Flam.* (Fire Retardant Chemistry Suppl.), **2**, 253 (Nov., 1975).

Johnson, D. F., Surface Finishing of Double Knitted Fabrics, *Can. Text. J.*, 93, 59 (June, 1976).

There is a growing interest in the surface finishing of double jersey fabrics, particularly those knitted from continuous filament yarn. The aim is to abrade or break surface loops in such a way that a smooth, plush-like appearance and feel is achieved, giving the fabric a wool-like or natural appearance. For double knits this can be achieved by either napping, or sueding which involves passing the fabric over rapidly revolving rollers covered with sandpaper or other abrasive material. This article discusses some of the factors involved in achieving the desired surface finish.

(L.H.)

Mangialardi, G. J., Micronaire Fineness as Affected by Cotton Ginning, *The Cotton and Gin Oil Mill Press,* 14 (25th October, 1975).

Micronaire was found to be affected by lint cleaning at the gin. There appeared to be two possible reasons for the decrease in micronaire with increase in the number of lint cleaning stages at the gin, viz. the removal of foreign matter by the gin and the preferential removal of coarse fibres from the lint being processed. The first of these possibilities was investigated and found to be responsible for the observed decrease in micronaire value. Nevertheless, the decrease in micronaire value was not considered to be sufficiently large to affect the cash value or the end use value of the cotton.

(L.H.)

Ruppenicker, G. F., Kingsbery, E. C. and Little, H. W., Cotton Fiber Strength – Its Effect on Knitting Yarns and Knitted Fabrics, *America's Textiles, The Knitter, AT-4,* 40 (Oct., 1975).

It was found that significant improvements in the strength of cotton knitting yarns and knitted fabrics can be achieved by utilizing specially selected high-strength cottons although fibre strength had no apparent effect on fabric shrinkage and abrasion resistance. When 20 to 40 *per cent* of an average tenacity polyester was blended with the cotton it was found that the yarn and fabric strength decreased while the abrasion resistance of the fabrics improved. The blended fabrics also suffered smaller strength losses after resin treatment.

(L.H.)

Frick, J. G. and Gautreaux, Gloria, A., The Effect of Fabric Structure in Crosslink Finishing of Knitted Cotton, *America's Textiles, The Knitter, AT-4,* 28 (August, 1975).

In a study of seven plain and patterned cotton knitted fabrics (single and

double jersey), produced from singles yarn, it was found that the response of the fabrics to crosslinking had little dependence upon the knitted structure. The physical state (condition) of the fabric, which could be altered by pre-treatment, was found to be of much greater importance. Crosslinking (i.e. resin treatment) was found to eliminate the major fraction of the shrinkage caused by washing. Pre-shrinkage had to form a part of the resin treatment if the laundry shrinkage was to be reduced to below five *per cent*. Excessive tensions applied to the fabric prior to crosslinking accentuated the need for a preshrinkage treatment. The latter could, under certain circumstances, be used to reduce the amount of resin required and the consequent strength losses suffered by the fabric.

(L.H.)

A NOTE ON THE PROPERTIES OF A BELOW STANDARD GRADE COTTON

by D. P. VELDSMAN and H. TAYLOR

ABSTRACT

A BSG cotton which differed from one used in a previous study in respect of micronaire and trash content was processed into yarn. The yarn tenacity was higher than that measured in the previous study because of its lower micronaire value.

INTRODUCTION

In a previous communication[1] results were recorded on the processing characteristics of a Deltapine BSG cotton and an Acala 1517 good grade cotton and various blends of these. The conclusions arrived at were that, in terms of yarn and fabric properties, the performance of a particular blend can be predicted once the performance of the individual components is known. In this particular instance, the BSG cotton had a relatively high trash content.

It was considered that any further information on the processing behaviour of other BSG cottons having properties which differ significantly from the above would be of great value in assessing their future use in blends with good grade cottons. Consequently, it was decided to process another BSG cotton.

EXPERIMENTAL

Raw Material:

The BSG cotton selected, together with the one used previously, had the following properties:

TABLE I

FIBRE PROPERTIES OF BSG COTTON

	Previously[1]	In this Report
2,5% Span length (mm)	26,7	25,2
Micronaire	3,7	3,3
Fineness	163	150
Maturity ratio	0,79	0,76
1/8-gauge tenacity (cN/tex)	19,6	19,2
Trash content (%)	15,5	5,70

Processing:

The cotton was processed in the blowroom in the normal manner to produce a lap of 9,6 kg. At the carding stage 2,3 *per cent* waste was extracted.

After *two* drawframe passages a 477 tex roving was produced which was spun into 15, 25 and 30 tex yarns respectively, using a metric twist multiplier of 38,0 (4,0 English cotton count). The end breakage rate at 10 000 r/min was well within 5 end breaks/100 spindle hours.

RESULTS AND DISCUSSION

For the sake of clarity, the results of the tests on the BSG cotton used previously and the present one are given in Table I.

It can be seen from Table I that, except for the trash content, the two cottons differ mainly in their micronaire values. Any differences in the yarn properties should, therefore, mainly depend on the influence of this parameter.

The results obtained on the 15, 25 and 30 tex yarns are given in Table II.

TABLE II

YARN PROPERTIES

Nominal Tex		Actual Yarn Tex	Yarn Tenacity (cN/tex)	% Irregularity (CV)	Neps per 1 000 Metres
15	Previous	15,1	11,3	23,3	373
	Current	14,9	13,0	23,2	907
25	Previous	24,6	12,2	21,7	236
	Current	25,5	13,4	19,6	528
30	Previous	30,0	12,6	17,2	188
	Current	31,7	13,9	17,0	343

From the results of Table II it is obvious that the yarns from the current BSG cotton are somewhat stronger (approximately 12 *per cent*). The latter is also about 8 *per cent* finer. This increased yarn strength could most likely be attributed to the increase in the number of fibres per cross-section of the yarn.

ACKNOWLEDGEMENT

The authors are indebted to the Department of Textile Physics for the fibre and yarn tests.

REFERENCE

1. Aldrich, De V., Blending of Two Cottons Differing Widely in Fibre Properties, *S. African Wool and Text. Res. Inst.* Techn. Rep. No. 299 (May, 1976).

THE CAUSTIC MERCERISATION OF COTTON FABRICS
PART I: A LABORATORY INVESTIGATION OF THE VACUUM IMPREGNATION OF CAUSTIC SODA

by H. M. SILVER

ABSTRACT

A heavyweight, plain weave cotton fabric was mercerised with caustic soda at atmospheric and sub-atmospheric pressures. A number of tests were carried out on the fabrics but no improvement in fabric properties resulted from mercerising the fabrics at sub-atmospheric pressures when compared with those mercerised at atmospheric pressures.

INTRODUCTION

The objectives of the mercerising process are, amongst others, dyestuff cost savings, increased lustre and retention of tensile strength after easy-care finishing. Mercerisation is normally achieved by impregnating the cotton fibres in yarn or fabric form with caustic soda, stretching the yarns or fabrics and rinsing. This process, however, is not as efficient as it could be, partly because of the interference of yarn and fabric structure in preventing effective penetration and full swelling[1].

One attempt to improve the uniformity of the mercerising treatment has been made by introducing liquid ammonia mercerisation. While this method results in less swelling of the cotton fibres when compared with the swelling obtained by treatment with caustic soda, the swelling of cotton in ammonia is much more even[2].

The use of vacuum impregnation to aid the even and thorough penetration of a solution into a fabric has been known for some time. Initial work that has been carried out has shown that this technique may be of real value in improving the efficiency of both dyeing and finishing techniques[3, 4]. The use of a vacuum, to achieve constant pressure within the zone 0 to 13,33 kPa (0 to 100 mm Hg), removes air and other gases from the interstices in a fabric. The immediate passage of the fabric from the vacuum into a solution followed by a return to atmospheric pressure "forces the liquid into the substrate against no resistance"[5]. Pressures greater than 13,33 kPa have been found to be not as effective as those in the zone 0 to 13,33 kPa. This results in easier and more uniform wetting out of the fabric.

This paper reports on laboratory investigations to determine whether the technique of vacuum impregnation can be successfully applied to the caustic soda mercerisation of cotton fabrics.

EXPERIMENTAL

Fabric used:

A plain cotton fabric of the following specifications was used throughout:

Mass/unit area	:	185 g/m^2
Ends/cm	:	40
Picks/cm	:	17
Warp yarn linear density	:	28 tex
Weft yarn linear density	:	33 tex

The fabric had been woven, scoured, bleached and desized in a mill. It was found that no further desizing was necessary.

Chemicals used:

Technical grade chemicals were used. The concentration of the caustic soda solution was 19 *per cent* (m/v) unless otherwise stated.

Equipment used:

A vacuum desiccator was adapted and used for all experiments. (See figure 1).

Mercerisation Treatments:

(a) **At Atmospheric Pressure**

The caustic soda solution was poured into the stainless steel dish in the desiccator, with the lid removed. The cotton fabric was submerged in the liquor for either 10 or 30 seconds. The excess caustic was then removed from the fabric which was placed on a pin frame and stretched in the warp direction to the desired dimensions. The fabric was then rinsed in hot and cold water, soured in dilute acetic acid and well rinsed again.

When no stretch was applied, i.e. for slack mercerisation, the fabric was rinsed immediately after impregnating with caustic soda.

(b) **At Sub-atmospheric Pressures**

With the fabric in the stainless steel bowl, a vacuum was drawn to the sub-atmospheric pressure required. The caustic soda was fed into the desiccator via the funnel as fast as possible. The pressure was maintained at approximately the required level throughout. Once the fabric was totally submerged by the caustic soda solution, the pressure in the desiccator was returned to atmospheric. The fabric was removed from the stainless steel dish and then stretched and rinsed as previously described.

To determine the effectiveness of the mercerisation treatments the following tests were carried out on the fabrics:

(i) **Barium Activity Number**

The degree of mercerisation was determined by calculating the Barium Activity Number according to AATCC Test Method 89 – 1971.

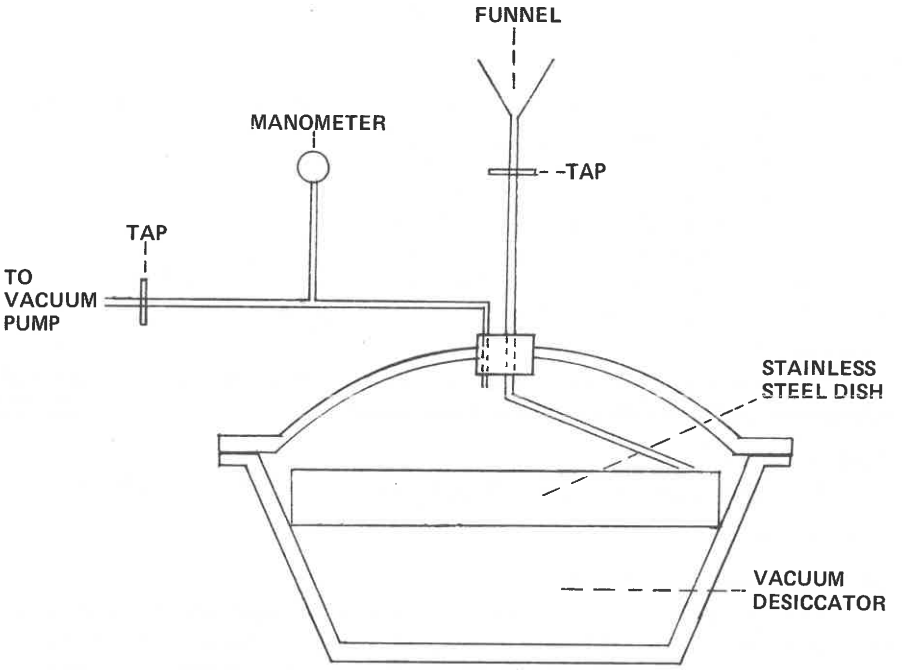

FIGURE 1

(ii) **Iodine Adsorption**

The iodine adsorption of the cotton fabric was determined according to the method described by Hessler and Power[6].

(iii) **Dye fixation**

The percentage exhaustion and fixation of reactive dyes on the fabrics as well as the Kubelka-Munk values of the dyed fabrics were determined. The fabrics were dyed according to the procedures laid down by the dyestuff manufacturers.

(iv) **Breaking Strength and Extension**

The breaking strength tests on the fabrics were carried out on 2 cm wide samples which were extended on the Instron tester with a gauge length of 20 cm.

Warp yarns were removed from the fabrics treated in the first experiment and the breaking strengths and extension of these yarns were determined by extending them on the Instron tester with a gauge length of 20 cm.

(v) **Resin application**

Ten *per cent* solids (o.m.f.) Fixapret CP® conc. was applied to the fabrics. The catalyst used was zinc nitrate at a concentration of 10 *per cent* on mass of resin and Tergitol Speedwet® was used as a wetting agent. These were dried at 100°C and then cured for 3 minutes at 160°C.

(vi) **Crease Recovery Angles**

The Monsanto wrinkle recovery angles were determined by the AATCC method[7]. Creasing and recovery were carried out at standard temperature and relative humidity.

RESULTS AND DISCUSSION

In the *first experiment* two methods of mercerisation were considered: slack, and normal mercerisation in which the fabrics are stretched back to their original dimensions. The fabrics were immersed for 30 seconds when mercerisation was carried out under atmospheric pressure. Three sub-atmospheric pressures were also considered. The results of these tests are listed in Table I. Not one of the properties of the mercerised fabrics showed an improvement. An analysis of variance on the breaking strength and percentage extension results confirmed that there was no significant improvement in the properties of those fabrics which had been treated at sub-atmospheric pressures compared with properties of those fabrics treated at atmospheric pressure.

As no significant improvement resulted from the first experiment, it was decided to determine, *in Experiment 2,* if the addition of a wetting agent to the caustic soda solution would result in improved properties in the mercerised fabrics. Only two pressures, atmospheric (760 mm) and 100 mm Hg, were used. Immersion time of the fabrics was 10 seconds. These results are listed in Table II.

Once again, mercerising the fabrics by vacuum impregnation resulted in no improvement in their chemical and physical properties. In particular, strength losses due to resin treatment were no less than those of fabrics mercerised at atmospheric pressure. The addition of a wetting agent had no effect on the fabric properties.

Two aspects of mercerisation had as yet not been investigated, namely that of varying the concentration of caustic soda and the degree of stretch of the fabric. In the *third experiment,* three concentrations of caustic were used and the fabrics were stretched after immersion in caustic soda to either 95 or 105 *per cent* of their original warp dimensions. No wetting agent was used in this experiment. These results are listed in Table III.

In this third experiment, the breaking strengths of the resin treated fabrics were greater for those which had been mercerised at sub-atmospheric pressure compared with those mercerised at atmospheric pressure. This difference was statistically significant at the 95 *per cent* confidence limit. No other property of the fabrics showed any difference between mercerising at 13,33 kPa pressure (100 mm Hg) or at 101,41 kPa (760 mm Hg). Stretching the fabrics in the warp direction to

TABLE I

RESULTS OF TESTS : EXPERIMENT 1

(a) DEGREE OF MERCERISATION

PRESSURE (mm Hg)	BARIUM ACTIVITY NUMBER		IODINE ADSORPTION (mg I_2/g Cell)	
	Slack	Stretched	Slack	Stretched
760	130	133	14,7	19,7
350	133	135	17,6	21,0
100	135	130	23,1	17,6
50	129	134	21,8	21,8
Unmer-cerised	—		13,4	

(b) DYEING RESULTS*

PRESSURE (mm Hg)	SLACK			STRETCHED		
	% Exh.	% Fixation	K/S Value	% Exh.	% Fixation	K/S Value
760	72,8	50,7	15,7	73,2	49,8	13,7
350	73,1	49,6	15,7	72,8	50,6	13,7
100	73,2	50,3	14,6	72,9	49,1	13,7
50	76,3	50,3	13,3	72,9	49,9	13,3
Unmer-cerised	71,9	48,8	6,6	—	—	—

*Dye used : C.I. Reactive Orange 20

(c) BREAKING STRENGTH AND EXTENSION

PRESSURE (mm Hg)	SLACK				STRETCHED			
	YARN		FABRIC		YARN		FABRIC	
	Breaking Strength (N)	Ext. (%)	Breaking Strength (N)	Ext. (%)	Breaking Strength (N)	Ext. (%)	Breaking Strength (N)	Ext. (%)
760	4,9	12,2	73,9	35,7	4,6	7,4	84,4	16,9
350	5,1	12,3	82,1	37,3	4,6	7,3	81,8	17,2
100	5,0	12,1	69,9	36,5	4,6	6,9	82,8	17,9
50	4,8	11,7	70,9	34,6	4,6	7,4	81,9	17,2
Unmer-cerised	4,7	7,4	82,3	16,2				

TABLE II

RESULTS OF TESTS : EXPERIMENT 2

(a) CHEMICAL PROPERTIES

PRESSURE (mm Hg)	WETTING AGENT (g/ℓ)	BARIUM ACTIVITY NUMBER	IODINE ADSORPTION (mg I_2 g Cell)	DYEING RESULTS*		
				Exhaustion (%)	Fixation (%)	K/S Value
760	0	131	47,2	61,1	36,6	9,0
760	5	129	60,5	59,7	35,1	9,3
100	0	135	68,6	64,6	36,3	9,7
100	5	128	44,9	63,7	35,3	9,5
Unmercerised	–	–	28,2	55,8	31,0	4,6

*Dye used : C.I. Reactive Red 4.

(b) PHYSICAL PROPERTIES

PRESSURE (mm Hg)	WETTING AGENT (g/ℓ)	BREAKING STRENGTH (Newtons)		EXTENSION (%)		CREASE RECOVERY ANGLE (Degrees)	
		No resin	Resin-treated	No resin	Resin-treated	No resin	Resin-treated
760	0	817	427	14,7	8,0	155	298
760	5	843	387	13,4	7,8	161	296
100	0	856	441	14,6	8,3	162	295
100	5	860	433	15,2	7,9	158	296
Unmercerised	–	829	384	14,9	7,6	170	290

105 *per cent* of their original dimension resulted in an increase in the breaking strength of the fabrics. This result, however, is known. This was even more noticeable with the resin-treated fabrics. An increase in caustic soda concentration resulted in a higher Barium Activity Number but concentrations as high as 25 *per cent* are uneconomical.

TABLE III

RESULTS OF TESTS CONDUCTED ON FABRICS MERCERISED IN EXPERIMENT 3

Pressure (mm Hg)	Caustic Soda (%)	Stretch (%)	Barium Activity Number	Dye Fixation* (%)	Breaking Strength (Newtons)		Crease Recovery Angle (Degrees)	
					No resin	Resin-treated	No resin	Resin-treated
760	15	95	109	32,8	743	260	170	306
760	15	105	109	35,4	848	407	157	299
100	15	95	110	34,2	726	296	165	298
100	15	105	111	32,2	800	433	174	299
760	19	95	128	33,6	763	293	168	300
760	19	105	130	35,5	827	415	175	298
100	19	95	136	36,9	777	289	180	300
100	19	105	138	32,8	809	470	165	298
760	25	95	156	36,2	753	340	174	295
760	25	105	155	33,6	774	499	180	296
100	25	95	162	35,2	865	352	183	300
100	25	105	162	34,5	806	525	193	301
Unmer-cerised	—	—	—	30,9	776	355	177	304

*Dye used : C.I. Reactive Blue 4.

SUMMARY AND CONCLUSIONS

A heavyweight cotton fabric was mercerised with caustic soda at atmospheric and sub-atmospheric pressures. Various tests were carried out on the fabrics. No improvement in fabric properties was found due to mercerisation under sub-atmospheric conditions when compared with fabrics which were mercerised at atmospheric pressure.

ACKNOWLEDGEMENTS

The author wishes to thank Mrs P. Creed for her technical assistance, as well as the Physics Department of SAWTRI for carrying out the physical tests.

THE USE OF PROPRIETARY NAMES

The fact that proprietary names have been used in this report in no way implies that there are no substitutes which may be of equal or even better value.

Tergitol® is a registered trade name of Cyanamid. Fixapret® is a registered trade name of BASF.

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A COMPARISON OF THE KNOT STRENGTH OF PHORMIUM TENAX AND SISAL

by L. HUNTER and S. SMUTS

ABSTRACT

The tenacities, knot tenacity in particular, of Phormium tenax and sisal (single fibres as well as twisted strands) have been compared. It was concluded that, in this respect, sisal was superior to Phormium tenax with the latter apparently more brittle than the former.

INTRODUCTION

Sisal is one of the fibres extensively used for the production of cords and twines. It was decided to investigate the feasibility of using *Phormium tenax* for this purpose in an attempt to extend its market and usage. One of the first steps was to evaluate those tensile properties of the fibre which were considered important for the end-use envisaged. Breaking strength and, more particularly, knot strength of single fibres and twisted fibre strands were regarded as important in this context and form the subject of this report. Values obtained on sisal were used as a basis of reference when evaluating the results obtained on *Phormium tenax*.

EXPERIMENTAL

Two lots each of *Phormium tenax* and sisal, all in fibre form, were covered in this study, these being as follows:

Sisal (A): This refers to a commercial sample of sisal fibre.
Sisal (B): This fibre was decorticated at SAWTRI.
Phormium tenax (C): This sample of fibre had been decorticated at SAWTRI some months previously, while
Phormium tenax (D): was decorticated shortly before the tests were carried out.

The tests were carried out on the fibres singly and when they were twisted (Z-twist) to form strands consisting of approximately 10 fibres each. Knot strength and normal breaking strength tests were carried out on both the single fibres and twisted fibre strands. The single fibres were tested with a gauge length of 10 mm and a rate of extension of 2 mm/min, while the twisted strands were tested at a gauge length of 50 mm and a rate of extension of 10 mm/min. The tests were carried out on an Instron tensile tester and were similar to the British Standards tests (BS 1932, Parts 1 and 2, 1965).

The twisted strand was obtained by combining about 10 fibres and then inserting the required twist (Z-twist) by hand. In all cases the linear density of the

TABLE I

BREAKING AND KNOT STRENGTHS OF *PHORMIUM TENAX* AND SISAL SINGLE FIBRES AND TWISTED STRANDS

Sample	Resultant Linear Density (tex)	Breaking Strength (N)			Tenacity (cN tex)		
		Normal Test	Knot Test	Ratio (%)	Normal Test	Knot Test	Ratio (%)
Single Fibres:							
Sisal (A)	32,8	18,7	5,4	29,0	57,0	16,5	28,9
Sisal (B)	39,4	21,7	6,7	30,8	55,1	17,0	30,9
Mean	36,1	20,2	6,1	30,0	56,0	16,8	30,0
Phormium tenax (C)	24,0	12,8	2,8	21,9	53,3	11,7	22,0
Phormium tenax (D)	27,1	11,9	3,2	27,1	43,9	11,8	26,9
Mean	25,6	12,4	3,0	24,5	48,6	11,8	24,5
Twisted Strands:							
Twist Factor = 20 (≈1,0 t.p.cm)							
Sisal (A)	371	139	69,6	50,1	37,5	18,8	50,1
Sisal (B)	360	139	69,6	50,1	38,6	19,3	50,1
Mean	366	139	69,6	50,1	38,1	19,1	50,1
Phormium tenax (C)	394	144	58,8	40,8	36,5	14,9	40,8
Phormium tenax (D)	421	127	49,0	38,6	30,2	11,6	38,4
Mean	408	136	53,9	39,7	33,4	13,3	39,6
Twist Factor = 25 (≈1,25 t.p.cm)							
Sisal (A)	404	123	74,0	60	30,4	18,3	60
Sisal (B)	417	143	83,3	58	34,3	20,0	58
Mean	411	133	78,9	59	32,4	19,2	59
Phormium tenax (C)	407	121	57,8	48	29,7	14,2	48
Phormium tenax (D)	406	113	54,8	48	27,8	13,5	49
Mean	407	117	56,3	48	28,8	13,9	49
Twist Factor = 30 (≈1,5 t.p.cm)							
Sisal (A)	373	106	71,5	67	28,4	19,2	68
Sisal (B)	402	110	81,3	74	27,4	20,2	74
Mean	388	108	76,4	71	27,9	19,7	71
Phormium tenax (C)	432	104	54,9	53	24,1	12,7	53
Phormium tenax (D)	417	109	51,9	48	26,1	12,4	48
Mean	425	107	53,4	51	25,1	12,6	51

fibres (or strands) was determined prior to the tensile test with the one-half of the sample subjected to the normal tensile test and the other half subjected to the knot test. Three different levels of twist, viz. 1,0 t.p.cm, 1,25 t.p.cm and 1,5 t.p.cm corresponding to metric twist factors (t.p.cm $\sqrt{\text{tex}}$) of 20, 25 and 30, respectively, were inserted.

Solely out of interest, some tests were also carried out on a few commercial sisal twines (cords) at test lengths of 50 mm and 500 mm, respectively.

The results of the various tests are given in Tables I and II.

RESULTS AND DISCUSSION

From Table I it is clear that, for both the fibres and the twisted strands, the knot strength of the sisal was superior to that of the *Phormium tenax*. This also applied to the normal breaking tenacity of the fibres and strands. Thus, for instance, the single fibre tenacity of the sisal was about 56 cN/tex and that of the *Phormium tenax* was about 49 cN/tex with the ratio of knot tenacity to normal tenacity being about 30 *per cent* and 25 *per cent*, respectively.

For the twisted strands the difference between sisal and *Phormium tenax* was even more pronounced, not so much for the normal breaking (or tensile) tenacity, but for the *knot tenacities* with, if anything, the higher twist levels accentuating this difference. It is interesting to note that the normal breaking strength and tenacity of both the sisal and the *Phormium tenax* decreased with an increase in

TABLE II

KNOT STRENGTHS OF SOME COMMERCIAL SISAL TWINES

Sample	Resultant Linear Density (tex)	Breaking Strength (N)			Tenacity (cN/tex)		
		Normal Test	Knot Test	Ratio (%)	Normal Test	Knot Test	Ratio (%)
50 mm Gauge Length:							
E (Dry Sisal)	2766	701	382	54,5	25,3	13,8	54,5
F (Sisal Gold)	2524	577	352	61,0	22,9	13,9	60,7
G (Green Binder)	2136	490	259	52,9	22,9	12,1	52,8
Mean	2475	589	331	56,1	23,7	13,3	56,0
500 mm Gauge Length:							
E (Dry Sisal)	3033	715	474	66,3	23,6	15,6	66,1
F (Sisal Gold)	2599	537	319	59,4	20,7	12,3	59,4
G (Green Binder)	2449	496	332	66,9	20,3	13,6	67,0
Mean	2694	583	375	64,2	21,5	13,8	64,2

twist whereas the knot strength (and tenacity) reached a peak at 1,25 t.p.cm (i.e. at a twist factor of 25). Nevertheless, the effect of twist on the knot strength was slight with the result that the ratio of knot tenacity to normal tenacity increased significantly with twist due to the concomitant decrease in the normal breaking strength and tenacity. All this indicates that the *Phormium tenax* fibre is considerably more brittle than the sisal fibre, which appears to make it unsuitable for such end-uses where a high knot tenacity is regarded as essential. The tenacity values presented in Table II for the commercial twines are generally lower than those obtained on the twisted strands, which is not unexpected in view of the fact that for the twisted strands the fibres were clamped at both ends, i.e. no fibres ended within the length of strand under test. Nevertheless, the ratio of knot tenacity to normal tenacity was of the same order as that shown in Table I for the twisted sisal strands. As expected, the longer gauge length resulted in a lower normal tenacity and consequently in a higher ratio.

SUMMARY AND CONCLUSIONS

The tensile properties, in particular the knot strength and ratio of knot strength to normal strength, of sisal and *Phormium tenax* single fibres and twisted strands have been compared. The aim of the study was to try and assess the merits of using *Phormium tenax* for cords and twines. The knot strength and knot tenacity were taken as criteria with the values for sisal being used as a basis of reference.

Different amounts of twist, corresponding to twist factors of 20, 25 and 30, were inserted into the strands of fibres and the normal and knot tenacities of such strands were then determined. The normal tenacity, knot tenacity and their ratio were generally lower for *Phormium tenax* than for sisal with the differences in the case of the last two properties becoming more pronounced as the twist was increased. The twisted sisal strands had a normal tenacity of the order of 33 cN/tex, a knot tenacity of the order of 19,5 cN/tex and a ratio for knot tenacity to normal tenacity of the order of 60 *per cent* (the latter being highly dependent upon twist), whereas the corresponding values for the *Phormium tenax* strands were of the order of 29 cN/tex, 13,3 cN/tex and 47 *per cent,* respectively. The results indicated that *Phormium tenax* is more brittle than sisal and that it may, therefore, not be suitable for end-uses where brittleness is a disadvantage.

The work described in this report is being followed up by a commercial trial in which about 1 000 kg of decorticated *Phormium tenax* will be processed into twines on processing machinery used for sisal. The performance of the *Phormium tenax* will then be evaluated.

ACKNOWLEDGEMENTS

The authors are indebted to Dr D. P. Veldsman for initiating this study and to Mr A. J. Lappin of Messrs Ropes and Mattings, Durban, for supplying some of the material. This report has been published by kind permission of Mr D. Vermeulen of the Department of Industries.

THE TREATMENT OF ALL COTTON AND 67/33 COTTON/WOOL BLENDS WITH THPOH AND LIQUID AMMONIA. A PRELIMINARY REPORT

by N. J. J. VAN RENSBURG and F. A. BARKHUYSEN

ABSTRACT

The effect of THPOH and liquid ammonia on the LOI values and certain physical properties of all-cotton and cotton/wool fabrics was investigated. It was found that a treatment with THPOH, followed by a treatment with liquid ammonia produced fabrics with LOI values higher than 27,0. The LOI values were, however, lower than those obtained by the conventional THPOH/ammonia vapour treatment. The THPOH/liquid ammonia treatment significantly increased the breaking strength and resistance of flat abrasion of both fabrics, but slightly reduced the tear strength of the all-cotton fabrics and the bursting strength of the cotton/wool fabrics.*

INTRODUCTION

The flame-retardant treatment of cotton with THPOH is a well-established finishing routine, especially in the U.S.A. The process involves the treatment of cotton with a THPOH solution, drying of the fabric to a moisture content of 5 to 25 *per cent,* followed by polymerisation in ammonia gas and oxidation with hydrogen peroxide[1]. The treatment has no adverse effect on the strength of the cotton and produces fabrics with a better handle than does any other flame-retardant.

Recently Calamari *et al*[2] indicated that THPOH could be polymerised on the fabric by treatment in a saturated solution of ammonia in isopropanol, or in liquid ammonia. In the latter case, however, very little information was given and it was therefore decided to investigate this aspect in greater detail.

SAWTRI has been actively involved in the treatment of cotton fabrics with liquid ammonia. A chainless merceriser was built and the effect of liquid ammonia on the properties of the fabrics has been studied in depth[3–5]. In general it was found that a liquid ammonia treatment had a beneficial effect on the cotton fabrics. This report describes the treatment of cotton with THPOH, followed by a treatment with liquid ammonia in the chainless merceriser with the object of imparting flame-retardant as well as mercerisation properties to the fabrics. It was recently shown that the conventional THPOH treatment could be successfully applied to wool/cotton blends[6] and consequently all-cotton as well as cotton/wool blended fabrics were used in this investigation.

*Tetrakis- (hydroxymethyl)-phosphonium hydroxide

EXPERIMENTAL

Materials:

Laboratory grade chemicals and commercial grade anhydrous liquid ammonia were used to treat a lightweight all-cotton plain weave fabric (128 g/m^2) and a 67/33 cotton/wool 2/2 twill fabric (140 g/m^2).

Treatments:

The THPOH solutions were made up according to the normal method[1]. Initially some small-scale laboratory trials were carried out. The fabrics were padded with the THPOH solutions on a Benz laboratory padder, air-dried to the required moisture content and then treated on a tensioning frame in liquid ammonia. After removal of the ammonia by heat, the fabrics were treated with a five *per cent* H_2O_2 solution, rinsed and dried. In subsequent pilot-scale experiments the fabrics were padded with THPOH solutions on a Peter Konrad padder, followed by air-drying to the required moisture content, and treatment with liquid ammonia on the SAWTRI liquid ammonia merceriser. The fabrics were stretched six *per cent* in the warp direction, the contact time in the liquid ammonia was five seconds and the ammonia was removed from the fabrics by heat. The fabrics were then oxidised with five *per cent* H_2O_2, rinsed and dried.

Tests:

The consolidation of the fabrics during the liquid ammonia treatment and the dimensional stability of the treated fabrics during washing in a Cubex apparatus were determined in the normal manner[4]. The various physical properties of the fabrics were determined as usual[5]. The limiting oxygen index (LOI) values of the fabrics were determined on an MKM JD-14 Oxygen Index Tester. The durability of the flame-retardant treatments to washing[6] was studied by washing the fabrics in an automatic washing machine at 60°C. Each washing cycle lasted 30 minutes.

RESULTS AND DISCUSSION

The results obtained from the laboratory trials are given in Tables I and II. Table I shows that treatment of the fabrics with 30 *per cent* THPOH, followed by drying to various levels and a treatment in liquid ammonia, increased the LOI values to different degrees. The best results were obtained when the fabrics were dried to a moisture content of about 20 *per cent*, which, inter alia, is also the recommended value for the conventional THPOH/ammonia gas treatment. The addition of urea and either methylated methylolmelamine or dibasic sodium phosphate to the THPOH did not increase the LOI values of the fabrics containing moisture. The LOI values of the bone-dry fabrics, however, were increased to some extent when compared with the THPOH only treatments. Drying of the fabrics containing THPOH, urea and methylolmelamine or dibasic sodium phosphate to a bone-dry state was carried out at 100°C, and this probably resulted in some curing

or polymerisation of the flame-retardant prior to the liquid ammonia treatment. All the LOI values were, however, lower than those values normally obtained with the THPOH/ammonia vapour treatment and none of the all-cotton fabrics and only one cotton/wool fabric had a LOI value greater than 27,0 after washing.

TABLE I

THE LOI VALUES OF COTTON AND COTTON/WOOL FABRICS TREATED WITH THPOH AND LIQUID AMMONIA

TREATMENT	LOI after			
	0	3 washing Cycles	0	3 washing Cycles
	Cotton		Cotton/wool	
30% THPOH – bone dry – NH_3	22,3	22,3	25,8	25,5
30% THPOH – 20% moisture – NH_3	25,8	25,1	26,5	26,5
30% THPOH – 70% moisture – NH_3	24,3	23,6	25,1	25,1
30% THPOH + 10% urea + 10% MMM* – bone dry – NH_3	25,8	25,5	–	–
30% THPOH + 10% urea + 10% MMM – 20% moisture – NH_3	24,0	22,8	–	–
30% THPOH + 10% urea + 10% MMM – 70% moisture – NH_3	23,4	21,8	–	–
30% THPOH + 8% urea + 4% dibasic sodium phosphate – bone dry – NH_3	27,9	26,1	30,3	28,3
30% THPOH + 8% urea + 4% dibasic sodium phosphate – 20% moisture – NH_3	24,0	21,8	28,3	24,8
30% THPOH + 8% urea + 4% dibasic sodium phosphate – 70% moisture – NH_3	22,3	20,7	27,5	25,8
Untreated	18,2	–	20,2	–
30% THPOH – 20% moisture-ammonia gas (conventional treatment)				

*MMM : methylated methylolmelamine

TABLE II

THE EFFECT OF THE IMMERSION TIME IN LIQUID AMMONIA ON THE LOI VALUES OF COTTON TREATED WITH THPOH

TREATMENT	TIME IN LIQUID NH_3 (SEC)	LOI After	
		0	3 washing cycles
30% THPOH – 20% moisture – NH_3	5	25,8	25,8
" "	15	25,5	25,5
40% " "	5	28,5	28,5
" "	15	26,1	26,1

Some further laboratory experiments were then carried out to establish the effect of different immersion times in the liquid ammonia on the LOI values of the cotton fabrics. The results, given in Table II, clearly show that the LOI values of the fabrics decreased when the time of immersion in the liquid ammonia was increased. This is probably due to extraction of some of the THPOH from the fibres by the liquid ammonia, and this aspect is to be studied in greater detail. It therefore seems advisable to employ the shortest contact time possible when liquid ammonia is used for the polymerisation of the THPOH on the fibres. Table II furthermore shows that it is possible to increase the LOI values of the fabrics to values higher than 27,0 by the application of 40 *per cent* THPOH and the use of a contact time of five seconds in liquid ammonia.

Some pilot trial experiments were then carried out. The fabrics were padded with solutions of THPOH on a Peter Konrad padder, followed by liquid ammonia treatment on the SAWTRI chainless liquid ammonia merceriser. The results obtained are given in Tables III and IV. Treatment of the fabrics with liquid ammonia improved the dimensional stability of the all-cotton as well as the cotton/wool fabrics. (See Table III.) Pretreatment with THPOH reduced this effect to some extent, but the dimensional stability of the fabrics treated with THPOH/liquid ammonia was, however, still better than that of the untreated fabrics.

The crease recovery angles of the fabrics treated with THPOH/liquid ammonia were lower than those of the fabrics treated with liquid ammonia only. (See Table IV.) The breaking strength of the fabrics treated with THPOH/liquid ammonia was significantly higher than that of the untreated fabrics or the fabrics treated with liquid ammonia only. A similar tendency was observed in the case of the breaking extension results. The bursting strength of the fabrics was decreased by the treatment with liquid ammonia. In the case of the all-cotton fabrics, however, the THPOH/liquid ammonia treatment produced fabrics with a higher bursting strength than the untreated fabrics or the fabrics treated with liquid ammonia only. The

TABLE III

THE EFFECT OF THPOH AND LIQUID AMMONIA ON THE DIMENSIONAL STABILITY OF COTTON AND WOOL/COTTON FABRICS

FABRIC	TREATMENT	TOTAL AREA SHRINKAGE (%) AFTER			
		Relaxation	30 min. wash	60 min. wash	120 min. wash
All-cotton	Untreated	5,7	7,2	5,9	8,8
	Liquid ammonia	4,4	3,6	3,8	5,0
	30% THPOH, liquid ammonia	2,6	4,2	5,8	6,2
	40% THPOH, liquid ammonia	3,6	5,0	4,5	6,9
67/33 cotton/ wool	Untreated	7,1	6,6	7,4	7,7
	Liquid ammonia	2,8	4,8	4,3	4,7
	30% THPOH, liquid ammonia	4,9	6,1	6,0	6,6
	40% THPOH, liquid ammonia	4,9	6,4	5,9	4,7

tear strength of the all-cotton fabrics was increased by the liquid ammonia treatment, and decreased by the THPOH/liquid ammonia treatment. In the case of the cotton/wool blend, however, the THPOH/liquid ammonia treatment produced fabrics with a *higher tear strength* than the liquid ammonia only treatment. In general the liquid ammonia treatment had little effect on the resistance of the fabrics to flat abrasion, while the THPOH/liquid ammonia treatment seemed to improve the resistance of the fabrics to flat abrasion, especially in the case of the all-cotton fabrics. Liquid ammonia had little effect on the bending length of the fabrics, while the THPOH/liquid ammonia treatment increased it slightly.

Finally, the LOI values of the fabrics treated with liquid ammonia on the SAWTRI liquid ammonia merceriser are shown in Table IV. It can be seen that the all-cotton as well as the cotton/wool fabrics could be rendered flame-retardant, i.e. LOI values higher than 27,0 could be obtained. The fact that slightly higher values were obtained in the case of the all-cotton fabric is probably due to slight differences in the moisture contents of the fabrics as they entered the liquid ammonia merceriser.

TABLE IV

THE EFFECT OF THPOH AND LIQUID AMMONIA ON CERTAIN PHYSICAL PROPERTIES OF COTTON AND COTTON/WOOL FABRICS

FABRIC	TREATMENT	Monsanto crease recovery angle (degrees)	Breaking Strength (N)	Breaking Extension (%)	Bursting Strength (kN/m^2)	Tear Strength (N)	Flat abrasion (% mass loss after 10 000 cycles)	Bending length (cm)	LOI after 5 washing cycles
All-cotton	Untreated.	159	448	20,2	672	15,3	6,5	2,00	18,2
	Liquid ammonia.	193	413	26,0	577	18,5	6,1	2,10	17,8
	30% THPOH, liquid ammonia.	174	482	25,2	718	11,3	3,1	2,43	27,2
	40% "	160	476	27,0	680	10,1	3,5	2,26	28,3
70/30 cotton/wool	Untreated.	247	333	13,5	940	18,0	9,0	1,40	20,2
	Liquid ammonia.	258	347	14,5	731	19,0	10,0	1,40	20,2
	30% THPOH, liquid ammonia.	232	373	18,8	714	27,7	7,2	1,65	26,5
	40% "	216	429	18,8	673	20,9	9,0	1,81	27,5

SUMMARY

All-cotton and 67/33 cotton/wool fabrics can be rendered flame-retardant by padding with THPOH, drying to about 20 *per cent* moisture content, followed by a treatment in liquid ammonia instead of ammonia vapour. For the *same level* of THPOH add-on, slightly lower LOI values were obtained when the fabrics were padded through liquid ammonia instead of a treatment with ammonia vapour. This was probably due to extraction of some of the THPOH from the fibres by the liquid ammonia. When the contact time of the fabric in the liquid ammonia was reduced, the LOI values of the fabrics increased. Attempts to increase the LOI values of the fabrics by the addition of urea and methylated methylolmelamine or sodium phosphate to the THPOH were not successful.

Certain physical properties of fabrics treated with THPOH, followed by liquid ammonia in the SAWTRI liquid ammonia merceriser, were determined. The dimensional stability of the fabrics treated with THPOH/liquid ammonia was slightly lower than that of fabrics treated with liquid ammonia only, but still better than that of the untreated fabrics. The breaking strength of the fabrics treated with THPOH/liquid ammonia was significantly higher than that of untreated fabrics or fabrics treated with liquid ammonia only. The THPOH/liquid ammonia treatment increased the resistance of the fabrics to flat abrasion. It furthermore also increased the tear strength of cotton/wool fabrics, but decreased that of the all-cotton fabrics.

The various treatments did not have an adverse effect on the handle of the fabrics.

ACKNOWLEDGEMENTS

The authors wish to thank the Director, Dr D. P. Veldsman, for initiating the project. They are also indebted to Miss C. Strydom and Mrs S. Buchanan for valuable technical assistance, and to the Textile Physics Department for carrying out the physical tests.

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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.