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SAWTRI BULLETIN

SOUTH AFRICAN
WOOL TEXTILE RESEARCH INSTITUTE
OF THE CSIR

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PORT ELIZABETH

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SAWTRI BULLETIN

Editor: M. A. Strydom

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TECHNICAL PAPERS:

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Port Elizabeth

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INSTITUTE NEWS

Dr D. P. Veldsman Takes Up New Position

The Director of SAWTRI for the last 16 years, Dr D. P. Veldsman, left the Institute at the end of May after a career in textiles spanning some 28 years. A double-M.Sc and D.Sc, he started his career with the old South African Wool Textile Research Institute in Grahamstown in 1951, and apart from a 4 year period in industry, he spent his entire professional career at SAWTRI. During his 16 years as Director, he not only extended the scope of the Institute's activities to include a cotton research programme and a Division for Clothing Technology, but has also occupied the Philip Frame Chair of Textile Technology at the University of Port Elizabeth since 1967. He served on numerous national and international committees related to textiles and textile science and is the recipient of various awards in recognition for distinguished services to the textile industry.

Dr Veldsman has been appointed successor to Mr S. D. van der Merwe as Director of the Port Elizabeth Technikon (formerly known as College for Advanced Technical Education).

Meetings, Visits and Lectures

Dr Veldsman addressed members of the Döhne Merino Stud Breeders' Association at a one-day symposium recently held at the Döhne Research Station near Stutterheim. Two interesting points were raised on this occasion, namely that the fact is often overlooked that *natural fibres* (wool and cotton) also provide a source of *protein* (mutton and oilseed), and that the *energy consumption* in producing synthetics is significantly higher than in the case of the natural fibres. Dr Veldsman has also been invited to read a paper on future trends in wool and mohair processing at the 21st Anniversary of the Faculty of Agriculture at the University of the Orange Free State in Bloemfontein.

Recent meetings were also held to discuss financial support for SAWTRI's research programme. It is with great appreciation that we can announce renewed contributions by the Rhodesian Cotton Growers' Association and the South African Cotton Board for cotton research and the Department of Industries for *Phormium tenax* research.

Dr Veldsman recently returned after a two-week overseas trip which included his last official attendance of the annual meeting of the IWS Research and Development Committee in Ilkley, UK.

Mr *Mike Cawood,* head of SAWTRI's newly-established Clothing Technology Division also recently returned after six months' training at WIRA.

This year is ITMA year. It has always been SAWTRI's policy to keep abreast with the latest developments in textile engineering, and this year will be no exception. Dr N. J. J. van Rensburg of the Textile Chemistry Division will

Dr L. Hunter, centre, talking to Dr A. R. Haly, left, and Dr M. Andrews of the CSIRO's Division of Textile Physics during their recent visit to SAWTRI.

Examining SAWTRI's lightweight wool shirting fabric are, from the left, Messrs. Tamura of Kanebo Ltd., P. Stucken of Stucken & Co., and T. Suka of the Mitsubushi Corporation, Japan.

Discussing some recent fabric development projects, from the left, Mr G. A. Robinson of the Knitting and Weaving Group and Mr N. J. Vogt, CSIR Regional Liaison Officer, Messrs T. Altham and J. Haarer of the IWS and Mr M. A. Strydom of SAWTRI.

SAWTRI's Clothing Technology Division recently had a Reliant fusing press installed. Here Mr Mike Cawood, Head of the Division, prepares some interlinings for fusing.

be covering the wet processing side while Messrs J. Klazar and G. A. Robinson of the Technical Services Group and the Knitting, Weaving and Clothing Technology Division, respectively, will be covering the rest of the field. ITMA 1979 is scheduled for October 2nd - 11th in Hannover, West Germany.

Visitors:

Visitors to SAWTRI over the last three months included:

Mr Dick Wagner, International Vice-President of Automatic Material Handling Inc., Greenville, South Carolina. Mr Wagner lectured to SAWTRI staff on the Bale-o-Matic and Simpla Doff systems marketed by AMH;

Mr Tom Hibbert, Chairman of British Mohair Spinners and Chairman of the International Mohair Association;

Dr A. R. Haly and *Dr M. Andrews* of the CSIRO's Division of Textile Physics, Ryde, Australia;

Mr Terence Altham, HQ Product Director, Womenswear, of the IWS, London;

Mr Horst Haarer, Deputy Director of the IWS's Austria, Germany and Switzerland region.

Mr Steve Davies of the Rhodesian Cotton Promotion Council, Salisbury;

Mr R. Strathmore of Gatooma Cotton Mills;

Mr Y. Tamura, Manager, Raw Wool Department, Kanebo Ltd., Osaka, Japan;

Mr T. Suka, of the Mitsubishi Corp., Osaka, Japan.

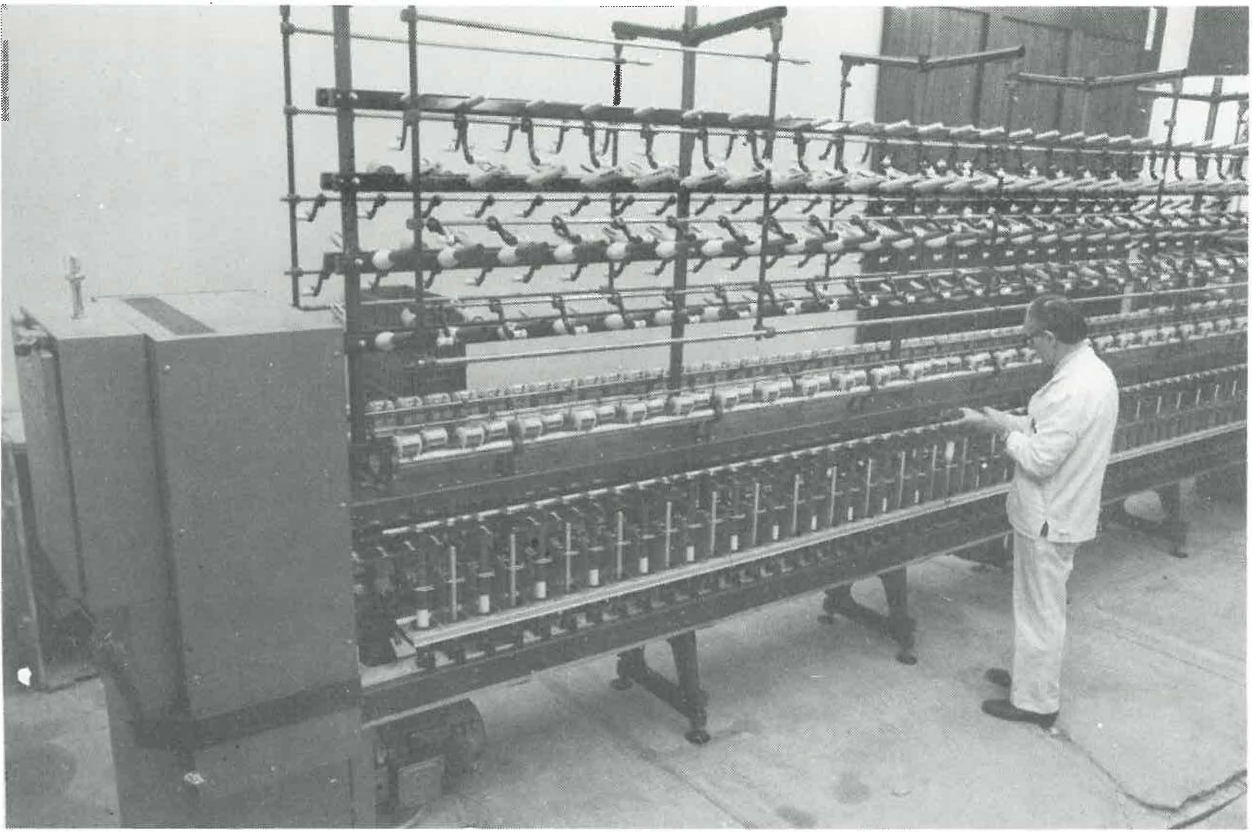
Increase in SAWTRI's Subscription Fee and Tariff Rates

The annual subscription fee (to local firms) has been R100 for the past 13 years while the service conditions and tariff schedules for testing have last been amended in 1974. Being a non-profit organisation has allowed the Institute to absorb large increases in labour, printing and material costs over the years, but in order to maintain our external sources of revenue at a realistic level, it had become necessary to consider increases in both subscription fees and tariffs for testing. Letters to this effect have been sent to all our subscribers.

Although the proposed increase in subscription may look dramatic (from R100 to R400 per annum), subscribers will have the benefit of a free "current awareness" information service (similar to the ® Wirascan service), as well as priority as far as testing services are concerned. Non-subscribers' enquiries will have to be wait-listed while the tariffs for such tests will be the standard rates plus 50%. Details concerning the current awareness service for textiles and the increased tariffs will be discussed in detail in a circular to be issued in the near future.

New Library Acquisitions

SAWTRI's library is continually expanding by the purchase of new textbooks and other sources of information. It has been decided that the *Bulletin*



SAWTRI's spinning plant recently installed this Platt Saco Lowell Twistomatic twisting frame with 120 spindles, to be used for conventional twisting as well as for uptwisting of Repco WCS yarns should also be used to bring news of this kind to our readers' attention, and in this issue we commence by listing a selection of new titles received since the beginning of 1979. Future listings will be done at intervals depending on how these new acquisitions are received. Subscribers of SAWTRI are reminded that books may be borrowed from the library through the interlibrary loan scheme.

Rapid Dyeing: Proceedings of a Shirley Institute Conference held on 9th November, 1977.

Contract Carpeting: Reference book for specifiers, architects, contractors and interior decorators in the UK.

Standard Methods for the Determination of Colour Fastness of Textiles and Leather, 4th Ed. (1978).

The Design of textiles for Industrial Applications: Proceedings of 61st Annual Textile Institute conference, 1977.

The Dyeing and Chemical Technology of Textile Fibres, 5th Ed.

The HATRA Sewing Room Technical Handbook.

New and Special Fibres: Proceedings of the American Chemical Society Conference, Chicago, 1975.

Polyvinyl Alcohol — Properties and Applications (Ed. C.A. Finch)

International Textile Review (Ed. P. York)

The Performance of Textiles, by D. S. Lyle.

Progress Report: 1980 Wool Textile Research Conference

The current position with regards to the organisation of the Conference is that synopses of the papers are being received for scrutiny by the Organising Committee. At this stage some 20 countries are involved. The Committee has also been extended by the appointment of *Mr W. MacDonald,* Managing Director of Gubb & Inggs Ltd, representing the Woolwashers & Carbonisers Association.

A choice of two pre-conference tours are currently also being organised. Both these tours will extend over 3 days, with sufficient time for delegates to reach Pretoria in time for registration and the official opening of the Conference on Tuesday, September, 26th. One tour is planned to cover the wine and fruit farms of the Western Cape while the other will be a wool/mohair tour of the Eastern Cape.

A firm decision has also been made regarding advertising in the official Conference Brochure. Local firms who are interested in advertising in the Brochure can contact the conference Secretariat of the CSIR in Pretoria regarding the rates.

New Subscribers

A word of welcome to the following new subscribers: Messrs Natal Thread (Pty) Ltd., Hammarsdale, Messrs Melbro Knitwear (Pvt) Ltd., Bulawayo, Messrs Security Mills (Pvt) Ltd., Bulawayo, Messrs Rieter AG, Winterthur, Switzerland.

Staff Matters

New appointments to the staff are:

Mr A. T. Vermaak, M.Sc. (Stellenbosch) as Research Officer in the Textile Physics Division;

Mrs F. C. Steyn as Assistant Technician in the Clothing Technology Department. Mrs Steyn holds a Diploma in Clothing Manufacture from the Cape Town Technikon;

Miss D. L. Wratten as Assistant Technician in the Textile Chemistry Division.

SAWTRI PUBLICATIONS

Technical Reports

No. 447 : Barkhuysen, F. A., The Dyeing of Wool in Liquid Ammonia, Part I: Preliminary Trials Using a Reactive Dye (April, 1979).

Other Publications

Strydom, M. A., The Dimensional Stability of Wool Worsted Fabrics in Making-Up. *Text. Ind. Southern Africa,* **2** (5), 5 (April, 1979).

Veldsman, D. P., Textile Research in South Africa, *J. Dietetics & Home Economics* **7** (1), 17 (1979).

Artzt, P., **Production of Fine Cotton Rotor Yarns.** *Textile. Praxis Int.,* **34** (1), V and 20 (1979).

It is claimed that combing is unnecessary for fine cotton rotor yarns (20 tex), there being little difference between the tensile properties of fine carded and combed rotor yarns, with the carded rotor yarns generally more even than the combed ring yarns. Finer slivers generally perform better than coarser ones when spinning fine rotor yarns, the optimum draft lying between about 140 and 170. The yarn strength is related to the fibre strength, with the micronaire value affecting the spinning limits.

(LH)

Coble, R. L. and Brian, S. B., **Possibility of Polyester in Open End Spinning,** *Text. Ind.,* **143** (2), 50 (1979).

The authors review the problems and potential of polyester in rotor spinning. It is estimated that of the 175 x 10^6 kg of yarn spun on rotor machinery during 1976 (which represents some 6% of the total spun yarn production) only about 10% was polyester. With improvements in fibres and machinery it is expected that by 1980 the total rotor yarn production will grow to about 500 x 10^6 kg, of which about 32% will be polyester. It is further estimated that of the total rotor spun yarn production some 56% will go into apparel uses, about 16% into home furnishing and 23% into industrial fabrics. The apparel usage of rotor yarns will be about 60% knitted fabrics and about 40% woven fabrics, while for furnishings it will be about 75% woven fabrics and about 25% knitted. It is stated that the break-even point for rotor- and ring yarns is about 60 tex for rotor machines with trash removal devices and about 23 tex for rotor machines without cleaning. The article further points out that the less labour-intensive nature of rotor spinning will be the chief factor affecting its growth. Fibre crimp, tenacity, modulus and finish greatly affect the performance of polyester in rotor spinning, with the high modulus (stiffer) fibres generally performing better.

Low levels of fibre finish are also preferable. Finer fibres give stronger yarns but more deposit. The formation of deposits is a major problem when spinning polyester, with high levels of fibre delustrant producing more deposit. Shorter and finer fibres often improve yarn quality. Narrow V-grooves are preferred for fine yarns and broader V-grooves for coarser yarns. Fine yarns tend to produce fewer end breakages and less opening roller deposit than the coarser yarns, the latter probably being a function of the amount of fibre fed.

(LH)

Kampen, W., **Einfluss Verschiedener Maschinenparameter auf die Eigenschaften Rotorgesponnener Wollgarne und Analyse der Rotorablagerungen,** *Melliand Tekstilber. Int.,* **60** (1), 18 (Jan., 1979).

Using two tops having methylene chloride extracts of 0,85 and 0,5% respectively (on conditioned mass), the authors found that the effect of the opening rollers on fibre shortening was small. However, as expected, an *increase in speed* of the opening rollers also increased fibre shortening, and they recommend that a speed of 6 000 rev/min should not be exceeded. Furthermore, the *type* of opening roller clothing was found to be of importance — a double-needled opening roller gave a lower mean fibre length.

It was also established that at an opening roller speed of 6 000 rev/min, using a single pinned opening roller, and after 4 hours spinning, the *self-cleaning* effect of the rotor was so great that the amount of residue in the rotor groove remained constant. For the double-pinned roller, however, the residue was still increasing after 4 hours.

To enhance the self-cleaning effect, experiments with a newly designed rotor were also carried out. This rotor, having a groove angle of 40°, was found to have a much better self-cleaning effect.

(DPV)

Anon., **Controlling the Fusing Process,** *Br. Cloth. Manuf.,* **15** (1), 37 (Jan., 1979).

The article deals with some vital factors in the fusing operation. The importance of maintaining the interface temperature, i.e. the *glueline temperature,* required for fusing, is emphasised. To counteract heat losses, the setting of the thermostat must be *higher* than the actual interface temperature required. Each fabric, whether face fabric or interlining, will absorb heat at different rates, depending on their thermal capacities which in turn are dependent on fibre type, fabric construction, and thichness.

Normally, on a continuous fusing press the laminate of fabric and interlining are heated from *both* sides. Therefore, heat transfer is by conduction. Hence, the glueline temperature will not be reached immediately. *Fusing time* is therefore as important as fusing temperature. Furthermore, the thermostat settings and temperatures achieved vary from one machine type to another. Consistent and adequate *pressure* towards the end of the heating cycle is vital for *continuous presses.*

As far as methods of fusing are concerned, *sandwich fusing* is used on both discontinuous and continuous presses, but particularly on the latter. However, *single fusing* with the interlining on top of the face fabric is the most common and safest method.

(DPV)

Anon, **Wash your Cotton and Get Rid of OSHA,** *America's Text. Rep./Bull. At-8,* No. 2, 16 (1979).

One large American mill finds that washing its raw cotton, at a cost of approximately 5 to 10 c/kg reduces cotton dust levels to acceptable levels. The cotton is processed into yarn without undue difficulty, only a slight drop in yarn strength being observed. However, a fibre finish, primarily a lubricant, is required to facilitate processing.

It is possible to bleach, and dye, the cotton. Steaming or autoclaving does not appear to be as effective as washing.

Additives can also reduce cotton dust by 40 to 70%.

(LH)

Murray, M. F. and Folk, C. L., **Self-Cleaning OE Spinning Rotors May Solve Clogged Groove Problems,** *America's Text. Rep./Bull., AT-8,* No. 2, 22 (1979).

In the case of a Toyoda rotor frame of the BD-200 type, holes drilled in the groove of the rotor improved their self-cleaning effect without adversely affecting yarn properties or end breakage rates. Futhermore, these yarns produced less linting during knitting. Although some fibre was removed through the holes, this was very slight. It would be necessary, however, to clean the perforations thoroughly during down-time.

(LH)

Carnaby, G. A., **The Waxing of Wool Yarns for Tufting,** *WRONZ Rep. No. 56* (Oct. 1978).

The waxing of wool yarns during winding and also on a tufting machine was investigated.

Waxing with paraffin wax during winding significantly reduced yarn breakages during tufting and increased carpet soiling only marginally. Waxing on the tufting machine is of some benefit for weak yarns or yarns which are difficult to process.

(LH)

Anon, **Energy Saving in the Dyeing and Finishing of Textiles,** *Int. Dyer,* **161** (8), 336 (20th April, 1979).

Four papers by Mr P. Jonas, Mr J. Thackray, Dr J. G. Roberts and Mr J. Jongbloet, recently presented at a Shirley Institute seminar, are summarized. Mr Jonas (Department of Energy) said that the North Sea oil supplies would run out in 15—20 years. Energy conservation in the textile industry was, therefore, of vital importance. Companies should appoint "energy managers" to examine the feasibility of energy conservation projects. Mr J. Thackray (Severn-Trent Water Authority) said that five new directives, relating to water quality, have been proposed recently. All these would have a bearing on cost. Dr Roberts (Shirley Institute) said that 550 one-day visits have been made in the textile industry. Studies showed that 17-25% of energy costs could be saved. Specific samples were given where £60 000 per annum could be saved. Examples of reducing energy costs in the boiler house, factory services, lighting, etc. were given. Mr Jongbloet discussed combined water recycling and steam generation with the IBK system and said that at least 25 p/m^3 effluent is saved by water recycling and steam generation. This system will be on exhibition at ITMA in October.

(NJJvR)

A NOTE ON DIELECTRIC DRYING AND HOT AIR OVEN DRYING OF LIGHTWEIGHT FABRICS

by G. H. J. VAN DER WALT and D. P. VELDSMAN

There seems to be a lot of uncertainty about the *economic viability* of dielectric drying (sometimes erroneously called *microwave* drying), and generally called radio-frequency drying (which, *inter alia,* incorporates both dielectric and microwave[1]).

According to the most recent literature on this aspect, dielectric heating definitely appears to be more economical than *hot air drying*. According to a U.K. report[2] which quotes electricity costs at 1,7 p/kWh (i.e. 2,7 cents/kWh), the cost of drying dyed *packages* (presumably wool) amounts to 1 c/kg yarn. If the average moisture content of the packages before drying was, say, 55%, then to dry off 500 g moisture per kg of yarn would amount to *0,002 c/g moisture*. On the other hand, steam-heated hot air drying costs *0,006 c/g moisture,* according to the same source.

Here at SAWTRI we have a small-scale dielectric dryer with an output of 1,5 kW at 13,56 MHz (Pye Thermal Bonders Ltd), having a staggered heating system with adjustable electrodes for drying. Using a lightweight cotton fabric (plus minus 130 g/m^2) padded to a moisture pick-up of 80% and using a drying speed of approximately 1 m/min, to dry the fabric to a regain of approximately 5%, the cost of electricity (at the current rate of 1,9 c/kWh), amounted to *0,003 c/g moisture evaporated.* By using a laboratory Benz continuous electrical drying oven at a similar speed and a drying temperature of 100°C, the drying cost amounted to *0,0033 c/g moisture* evaporated. This calculation, of course, did not take congnisance of the initial warming up of the oven. In both cases the cost of electricity to drive a fan (for vapour extraction) was ingored.

Comparative costs for other (heavier) types of fabrics will be discussed in greater detail at a later stage.

Although SAWTRI's calculations differ to a certain extent from those quoted in the overseas source, it would appear that the current cost of dielectric drying compares favourably with electric oven drying. One should also take cognisance of the neatness of this technique of drying, the limited floor space and the overall affect on the fabric as such. Japanese workers[3,4] recently claimed that resin-finished cotton fabrics dried by microwave heating are superior to those conventionally dried in respect of the lower degree of resin migration towards the fabric surface which, in turn, leads to better strengths and handle.

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THE USE OF GLYCIDYLTRIMETHYLAMMONIUM CHLORIDE TO IMPROVE THE DYEING EFFICIENCY AND WET FASTNESS PROPERTIES OF COTTON

by N. J. J. VAN RENSBURG

ABSTRACT

The use of glycidyltrimethylammonium chloride to improve the dyeing efficiency and certain fastness properties of different dyes on cotton was evaluated. It was found that a pretreatment of cotton with glycidyltrimethylammonium chloride generally reduced the fixation of reactive cotton dyes which were applied according to the cold pad-batch procedure. A pretreatment or a simultaneous treatment also increased the percentage acid wool dye which exhausted onto cotton. The fastness properties of the acid dyed samples, however, were very poor.

A treatment with glycidyltrimethylammonium chloride also significantly increased the percentage exhaustion of direct dyes onto cotton. A pretreatment generally produced better dyeing efficiencies and fastness properties than a simultaneous treatment, or an aftertreatment which generally gave the worst results.

INTRODUCTION

There is a wide range of treatments available for improving the fastness of dyes on cotton[1]. These treatments can be applied to the cotton at various stages, namely before, during or after the dyeing step and involve the use of various chemical compounds. Several authors have reported on the use of amino epoxy compounds for the modification of cotton to increase the affinity of the fibre for dyes[2—4]. More recently some papers have been published on the use of quaternary ammonium epoxy compounds in the dyeing of cotton with acid, direct or reactive dyes[5—8]. It is claimed that compounds such as glycidyltrimethylammonium chloride can be added directly to the dyebath without changing the stability of the bath[9]. Furthermore, this treatment is claimed to improve the dyeing efficiency and fastness properties of certain dyes on cotton. In the case of exhaust dyeings, a pretreatment with glycidyltrimethylammonium chloride is apparently the only suitable method, while a pretreatment or simultaneous treatment can be used in the case of pad-batch or pad-thermosol treatments. The pretreatment is said to produce slightly better results than the simultaneous treatment with reactive dyes. In the case of the direct dyes, however, the simultaneous treatment is said to be more advantageous[9].

It has been claimed that glycidyltrimethylammonium chloride is the only quaternary ammonium epoxy compound which can be produced economically in a pure state for use in dyeings[9]. Furthermore, substantial savings of dyestuffs can be obtained with this compound, due to the increase in the degree of fixation of dye. It was decided, therefore, to initiate a study to evaluate the efficiency of glycidyltrimethylammonium chloride as a fixing agent for a range of dyes on cotton.

EXPERIMENTAL

A lightweight, bleached all-cotton fabric (130 g/m^2) was used in this study. The glycidyltrimethylammonium chloride which was used in this study was a commercial product, namely ® Glytac A100. All other chemicals were of laboratory grade quality while the dyes were commercially available products.

Three series of experiments were carried out using reactive and direct cotton dyes as well as acid wool dyes. In the case of the reactive dyes the cold pad-batch technique, as recommended by the dyestuff manufacturers was employed, using untreated cotton as well as cotton which had been pretreated with 20 g/*l* Glytac A100 according to the method described by Rupin[9]. The direct dyes were applied to the fabrics by an exhaustion process using untreated cotton, or cotton which had been pretreated with Glytac A100. In some cases the dyed fabrics were aftertreated with Glytac A100 and in some other cases a simultaneous exhaustion treatment with dye plus Glytac A100 was employed. The acid wool dyes were applied to untreated cotton or cotton which had been pretreated with Glytac A100 by an exhaustion process.

Dye exhaustion was determined spectrophotometrically. The amount of dye fixed onto the cotton was determined either after rinsing the fabric in cold water or after boiling for 15 minutes in water containing 1% ® Ultravon HD. Fastness tests were carried out in the usual manner.

RESULTS AND DISCUSSION

The results obtained with certain *reactive cotton dyes,* when applied to the fabrics according to the cold pad-batch method, are shown in Table I. The dyes were applied to untreated samples as well as to cotton fabrics which had been pretreated with 20 g/*l* Glytac A100. It can be seen that the pretreatment with Glytac generally had an adverse effect on the fixation values of most of the dyes studied. On average the percentage dye fixation, as determined by cold water extraction after batching for 24 hours, decreased by about 20% as a result of the treatment with Glytac A100. Only in the case of Reactive Red 125 did a pretreatment seem to offer a slight advantage. In general, the Glytac A100 pretreatment did not seem to improve the fastness properties of the fabrics. Table I also shows that the degree of fixation of the dyes increased when the batching time increased from 24 to 48 hours. Furthermore extraction with hot water tended to give higher fixation values than extraction with cold water. This indicates that the temperature of the rinsing bath could possibly effect the degree of fixation of the dyes. Rupin[9] did not specify the

TABLE I

THE EFFECT OF A PRETREATMENT WITH GLYTAC A100 ON SOME PROPERTIES OF COTTON FABRICS DYED WITH REACTIVE DYES ACCORDING TO THE COLD PAD-BATCH TREATMENT

Dye (2%)	Glytac pre-treatment (20 g/*l* at 80% wet pick-up)	% Dye left on fabric after batching for			Wash Fastness			Alkaline Perspiration fastness			Rubbing Fastness	
		24 hours		48 hours								
		Cold Water Extract	Hot Water Extract	Cold Water Extract	Effect on Shade	Staining		Effect on Shade	Staining		Dry	Wet
						Cotton	Wool		Cotton	Wool		
Reactive Red 2*	No	48,0	62,2	66,9	4	4	3-4	4	3-4	3-4	5	5
Reactive Red 2	Yes	25,2	41,7	56,1	4	4	3-4	4	3-4	3	5	3-4
Reactive Red 2**	No	67,1	73,7	77,8	3	3-4	3-4	4	2	2	5	3-4
Reactive Red 2	Yes	50,4	61,7	47,4	4	3-4	4	4	2-3	2-3	5	3
Reactive Red 58***	No	46,4	63,5	66,1	4	5	4	4	4-5	4-5	4	3-4
Reactive Red 58	Yes	33,3	56,5	63,6	4	4	4	5	3-4	4	5	4
Reactive Red 120(S)***	No	73,3	85,6	86,7	4-5	3-4	3-4	4	3-4	3-4	5	4
Reactive Red 120(S)	Yes	63,5	64,7	64,7	2	3	3-4	3	2-3	3	5	4-5
Reactive Red 125****	No	89,6	89,6	90,9	3	2-3	3-4	3	3	2-3	5	3-4
Reactive Red 125	Yes	88,9	92,7	93,3	4	4	4	3	3-4	4	3	3

*Treated with 20 g/*l* soda ash

**Treated with 4 g/*l* soda ash plus 16 g/*l* sodium bicarbonate

***Treated with 15 g/*l* sodium hydroxide plus 30 g/*l* sodium chloride

****Dried at 60°C, padded through sodium silicate, followed by batching

TABLE II

THE EFFECT OF GLYTAC A100 ON THE EXHAUSTION AND COLOUR FASTNESS OF COTTON FABRICS DYED WITH ACID WOOL DYES

Dye	Glytac Treatment	Dye Exhaustion (%)	ISO 3 Wash Test			Alkaline perspiration fastness			Rubbing Fastness	
			Effect on Shade	Staining		Effect on Shade	Staining		Dry	Wet
				Wool	Cotton		Wool	Cotton		
Acid Yellow 25:1	None	11,0	ALL DYE STRIPPED FROM FABRIC			1	3	5	5	5
Acid Yellow 25:1	Pretreated	25,0				1	2	4-5	5	4-5
Acid Yellow 25:1	Simultaneous	21,9				1	2-3	4-5	5	4-5
Acid Red 259	None	18,2				2	1-2	1-2	5	4
Acid Red 259	Pretreated	28,9				2	2	2	5	4
Acid Red 259	Simultaneous	27,8				2	1-2	1-2	5	4
Acid Blue 277	None	15,1				2	2	2	5	4
Acid Blue 277	Pretreated	21,7				2	1-2	2	5	4
Acid Blue 277	Simultaneous	17,5				2	1-2	2	5	4

temperature of his rinsing bath, but he did soap the samples at 100°C, which could have affected his fixation values.

In some further studies the treatment of cotton with *acid wool dyes* and Glytac A100 was evaluated. Untreated cotton samples as well as fabrics which had been pretreated with Glytac A100 were dyed with three different acid dyes. Furthermore, a simultaneous treatment with dye plus Glytac A100 was studied. The results are given in Table II. It can be seen that the percentage dye which exhausted onto the fabric was increased by a pretreatment with Glytac A100, as well as by the simultaneous Glytac A100/dye treatment. The pretreatment generally resulted in higher dye exhaustion values. The fastness to washing (ISO 3 test) and the alkaline perspiration fastness of the samples were, however, very poor and this treatment can, therefore, not be considered suitable.

In a third series of experiments the effect of Glytac A100 on some properties of cotton fabrics dyed with *direct cotton dyes* was investigated. The Glytac A100 was applied to the fabrics prior to, during, or after the dyeing stage. The results are given in Table III. It can be seen that, as far as dye exhaustion was concerned, the use of Glytac A100 proved to be advantageous. The average

TABLE III

THE EFFECT OF GLYTAC A100 ON THE EXHAUSTION AND COLOUR FASTNESS OF COTTON FABRICS DYED WITH DIRECT DYES

Dye	Glytac Treatment	Dye Exhaustion (%)	ISO 3 Wash Test			Alkaline perspiration			Rubbing Fastness	
			Effect on Shade	Staining		Effect on Shade	Staining		Dry	Wet
				Wool	Cotton		Wool	Cotton		
Direct Orange 61	None	24,5	4	5	3	5	5	4	5	3-4
Direct Orange 61	Pre-treated	59,5	4	5	3	5	5	4	5	4
Direct Orange 61	Simultaneous	51,0	4	5	3	5	5	4-5	5	4
Direct Orange 61	After treated		4	5	3	4	4	3	5	3
Direct Green 26	None	15,5	4	4-5	3	4	5	5	5	4
Direct Green 26	Pre-treated	44,7	5	4-5	4-5	5	4-5	4	5	4-5
Direct Green 26	Simultaneous	40,8	5	4-5	4	5	4-5	4	5	4-5
Direct Green 26	After treated		5	4-5	4	3	4-5	3	5	3
Direct Blue 207	None	53,0	4	4-5	3-4	5	5	5	5	4-5
Direct Blue 207	Pre-treated	86,7	5	5	5	5	5	5	5	4
Direct Blue 207	Simultaneous	83,9	5	4-5	4	5	5	5	4	5
Direct Blue 207	After treated		4	5	2	4	5	5	5	3
Direct Blue 189	None	13,9	4	4-5	4	4	4	4	5	4-5
Direct Blue 189	Pre-treated	47,2	4	4-5	4-5	5	4	3-4	5	4-5
Direct Blue 189	Simultaneous	39,4	4	4-5	4-5	4	3	3-4	5	4-5
Direct Blue 189	After treated		3	4-5	3	4	2	2	3	5
Direct Brown 119	None	31,1	3	4-5	3	3	4	4	5	4-5
Direct Brown 119	Pre-treated	81,7	5	4-5	4	5	5	5	5	4
Direct Brown 119	Simultaneous	79,6	4	4	3-4	5	4-5	4-5	5	4
Direct Brown 119	After treated		3	4	3	4	5	4-5	5	3

percentage dye exhaustion onto untreated cotton was about 30%, which increased to more than 60% when Glytac A100 was used. The effect was more pronounced with certain dyes than with others, but in practically all the cases the dye exhaustion could be doubled by a treatment with Glytac A100. A pretreatment gave slightly higher exhaustion values than a simultaneous treatment (± 8,5%). These results are in agreement with the findings of Rupin on certain direct cotton dyes[9]. Table III furthermore shows that the treatment with Glytac A100 generally slightly improved the fastness to washing (ISO 3 test). The effect of the alkaline perspiration fastness was not pronounced nor consistent. A pretreatment generally gave the best wash- and alkaline perspiration fastness. Both a pretreatment and the simultaneous treatment improved the rubbing fastness of the samples slightly, whereas it deteriorated slightly in the case of an aftertreatment with Glytac A100.

SUMMARY

The use of Glytac A100 (glycidyltrimethylammonium chloride) to improve the dyeing efficiency and certain fastness properties of different dyes on cotton was evaluated. In the case of reactive cotton dyes, applied by the cold pad-batch process, a pretreatment with Glytac A100 generally decreased the dye fixation by about 20%.

The effect of Glytac A100 on the dyeing of cotton with acid wool dyes was also investigated. It was found that a treatment with Glytac A100 increased the dye exhaustion considerably, but unfortunately the fastness properties of the samples were very poor.

The effect of various treatments with Glytac A100 on some properties of cotton fabrics dyed with direct cotton dyes was investigated. Glytac A100 was applied to the fabrics prior to, during, or after the dyeing stage. Treatment with Glytac A100 generally increased the dye exhaustion from about 30% to more than 60%. A pretreatment with Glytac A100 gave slightly higher exhaustion values than the simultaneous treatment. The effect on the wet fastness properties of the fabrics was, in general, relatively small, with the pretreatment giving the best results, and the aftertreatment the worst results.

ACKNOWLEDGEMENTS

The technical assistance of Mr S. Musmeci is greatly appreciated and the permission of the Rhodesian Cotton Promotion Council to publish this report is gratefully acknowledged.

THE USE OF PROPRIETARY NAMES

® Glytac is the proprietary name of Messrs Protex and ® Ultravon of Messrs Ciba-Geigy. The fact that products with proprietary names have been used in this publication does not mean that there are not other products of equal or greater merit.

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THE USE OF INFRARED SPECTROSCOPY TO IDENTIFY CERTAIN SHRINKRESIST RESINS AND POLYETHYLENE SOFTENERS ON WOOL FIBRES

By E. WEIDEMAN and N. J. J. VAN RENSBURG

ABSTRACT

A method is described whereby the presence of a methylolmelamine resin on wool can be detected by means of infrared spectroscopy after dissolving the wool in sodium hydroxide. Similar attempts to detect a polyamide epichlorohydrin resin were unsuccessful, due to the similarity between the spectra of wool and the polyamide resin. However, it appears possible to detect the presence of a polyethylene softener on the shrinkresist treated wool, using this method.

INTRODUCTION

There are various methods available for the quantitative determination of resins on fibres[1]. Most of these utilise gas chromatographic techniques and are based on the assumption that the identity of the resin on the fibre is known[2-3]. It is frequently necessary, however, to detect the presence of unknown resins on fibres. These qualitative identification tests are normally based on staining or spot tests, but in some cases solubility tests may be used.

Various chemically different resins are used for the shrinkresist treatment of wool. In the case of wool which had been shrinkresist treated with a polyamide epichlorohydrin resin the following staining agents or dyes have been found useful in practice[2]: CI. Reactive blue 1, Reactive blue 75, Acid Blue 85 and Basic Blue 140. In the case of wool which had been treated with a melamine resin certain staining tests could be used to detect the presence of a melamine resin on the wool[1]. In general, however, staining tests are not very specific and erroneous conclusions could be reached when the analysis of a sample is based on spot tests only.

Another more specific technique which could be used for the identification of resins on wool is infrared (IR) spectroscopy. This method has found widespread use in the textile field. It has been used, for example, for the identification of flame-retardants[4], resins[5,6] and softeners on fabrics[7]. Furthermore IR spectroscopy can be used for determining the composition of wool/cotton blends[8]. For the shrinkresist treatment of wool relatively low add-on levels of resin (1,0 to 2,5% o.m.f.) are normally employed. The conventional IR techniques can normally not be used to detect the presence of such low concentrations of resin. When the resin is deposited on the fibre surface special infrared techniques, such as attenuated total reflectance (ATR) or multiple internal reflection (MIR) are used. Specialised equipment and techniques are required for ATR and MIR analyses and it was desirable, therefore, to develop some other methods which could be used to detect the presence of resin or polymer on the fibre.

One approach[9] is to dissolve the wool selectively so as to retain the shrinkresist resin in the form of insoluble tubes. It was decided to investigate the possibility of using this differential dissolving technique together with IR spectroscopy for detecting the presence of certain shrinkresist resins and softening agents on wool.

EXPERIMENTAL

Material

A plain weave woven wool fabric (140 g/m^2) was used for the various treatments.

Chemicals

Laboratory grade chemicals were used. For the shrinkresist treatments commercially available aminoplast resin (® Aerotex M3) or polyamide epichlorohydrin resin (® Hercosett 125) were used. In some cases a commercially available softening agent (® Mystolube S) was used together with the resin.

All the percentages are expressed as mass per volume and all solutions were used at room temperature (about 25°C), except where indicated otherwise.

Apparatus

A Benz laboratory apparatus was used for the shrinkresist treatments. A Pye-Unicam infrared spectrophotometer was used for the IR studies.

Shrinkresist Treatments

The fabrics were chlorinated with DCCA[10] (® Basolan DC, 1,5% active chlorine in 10% acetic acid), followed by padding with the resin solutions to a wet pick-up of 100%. In the case of the aminoplast resin the fabrics were padded with a solution containing 2% Aerotex M3 acid colloid resin[11]. In some cases the resin bath contained 0,5% Mystolube S. The fabrics were air dried and cured for 12 minutes at 120°C. The Hercosett 125 resin (2%) was padded onto the fabric and the softener was applied afterwards in a bowl before drying and curing at 90°C for 15 minutes.

Dissolution of resin-treated wool samples

The wool samples were dissolved in sodium hydroxide according to the method described by Makinson[9]. The insoluble residue or resin tubes were centrifuged, washed and centrifuged till free from sodium hydroxide. The residues were finally dried at 100°C and stored in a desiccator over silica gel. For reference purposes the IR spectra of the various resins and the softening agent were determined in a similar manner. The IR spectra of the various residues were determined in the usual manner using potassium bromide discs.

In some cases the samples (2 g wool or the tubes obtained after the NaOH treatment) were boiled for 5 minutes in 20 ml trichloroethylene. The solutions were filtered and concentrated to about 0,5 ml . Each concentrate was then poured onto a sodium chloride crystal and the solvent was evaporated by hot air. The IR spectra of the solvent-soluble matter were then determined.

RESULTS AND DISCUSSION

A summary of the IR absorption spectra of the commercial resins and softener, as well as the spectra of the residues or tubes obtained after dissolving the various wool samples in sodium hydroxide, are presented in Table I. It should be clear that there is very little difference between the spectra of the residues of untreated wool, chlorinated wool and the chlorinated Hercosett/ Mystolube treated wool. This is due to the fact that, basically, both wool and Hercosett are polyamides which contain a large percentage of -CO-NH- groups. There is, however, a shift in the absorption band obtained at 3 300 cm^{-1} by the untreated and chlorinated wool samples to 3 400 cm^{-1} for the chlorinated Hercosett/Mystolube treated wool. This shift is probably due to the absorption band shown by Hercosett at 3 450 cm^{-1} and Mystolube at 3 460 cm^{-1}. In general, however, it is inadvisable to use the proposed technique to detect the presence of Hercosett resin on wool fibres.

Table I shows, however, that the presence of the melamine resin (Aerotex M-3) could be established through the presence of certain melamine absorption bands at 820, 1 350, 1 500 and 1 580 cm^{-1}, respectively. The last absorption band (at 1 580 cm^{-1}) is the strongest in the spectrum of Aerotex, as well as in that of the residue obtained from the Aerotex treated wool. This band, together with the band at 820 cm^{-1}, therefore, appears to be the most useful for identifying the melamine resin. Jayme[6] used the bands at 1 560 cm^{-1} and 2 900 cm^{-1} for the quantitative determination of melamine resins on paper. Some wool tops, which had been treated during industrial trials with the chlorine/Aerotex acid colloid process were analysed by this method and the presence of the melamine resin on the wool was positively identified through the infrared absorption bands mentioned above.

It was also possible to detect the presence of the polyethylene softener (Mystolube) on the Aerotex/Mystolube treated wool. When the tubes obtained after the sodium hydroxide treatment were extracted with hot trichloroethylene, followed by IR analysis of the extract, characteristic bands shown by Mystolube were found at 725, 735, 2 860 (second strongest) and

TABLE I

CHARACTERISTIC INFRARED ABSORPTION BANDS SHOWN BY THE RESINS* SOFTENING AGENT AND THE VARIOUS WOOL SAMPLES

SAMPLE	ABSORPTION BAND (cm^{-1})													
1. Residue** — Untreated wool	580			1110	1250	1310	1420 1465		1560	1665 ++		2850	2920 ++ 2960	3300 ++
2. Residue** — Chlorinated Wool (1,5% chlorine)	580			1110	1250		1465		1540	1665 ++		2850	2920 + 2960	3300 +
3. Residue** — Hercosett/ Mystolube wool	580			1110	1250		1420 1470		1560	1660 ++		2850	2920 + 2960	3400
4. Residue** — Aerotex wool	580		820	1110		1350		1500 +	1580 ++				2920 2940	3400
5. Residue** — Aerotex/ Mystolube wool	580		820	1110		1350		1500 +	1580 ++			2850	2920 2960	3410
6. Hercosett 125	580			1150	1250	1390	1460		1560	1650 ++	1730		2920 2960	3450 ++
7. Hercosett 125/ Mystolube (2:1)	580			1110	1250	1390	1470		1560	1650	1730	2850 +	2920 ++ 2950	3450
8. Mystolube		725 735		1110	1255	1360 1380	1470				1720 1735	2860 +	2940 ++	3460
9. Aerotex	580		820	1100		1350		1500 +	1580 ++		1750		2930	3400
10. Aerotex/ Mystolube (2:1)	580	725	820	1110		1350		1500 +	1580 ++			2850	2920	3410
11. Trichloro-ethylene soluble fraction of 5			820	1110	1250	1350	1470	1500	1580		1720	2855 +	2930 ++	3460
12. Trichloro-ethylene soluble fraction of 3		725 735		1110	1260	1390	1470				1720	2510 2620 2860 +	2930 ++	3400
13. Trichloro-ethylene soluble fraction of 2				1110	1260	1390	1470				1730	2860 +	2930 ++	3440

*All resin-treated wool samples had been pretreated with 1,5% active chlorine. The ratio of resin to softening agent was 2:1 in all cases. The add-on level of resin was 2% in all cases.

**The residue which remained after the wool had been dissolved in sodium hydroxide.

++ Strongest band.

+ Second strongest band.

2 930 cm^{-1} (strongest). The IR spectra of the trichloroethylene extracts of the chlorinated wool samples showed certain bands which were similar to those given by Mystolube, namely at 2 860 and 2 930 cm^{-1}. In the latter case, however, the presence of the two bands at 725 and 735 cm^{-1} indicated the presence of Mystolube. McCall *et al*[6] stated that these two bands (doublet) are characteristic of polythylene softening agents. In a similar manner it was possible to detect the presence of Mystolube in the residue of chlorinated Hercosett/Mystolube treated wool. The possible interference of spinning lubricants and other processing auxiliaries has not been investigated.

SUMMARY

The presence of a melamine type resin (Aerotex M3) on shrinkresist-treated wool can be detected by dissolving the wool in sodium hydroxide followed by the IR analysis of the insoluble residue or resin tube. The identification is based on the presence of absorption bands at 820, 1 350 and 1 500 cm^{-1} and a strong band at 1 580 cm^{-1} given by the Aerotex M3 resin.

This technique cannot be used in the case of Hercosett treated wool, due to the similarities between the spectra of wool and that of Hercosett.

It is also possible to detect the presence of a polyethylene softening agent on shrinkresist treated wool by extracting the residues with hot trichloroethylene, followed by infrared analysis of the extract. Characteristic bands can be observed at 725 and 735 cm^{-1}. It is, however, possible that other processing auxiliaries could give rise to similar bands and this possibility is to be investigated in more detail at a later stage.

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THE USE OF PROPRIETARY NAMES

® denotes registered trade marks. ® Aerotex M3 is the trade mark of Messrs Cyanamid, ® Hercosett 125 of Messrs Hercules Inc., ® Mystolube S of Messrs Catomance, ® Basolan DC of Messrs BASF.

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

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A GUIDE TO IRREGULARITY AND BREAKING STRENGTH OF RWCS MOHAIR YARNS

by D. W. F. TURPIE, L. HUNTER and S. G. MARSLAND

ABSTRACT

Values for irregularity and breaking strength of RWCS mohair yarns are given for a selection of mohair tops ranging from 25 to 40 μm in mean fibre diameter.

INTRODUCTION

Although the production and properties of Repco wrapped core-spun (RWCS) yarns in wool[1] and mohair[2,3] have been reported earlier, no study has been undertaken to establish typical properties of such yarns containing mohair, when fibre diameter and the number of fibres in the yarn cross-section are varied systematically. Such information is required to enable spinners to select the most suitable diameter fibre for a certain yarn linear density and yarn performance (quality) in terms of tensile and irregularity characteristics. It was, therefore, decided to undertake a study in which mohair RWCS yarns with different numbers of mohair fibres in their cross-section are produced and to relate the yarn tensile and evenness properties to the mohair fibre diameter and the number of fibres in the yarn cross-section.

EXPERIMENTAL

Six different mohair tops were autolevelled, drawn and spun on a Repco Mk.1 spinning machine into wrapped core-spun (RWCS) yarns. Both core and binder threads were of 22 dtex nylon multifilament. The linear densities of the yarns were varied so as to produce yarns having about 20, 30 and 40 *mohair* fibres in the cross-section. (Each of the nylon yarns contained 7 filaments.) The draft on the Repco was maintained constant throughout at 22, and the roving linear densities adjusted accordingly. Spinning was carried out at 220 m/min .

After spinning, all yarns were uptwisted to a tex twist factor of 25,8 (worsted twist factor 2,2). This relatively low twist factor was selected so as not to lose too much lustre in the yarn. The yarns were steamed at 90°C then conditioned and tested for irregularity, breaking strength and extension on the Uster range of testing equipment. Hairiness was measured at a distance of 3 mm on the yarn taken from spinning tubes, using a Shirley Yarn Hairiness meter.

RESULTS AND DISCUSSION

The physical properties of the mohair tops together with the yarn results for irregularity, breaking strength and extension are given in Table I. The

TABLE I

RESULTS OF IRREGULARITY, BREAKING STRENGTH AND EXTENSION

Lot	Mean fibre diameter (µm)	CV (%)	Mean fibre length (mm)	DCM-extractable matter (%)	Yarn Linear Density (tex)	Thin places per 1 000 m	Thick places per 1 000 m	Neps per 1 000 m	Irregularity (CV in %)	Breaking Strength (cN)	Tenacity (cN/tex)	Extension (%)	Hairiness (Hairs/m)
A	24,7	32	72	1,0	18	1016	542	1111	25,5	243	13,9	25,2	20
					25	361	206	397	21,6	300	11,9	25,8	19
					32	156	54	165	18,6	347	10,7	23,2	34
B	26,7	30	81	1,2	20	1200	601	1297	26,9	257	12,4	23,1	28
					28	691	324	673	22,8	289	10,0	20,2	29
					36	366	120	282	20,4	363	9,8	22,2	40
C	27,1	28	87	1,2	20	1049	541	1154	26,7	252	12,8	22,5	21
					28	433	224	358	22,0	329	11,7	23,4	32
					36	204	37	121	19,2	409	11,0	24,3	40
D	29,7	28	70	2,1	24	1447	979	1517	28,9	261	11,4	20,0	49
					34	839	456	808	24,7	308	9,2	20,4	55
					44	442	191	384	21,3	407	8,8	22,1	61
E	30,2	23	80	1,2	24	938	582	1026	26,2	296	11,9	21,5	31
					34	566	337	506	23,4	332	9,7	24,0	34
					44	269	123	249	20,5	416	9,5	23,3	37
F	39,6	25	88	1,1	38	1173	774	1320	28,9	313	8,2	18,0	43
					55	720	287	660	24,5	470	8,5	20,9	51
					73	446	181	258	22,5	599	7,8	23,1	63

mean fibre diameter of the tops ranged from about 25 to 40 µm . Length varied from about 70 to 87 mm, the mean value being about 80 mm . The selection was considered to be a fairly practical one. The linear densities of the yarns which were spun from these tops ranged in the case of the finest top from 18 to 32 tex and, in the case of the coarsest top from 38 to 73 tex, these ranges spanning the same number of mohair fibres in the respective cross-sections of the yarns.

Linear regression analyses were carried out for each of the dependent variables using mean fibre diameter (µm), mean fibre length (mfl) and yarn linear density (tex) as independent variables. The number of data points was 18

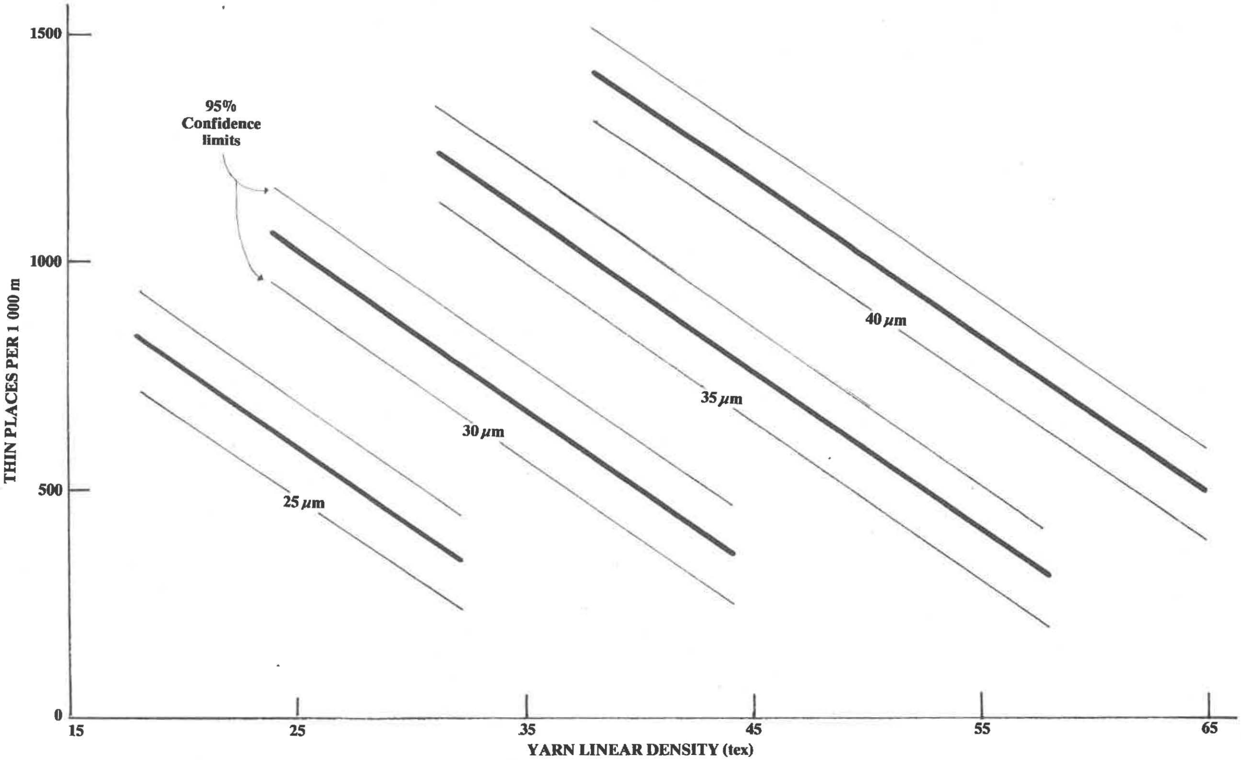

FIGURE 1

No. of Thin Places in RWCS Mohair Yarns, for Various Mean Fibre Diameters of Top

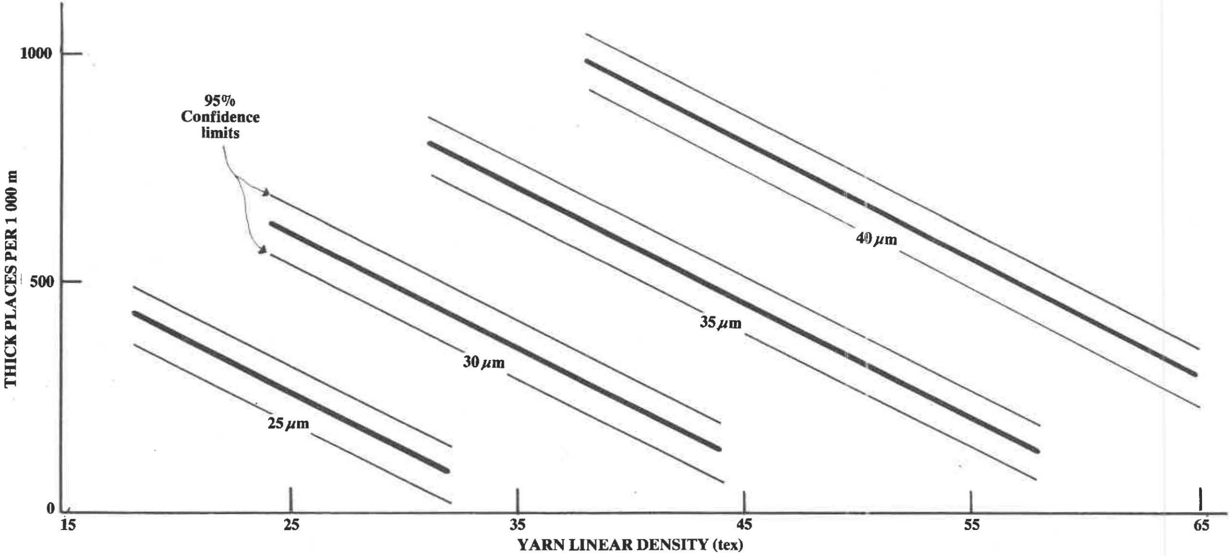

FIGURE 2

No. of Thick Places in RWCS Mohair Yarns, for Various Mean Fibre Diameters of Top
(**Note:** Mean fibre length taken as 80 mm . Add/deduct about 12 thick places per mm decrease/ increase in m.f.l.)

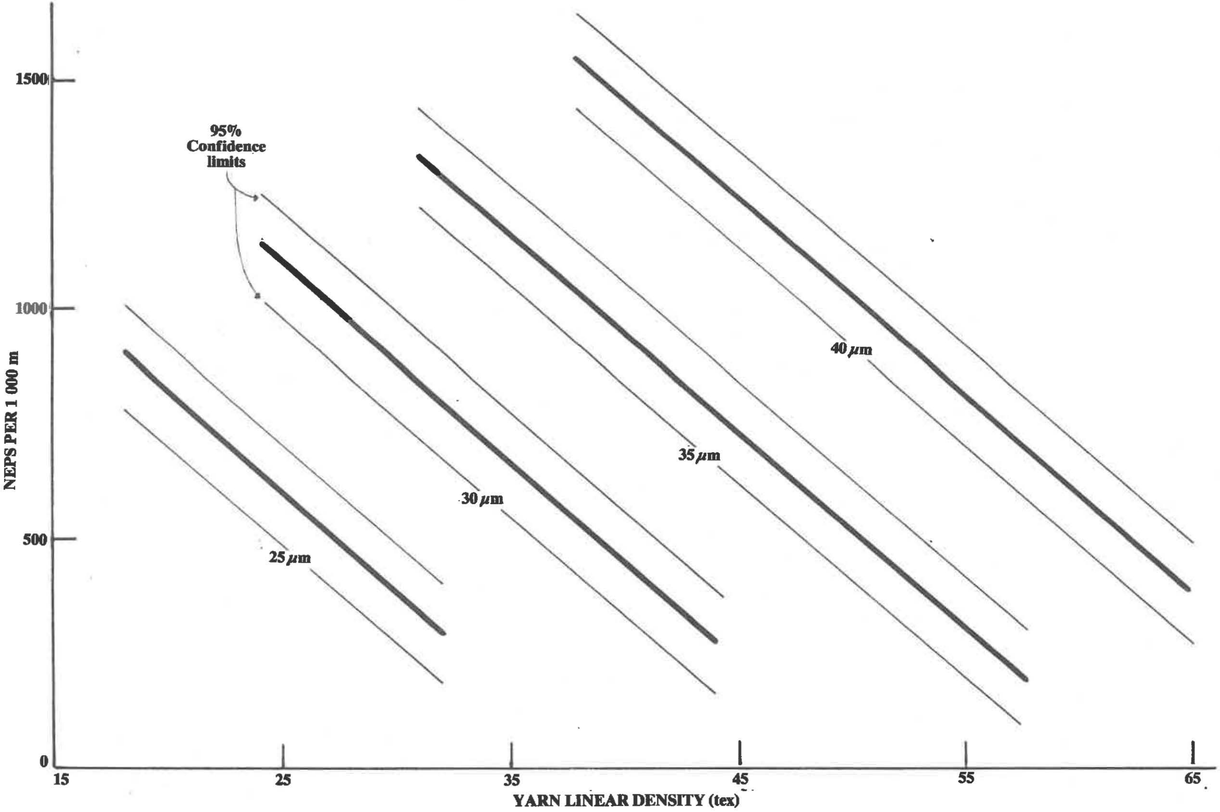

FIGURE 3

No. of Neps in RWCS Mohair Yarns, for Various Mean Fibre Diameters of Top

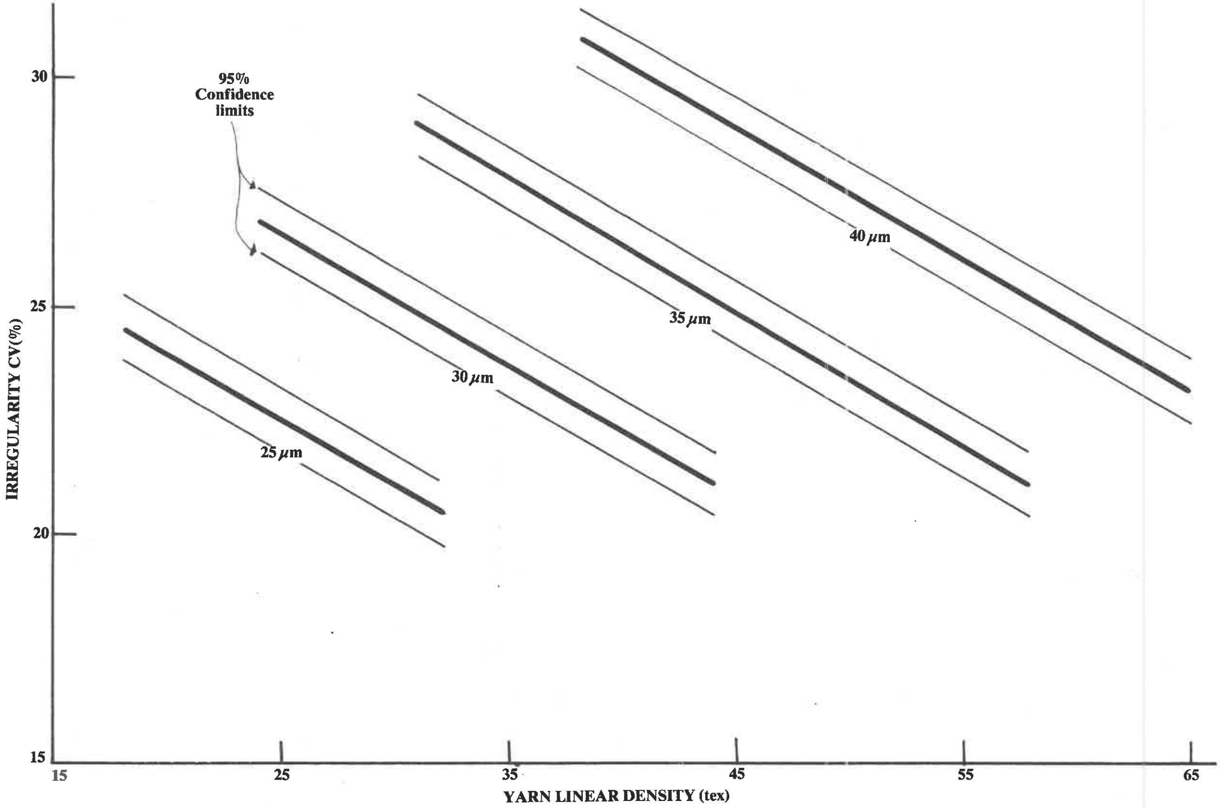

FIGURE 4

Irregularity (CV) of RWCS Mohair Yarns, for Various Mean Fibre Diameters of Top

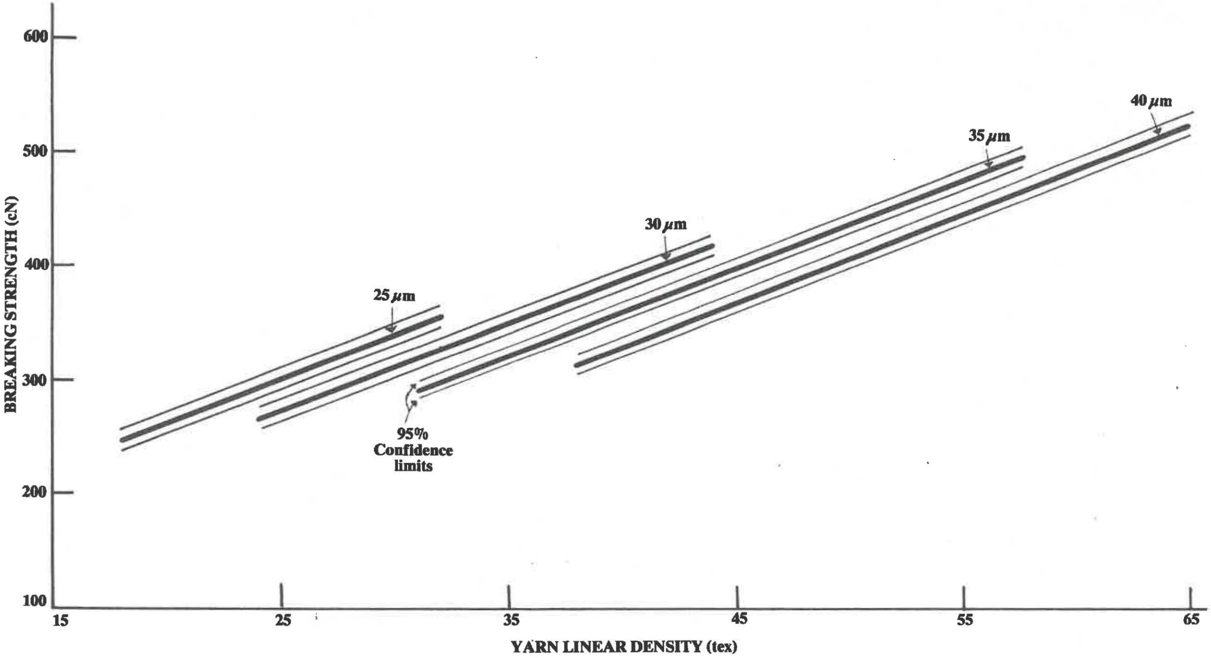

FIGURE 5

Breaking Strength of RWCS Mohair Yarns for Various Mean Fibre Diameters of Top
(Note: Mean fibre length taken as 80 mm . Add/deduct about 2 cN per mm increase/decrease in mean fibre length.)

in each case. The following equations were found to be significant at the 99% level of confidence:

THIN PLACES per 1 000 m = 87,4 μm − 35,5 tex − 702 Fit = 72%
THICK PLACES per 1 000 m = 69,5 μm − 11,6 mfl
− 25,0 tex + 82 Fit = 83%
NEPS per 1 000 m = 101,3 μm − 43,9 tex − 828 Fit = 78%
IRREGULARITY (CV%) = 0,82 μm − 0,29 tex + 9,3 Fit = 82%
BREAKING STRENGTH (cN) = −5,9 μm + 1,6 mfl
+ 7,7 tex + 130 Fit = 97%
HAIRINESS (hairs/m) = 0,75 tex + 12,7 Fit = 59%
TENACITY (cN/tex) = −0,11 tex + 14,1 Fit = 71%

Equations for all but the last two of the above parameters have been represented graphically in Figs 1 to 5 respectively, with the 95% confidence limits of the means shown in each case. For convenience, values for 25, 30, 35 and 40 μm have been illustrated in each case and the means have only been drawn within the ranges investigated in the experiment. In view of likely curvature, which could not be detected with only three points being considered for each top, the reader should be careful not to extrapolate beyond the limits shown in the graphs.

It can be seen from Figs 1—4 that the frequency of thin places, thick places, neps and the irregularity CV all decreasd with increasing yarn linear density and increased with increasing mean fibre diameter, as would be expected. In view of the significance of mean fibre length with respect to thick places, the graph has been drawn for the mean value considered in the experiment, namely 80 mm . An adjustment should be made for decreases or increases in length as indicated in the footnote. The absolute values for thin places, thick places and neps were extremely high by normal standards, and the irregularity CV was correspondingly high. These values are, however, typical for this type of yarn.

The results for breaking strength given in Fig 5 illustrate that the breaking strength increased significantly with increase in yarn linear density and was further increased by decreasing mean fibre diameter. Here again, in view of the statistical significance of mean fibre length, the graph has been drawn for a mean fibre length of 80 mm . An adjustment for other lengths should be made in accordance with the footnote.

A graph for tenacity has not been included in view of the much better correlation found for the breaking strength values. A graph for hairiness has not been included in view of the relatively poor fit to the data. (The fact that diameter did not have a statistically significant effect on hairiness and tenacity may have been due to the experimental design.)

SUMMARY AND CONCLUSIONS

A selection of mohair tops ranging from about 25 to 40 μm were spun into RWCS yarns and their physical properties measured so as to give spinners some guide as to expected values for irregularity and breaking strength of such yarns. Each top was spun to three different linear densities spanning a range from 20 to 40 mohair fibres in the cross-section.

Linear regressions were carried out using mean fibre diameter, mean fibre length and yarn linear density as independent variables. The fit for the irregularity data was good (about 80%) while the fit for the breaking strength data was excellent (97%). Curves were drawn showing the 95% confidence limits to assist spinners requiring this information. Absolute values for the irregularity parameters were high by normal standards. These values are, however, typical for this type of yarn.

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A LABORATORY PROCEDURE FOR THE ESTIMATION OF THE DIRT PARTICLE SIZE DISTRIBUTION IN RAW WOOL

by D. W. F. TURPIE

ABSTRACT

A procedure is described for the routine determination of the distribution of solid dirt particles in raw wool. Results obtained on 25 different fleece wools are given from which it is evident that the particle size of the bulk of the dirt lay in the region of about 10 to 30 µm, a rejection of about 95% being expected from a pore size of about 3 µm, the latter confirming earlier reported work.

INTRODUCTION

A study of the particle size distribution of solid dirt in a range of South African fleece wools was recently carried out[1]. The aim of the study was to ascertain the pore size which would be theoretically required for the efficient removal of suspended dirt particles from liquors produced during the scouring of these wools. Initially the work was carried out using only two or three staples of raw wool (equivalent to about 1 g clean). These were washed with a solvent mixture comprising ethanol and petroleum spirit and the solvent, containing the dirt in suspension, was prefiltered through a 50 µm gauze and then passed through a succession of membranes ranging in pore size for 8 µm down to 4 µm . The residues were dried, then washed with water, dried again and weighed. Later, it was decided to examine the distribution of the coarser particles and a somewhat larger number of staples of the same lots were washed in a similar manner and the solvents passed under gravity through a succession of stainless steel wire gauze filters having square apertures of from 400 µm down to 50 µm in width. Gravitational settling suffered from the disadvantages that layers of dirt trapped by the gauze could themselves act as filters for still smaller particles. An overall disadvantage was also the difficulting of selecting a representative sample from so few staples. Although the work provided valuable information not hitherto available, it was considered that to characterise a specific wool lot in terms of particle size distribution of its dirt on a routine basis, an improved procedure was required. This report outlines a procedure which was arrived at after some initial experimentation, and which has since been used successfully on a wide range of samples.

TEST PROCEDURE

Apparatus used

(i) ® Fritsch "Analysette 3" electromagnetic laboratory sieve shaker. Test sieves having square apertures of 400, 200, 100, 50 and 20 μm in width together with a wet sieving head and pan.
(ii) Small storage tank and circulating pump (required for sampling purposes).
(iii) Low temperature drying oven (60°C).
(iv) ® Nuclepore membrane holder/multiple holder adapter combination, polycarbonate membranes having round apertures (pores) of 12, 8, 3 and 1 μm in diameter and matched glass fibre pre-filters for each membrane.
(v) Pressurised feed tank (for attachment to Nuclepore holders).
(vi) Laboratory mangle.

Experimental procedure

A. Wool washing

1. Dry a sample of the raw wool (preferably a core-sample if available) of mass 125 g and then wash in 0,5 litres of a solvent mixture comprising ethanol/petroleum spirit (b.p. 100-120°C) in equal parts. Squeeze the wool through a laboratory mangle, collecting the liquor through a coarse strainer to trap any fibres or particles larger than 1 mm . Repeat with a fresh liquor (1,5 *l*). The combined liquor obtained will be referred to as the *solvent* liquor.

2. Dry the wool sample in a warm atmosphere or incubator.

3. When the wool sample is dry wash with 0,5 litres of water (at about 40°C) containing a small amount of non-ionic detergent (say 0,1% v/v), squeeze, rewash with a fresh volume (1,5 *l*) and squeeze again. Collect the liquor through a coarse strainer. The combined liquor will be referred to as the *aqueous* liquor.

B. Macro-Sieving

4. Set the sieve shaker up with the three coarsest sieves stacked one on top of the other, pour the solvent liquor through the sieves and collect the filtrate. After the initial, normally rapid, passage of the bulk, clamp on the wet sieving head or dome, vibrate at 3 000 oscillations/min with pre-set interruption and adjust the amplitude (normally about 1-2 mm). The vibrations distribute the residue evenly over the surface of the sieves and allow further drainage to take place. When all the solvent liquor has passed through, remove the dome and rinse the column with about 250 m*l* of the filtrate. Resume shaking until all surplus solvent has been drained. Dismantle the column, dry the sieves (60°C) and store the filtrate (referred to as the FIRST SOLVENT FILTRATE).

5. Set up the sieve shaker with the two finest sieves and pour the first solvent filtrate through. The flow in this case will be much slower than before and it

will be necessary to alternately clamp on and release the dome a few times, to use two small rubber balls (provided with the instrument to assist filtration) in conjunction with the finest sieve, and to use a higher amplitude (normally about 2-2,5 mm) for the vibrations than previously. When all the solvent filtrate has passed through, rinse the column with an aliquot of the filtrate. Dismantle the column and dry the sieves.
Make up the filtrate to a specific volume, e.g. 2 litres and transfer it to the small storage tank. This filtrate will be referred to as the SECOND SOLVENT FILTRATE.

6. Circulate the second solvent filtrate in the small storage tank, draw off a 200 m*l* reference sample and discard the remainder. Rinse out the tank well with hot water containing detergent.

7. Re-assemble the three coarsest sieves (still dirty, but now dry) on the sieve shaker and introduce the AQUEOUS LIQUOR. Follow the procedure detailed under "4" above. The filtrate produced will be referred to as the FIRST AQUEOUS FILTRATE.

8. Re-assemble the two finest sieves (still dirty, but now dry) and follow the procedure detailed under "5" above. The filtrate produced in this case will be referred to as the SECOND AQUEOUS FILTRATE.

9. Make up the volume of the second aqueous filtrate to equal the volume of the second solvent filtrate. Then follow the sampling procedure as in "6" above.

10. Dismantle the column, dry the sieves at 60°C (about 2 hours), and then weigh to determine the mass of trapped particles.

11. Clean the sieves, dry them and tare them again ready for the next experiment. Cleaning is conveniently carried out by immersing each sieve individually in a basin of hot water (60°C) and gently brushing the surface on both sides with a household dishwashing brush with soft nylon bristles.

C. Micro-Sieving

12. Determine the mass of each pair of membranes/prefilters.
13. Shake the reference sample of the second solvent filtrate well by hand, draw off an aliquot (about 5 m*l*) and transfer to the feed tank, below which is attached a Nuclepore holder containing the 12 μm membrane and its prefilter.
14. Apply pressure and collect the filtrate in a beaker. Release pressure, introduce a small volume of solvent mixture for rinsing purposes, re-apply pressure and add filtrate to the beaker.
15. Replace the nuclepore holder with another one containing the 8 μm membrane and its prefilter.
16. Transfer the filtrate collected in (14) above to the feed tank, and pass

through the 8 μm membrane under pressure. Rinse as previously and collect the filtrate.

17. Proceed in this manner until all the various membranes have been used. The final filtrate can now be discarded (or retained for passage through still finer membranes if so desired).

18. Loosen the membrane holders sufficiently to allow free passage of air around the membranes, place in a drying oven, dry at 60°C, and then reassemble. (Drying takes about 15 minutes.)

19. Shake the reference sample of the second aqueous filtrate well by hand, draw off an aliquot of the same size as in "13" above, transfer to the feed tank, below which the Nuclepore holder with the 12 μm membrane and its prefilter has been attached.

20. Apply pressure and collect the filtrate in a beaker. Release pressure, introduce a small volume of water for rinsing purposes, re-apply pressure and add filtrate to the beaker.

21. Replace the nuclepore holder with the next one and proceed as before until, finally a filtrate is collected representing that which was able to pass through the finest pore size used. The final filtrate can now be discarded (or retained for passage through still finer membranes if so desired).

22. Remove the membranes and prefilters from their holders, dry at 60°C (this takes about 1½ hours) and then weigh to determine the mass of the trapped particles.

23. All membranes and prefilters are now disposed to waste and the holders cleaned and dried.

Note: **1.** With two complete sets of sieves and Nuclepore holders it should, on average, be possible to do two samples each day.

2. Once the wool sample has been washed, there should be no delay in the carrying out of the test. Delays can cause bacterial growth to take place and would seriously affect the results. It is possible that addition of a small quantity of bacteriocide to the liquors would be an advantage at the start.

RESULTS AND DISCUSSION

The test procedure was carried out on a range of 25 different fleece wools. These wools ranged from 7/9 to 12 months in length, from about 18 to 33 μm in mean fibre diameter and from about 2 to 6,5 crimps/cm in staple crimp frequency. The mean mass of dirt trapped by successive sieves and membranes is given in Table I. The total mass trapped averaged about 14 g on 125 g (or about 11%) and the standard deviation of this value was about 4 g . Values for the percentage of dirt trapped by each particular sieve indicate that the bulk of the dirt had a *particle size of about 10 to 30 μm* . This is clearly illustrated by Fig 1. The cumulative percentage of dirt rejected by successively smaller apertures, which is also illustrated in Fig 1, would seem to confirm earlier

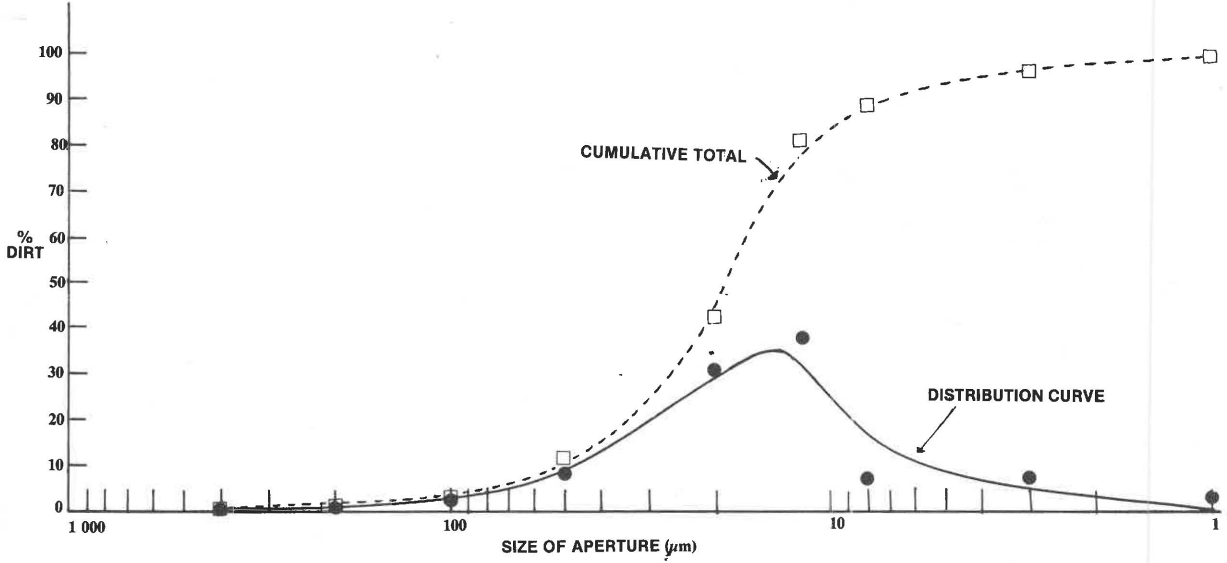

FIGURE 1

Mean frequency distribution of dirt particles in 25 samples of fleece wool together with the cumulative total rejected by decreasing aperture sizes.

TABLE I

MASS OF DIRT TRAPPED BY SUCCESSIVE SIEVES AND MEMBRANES FROM 125 g OF RAW WOOL

Size of aperture (μm)	Mean mass of dirt (g)	Standard deviation (g)	% of total	Cumulative (%)
400	0,08	0,04	0,6	0,6
200	0,12	0,05	0,8	1,4
100	0,35	0,20	2,4	3,8
50	1,12	0,58	8,1	11,9
20	4,46	1,58	31,0	42,9
12	5,52	1,83	38,4	81,3
8	1,07	0,43	7,4	88,7
3	1,13	0,44	7,9	96,6
1	0,50	0,39	3,4	100,0
TOTAL	14,35	3,88	100,0	

work[1] in so far that a pore size of around 3 μm would be sufficient to reject about 95% of the dirt. With respect to the cumulative distribution for the high particle sizes, i.e. from 20 to 400 μm, the curve indicates somewhat lower values than previously reported, but it is thought that the present values are the more reliable in view of the improved technique.

SUMMARY AND CONCLUSIONS

A routine procedure for the measurement of the particle size distribution of dirt in raw wool is described. A core sample is washed in solvent, then in water and the suspended dirt in the range 400 μm to 20 μm sieved out by an electromagnetically operated sieve shaker from the one medium and then from the other in sequence. An aliquot of the filtrate from the solvent medium is then passed through a series of membranes in the range 12 μm to 1 μm under pressure, and this is followed by an aliquot of the aqueous filtrate. Details of the procedure itself are given, the duration of the test being about 4 hours per sample.

Using this procedure the particle size distribution in 25 different fleece wools was studied. The particle size of the bulk of the dirt lay in the region from about 10 to 30 μm. A rejection of about 95% could be expected from a pore size of about 3 μm, which confirmed earlier results.

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THE PARTICLE SIZE DISTRIBUTION OF SUSPENDED SOLID DIRT IN A RANGE OF INDUSTRIAL RAW WOOL, MOHAIR AND KARAKUL AQUEOUS SCOURING WASTES

by T. E. MOZES and D. W. F. TURPIE

ABSTRACT

The particle size distribution of suspended solid dirt, as determined by a filtration technique, was investigated in eighteen industrial liquors, two industrial centrifuged effluents and two industrial secondary sludges. The log transform of the particle size followed an approximately normal distribution for all types of scouring waste studied. The various distributions showed peaks between 5 and 20 µm for liquors and secondary sludges and between 0,5 and 1 µm for centrifuged effluents. About 95% of the dirt particles were larger than 1 µm in the case of liquors and 0,5 µm in the case of centrifuged effluents.

INTRODUCTION

An investigation into the particle size distribution of solid dirt particles in a range of South African wools[1] showed that detergent requirements during scouring were correlated with several parameters, and in particular with particle size distribution.

More recent publications on the topic[2, 3] showed that the bulk of the dirt lay in the region of 10 to 30 µm[3], with about 95% of the particles larger than 3 µm[2, 3]. However, for purposes of these studies the particle size distributions were measured on the *wool* and not in the *aqueous medium* in which the wool was scoured. It was, therefore, decided to measure the particle size distribution of suspended solid dirt in scouring liquors, effluents and sludges using a routine test procedure suggested by Turpie[3], suitably modified for this particular application.

EXPERIMENTAL

A wide range of industrial scouring liquors produced from raw wool, mohair and karakul was investigated. They were 18 samples originating from either the first or second scouring bowl or from the first bowl side-settling tank. In addition to these samples, two industrial centrifuged effluents (samples 19 and 20) and two industrial secondary sludges (samples 21 and 22) were investigated. These four samples were not related in any way to the liquor samples investigated and were obtained by the centrifuging of liquors which underwent routine *primary settling prior to centrifuging.*

The test procedure for the determination of particle size distribution was very similar to that devised for raw wool[3]. However, since the particles of dirt were already suspended in an *aqueous* medium, it was convenient to pass the *aqueous* medium through a succession of macro sieves and micro sieves, then to dry these and to degrease them *subsequently,* while still on the sieves, by passing the *solvent* mixture (equal parts of ethanol and petroleum spirit) through the macro sieves and micro sieves in succession.

After some initial experimentation it was decided to standardise on a sample size of one litre for all scouring wastes and to use one litre of solvent mixture for degreasing. The size of the aliquot used for microsieving of the filtrates from the macrosieves was generally 5 m*l* .

RESULTS AND DISCUSSION

Results for the particle size distribution of the suspended solid dirt in all twenty-two samples are given in Table I. The mean values for the eighteen *liquor* samples, the two *effluent* samples and the two *sludge* samples are given in Table II. This table also shows the respective mean percent rejections and the mean cumulative percent rejections for all three types of waste. The latter two variables are plotted against the size of the filter mesh on a logarithmic scale in Figs 1 and 2, respectively. In both figures the curve indicated by broken lines corresponds to that obtained by Turpie[3] for raw wools.

It is clear from Fig 1 that the particle size followed an approximately normal distribution in all cases. The curves corresponding to the particle size distribution in scouring liquors and to that in raw wools were somewhat similar but the range in which a peak was obtained was wider for the latter. This similarity agrees well with the fact that, in general, *the particle size distribution of suspended solid dirt on the fibre is to be expected to be similar to that in the medium in which the fibre is scoured, i.e. the scouring liquor.* A reduction in the percent rejection of particles between 20 and 100 μm for liquors may well be due to some settling of these particles in the scouring bowls and their side-settling tanks.

It is also clear from Fig 1 that the particle size distribution curves for liquors and secondary sludges showed peaks between approximately 5 and 20 μm while that for centrifuged effluents between approximately 0,5 and 1 μm . This is to be expected since centrifuged effluents, in general, mainly contain those particles which are too small to be removed by centrifuging. A higher peak for the secondary sludge particle size distribution curve as compared to that for the liquor is believed to be due to concentration of particles of that size by the centrifugal process.

Fig 2 clearly shows that, if one would theoretically assume no interaction between suspended solid dirt and grease in scouring wastes, then a filter medium having a pore size of about 0,5 μm would be able to reject 95% of the former constituent in centrifuged effluents. A figure of about 1 μm would be

TABLE I

SUSPENDED SOLID DIRT CONTENT (mg/*l*) OF THE SAMPLES INVESTIGATED AS DETERMINED BY FILTRATION THROUGH SUCCESSIVE SIEVES

Description of sample	Sample No.	400 μm	200 μm	100 μm	50 μm	20 μm	12 μm	8 μm	3 μm	1 μm	0,4 μm	0,1 μm	Total
Liquor	1	70	160	110	140	960	4 860	360	600	760	800	nil	8 820
	2	70	60	110	190	1 520	3 150	750	250	100	600	—	6 800
	3	20	70	140	140	1 910	6 300	1 300	1 400	1 600	950	—	13 830
	4	40	40	60	70	100	1 500	550	1 300	300	550	—	4 510
	5	130	120	70	80	1 470	7 580	420	600	360	1 820	—	12 650
	6	50	170	130	100	420	2 080	780	800	480	1 240	nil	6 250
	7	110	150	100	1 420	1 650	5 740	600	1 140	960	960	—	12 830
	8	10	60	40	320	1 210	1 860	820	820	240	100	—	5 480
	9	80	350	490	570	1 650	5 650	1 000	2 400	1 450	1 050	—	14 690
	10	120	100	70	180	1 200	7 250	2 200	3 000	2 200	2 150	—	18 470
	11	300	250	380	370	1 620	8 700	1 400	2 600	2 000	1 450	nil	19 070
	12	130	170	260	1 060	1 190	7 200	3 200	2 900	800	850	—	17 760
	13	20	100	120	190	700	5 150	1 650	1 100	550	450	—	10 030
	14	40	70	70	30	990	2 250	300	600	350	350	—	5 050
	15	90	70	60	30	180	1 300	160	420	40	40	—	2 390
	16	10	110	130	550	700	1 480	420	680	60	60	nil	4 200
	17	140	120	340	780	3 640	4 950	1 000	2 050	300	650	—	13 970
	18	160	150	300	300	1 770	4 050	1 600	2 350	850	500	—	12 030
Centrifuged Effluent	19	50	40	180	90	140	420	940	1 660	1 180	400	—	5 100
	20	10	60	80	50	70	420	120	740	380	720	nil	2 650
Secondary Sludge	21	100	50	50	250	600	19 750	5 750	6 000	750	1 250	nil	34 550
	22	450	450	650	500	7 150	41 250	8 750	11 500	1 250	2 000	—	73 950

TABLE II

MEAN VALUES FOR THE SUSPENDED SOLIDS, PERCENT REJECTION AND PERCENT CUMULATIVE REJECTION FOR LIQUOR, CENTRIFUGED EFFLUENT AND SECONDARY SLUDGE SAMPLES

Description of sample	**Variable**	**400 µm**	**200 µm**	**100 µm**	**50 µm**	**20 µm**	**12 µm**	**8 µm**	**3 µm**	**1 µm**	**0,4 µm**	**0,1 µm**	**Total**
Liquor	Suspended solids (mg/*l*)	88	129	166	362	1 271	4 503	1 028	1 389	744	809	nil	10 489
	% Rejection	0,8	1,2	1,6	2,5	12,1	42,9	9,8	13,3	7,1	7,7	nil	100,0
	% Cumulative Rejection	0,8	2,0	3,6	7,1	19,2	62,1	71,9	85,2	92,3	100,0	100,0	—
Centrifuged Effluent	Suspended solids (mg/*l*)	30	50	130	70	105	420	530	1 200	780	560	nil	3 875
	% Rejection	0,8	1,3	3,4	1,8	2,7	10,8	13,7	31,0	20,1	14,4	nil	100,0
	% Cumulative Rejection	0,8	2,1	5,5	7,3	10,0	20,8	34,5	65,5	85,6	100,0	100,0	—
Secondary Sludge	Suspended solids (mg/*l*)	275	250	350	375	3 875	30 500	7 250	8 750	1 000	1 625	nil	54 250
	% Rejection	0,5	0,5	0,7	0,7	7,1	56,2	13,4	16,1	1,8	3,0	nil	100,0
	% Cumulative Rejection	0,5	1,0	1,7	2,4	9,5	65,7	79,1	95,2	97,0	100,0	100,0	—

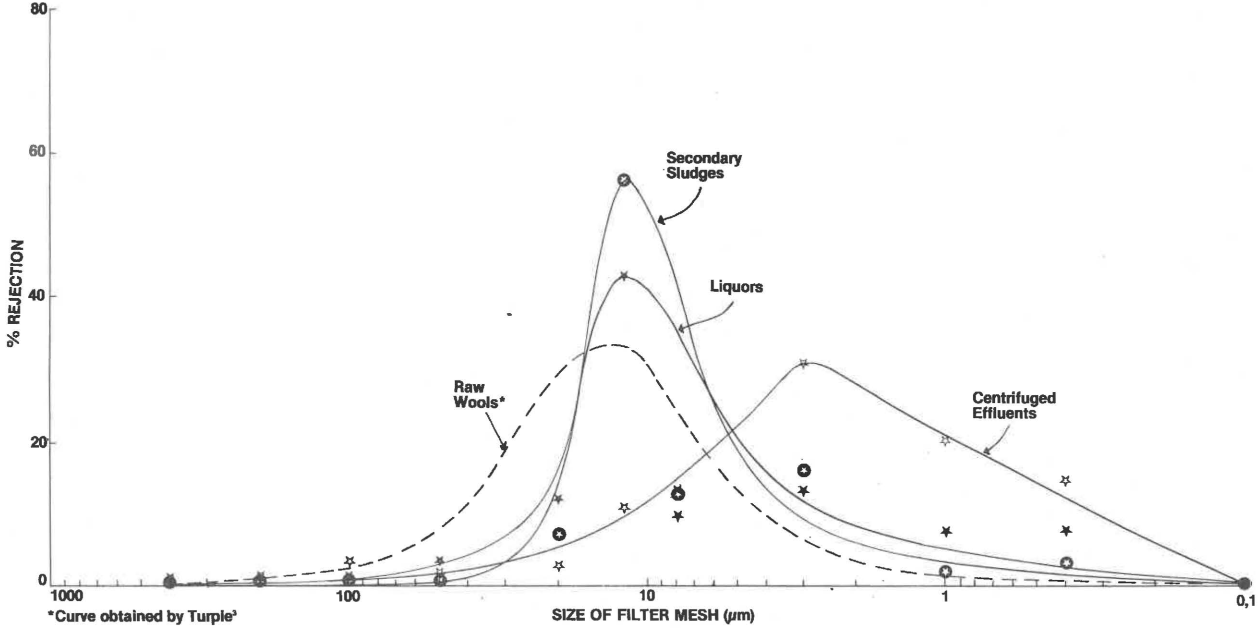
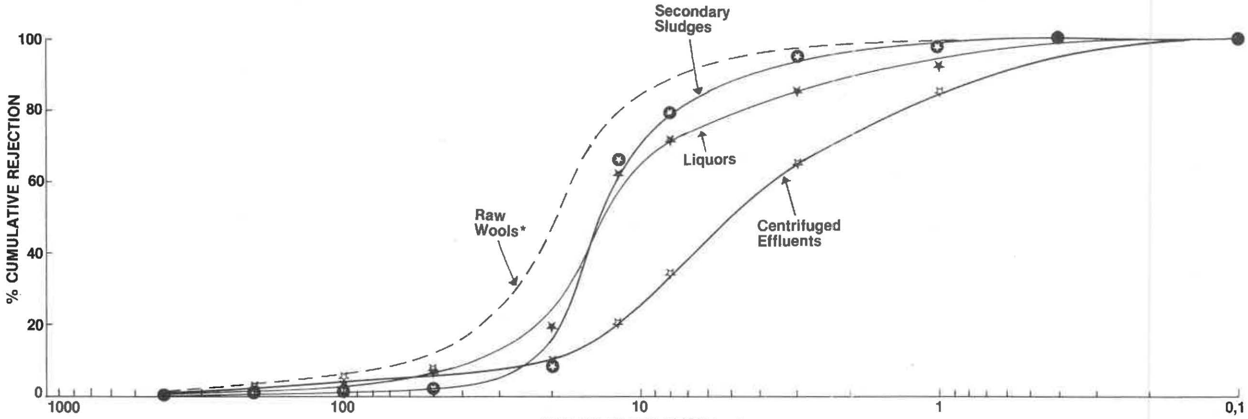


FIGURE 1

Mean particle size distribution of suspended solid dirt



*Curve obtained by Turpie[3]

FIGURE 2

Mean cumulative particle size distribution of suspended solid dirt

obtained for the same rejection level in liquors. This largely agrees with the results of the previously mentioned research work performed on raw wool[2, 3]. In practice, however, the suspended solid dirt present in scouring wastes is known to be associated to a certain degree with grease. This would suggest that a filter medium having a pore size of 1 to 2 μm would probably ensure the removal of 95% of the suspended solids content of liquors and centrifuged effluents.

SUMMARY AND CONCLUSIONS

The test method devised for the determination of the particle size distribution of dirt on raw wool was suitably modified for the analysis of wool, mohair and karakul aqueous scouring wastes. The particle size distribution of suspended solid dirt was investigated in eighteen industrial liquors, two industrial centrifuged effluents and two industrial secondary sludges.

The log transform of the particle size was found to follow an approximately normal distribution in all cases, with peaks between 5 and 20 μm for liquors and secondary sludges and between 0,5 and 1 μm for centrifuged effluents. Similarity was found between the particle size distribution curve for liquors and that obtained for raw wools in an earlier investigation. About 95% of the suspended solid dirt particles were larger than 1 μm in both cases. The corresponding value for effluents was found to be 0,5 μm, indicating that particles of relatively small size (0,5 to 1 μm) are not removed to any great extent into the sludge phase during the centrifuging process.

Due to the known association of suspended solid dirt with grease in scouring wastes, a filter medium having a pore size of 1 to 2 μm would probably ensure the removal of 95% of the suspended solids content of liquors and centrifuged effluents.

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