SAWTRI BULLETIN

SOUTH AFRICAN
WOOL TEXTILE RESEARCH INSTITUTE
OF THE CSIR
P.O. BOX 1124
PORT ELIZABETH

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

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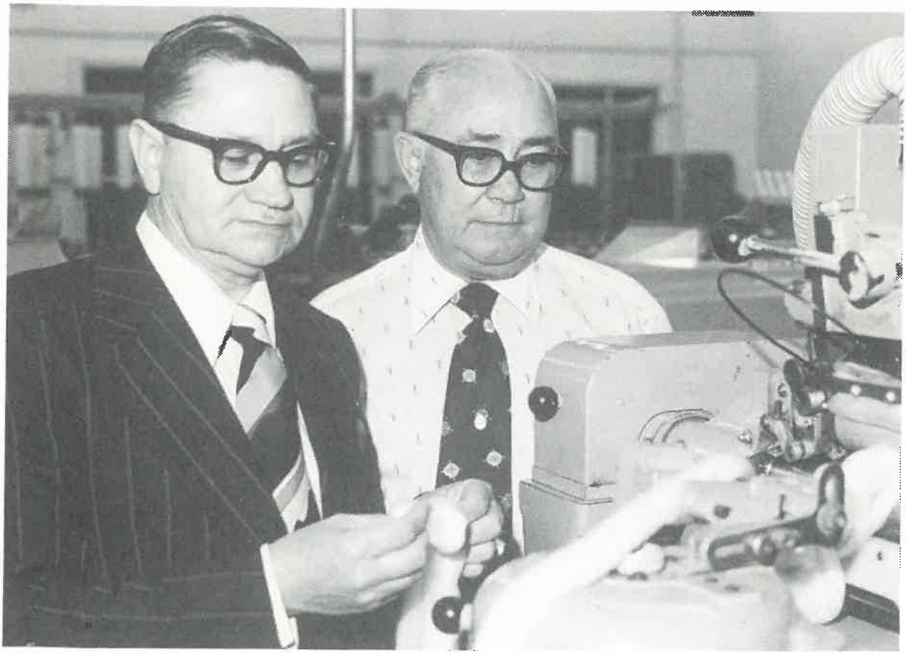
PUBLICATIONS COMMITTEE

INSTITUTE NEWS

Director returns from extended overseas trip

Dr Veldsman returned to office on June 13th after visisting the USA, the UK and Iran. After attending the Research and Development Committee meeting at the IWS Technical Centre in Ilkley, he paid an interesting visit to Iran where he consulted with staff members of the Institute of Standards and Industrial Research of Iran (ISIRI) in Karadj. This Institute is the equivalent of the South African Bureau of Standards. Dr Veldsman also visited the Textile Department of the Tehran Polytechnic. On May 29th he addressed a large meeting of representatives from industry, the Ministry of Industries and Mines, the Tehran Polytechnic Textile Department and ISIRI in the ISIRI Auditorium on various matters relating to worsted processing and quality control. An interesting observation which Dr Veldsman made during his visit to Iran was the potential market for worsted cloth which currently exists in that country. "The time is now ripe for export-conscious firms in the local worsted industry to explore possible exploitation of this very lucrative market", Dr Veldsman said upon his return to South Africa.



The Director with Mr Harry Arthur, Deputy Director of the Texas Textile Center, Lubbock, Texas.

Local meetings and lectures

Mr G. A. Robinson, Group Leader for Knitting and Weaving, addressed the Transvaal Branch of the Textile Institute at their June meeting in Johannesburg. He lectured on results of the productivity survey of the weaving industry carried out by the National Productivity Institute in 1974.

Dr M. B. Roberts, Group Leader for Dyeing and Finishing, recently visited Rhodesia where he addressed members of the textile industry in Bulawayo on July 7th. The topic of his talk was the improved utilisation of factory services in dyeing and finishing, and in particular the economics and technical benefits of low liquor-to-goods ratios, heat recovery from hot effluents and air and the use of insulation techniques and automatic controls were discussed.

Mr. E. Wellinger, Head of the Marketing Centre for proofing agents at Ciba-Geigy, Basle, discussed new trends in textile finishing at a meeting of the Textile Institute's Eastern Cape Branch at SAWTRI on June 16th.

The working sub-committee of the SAWTRI/RCGA steering committee met on August 18th to discuss progress reports on SAWTRI's project work on behalf of the RCGA, and to co-ordinate the program for the rest of the year.

Dr S. van der Merwe, Minister of Planning and the Environment, unlocking the main entrance to the new CSIR Regional Office wing. With him is Dr C. van der Merwe Brink, President of the CSIR and Dr D. P. Veldsman, Director of SAWTRI.

Visitors

Four important study groups visited the Institute during the last three months for technical discussions and to gain first-hand knowledge of the latest trends in textile processing and research.

Approximately 30 wool farmers from the Highlands district of Grahamstown visited the Institute on June 14th. This district is renowned for the very fine merino wool it produces. They were followed on June 29th by a large contingent of the Western Australian Pastoralists and Graziers Association under Mr Jim Samson, OBE. On September 7th about 40 students from the Grootfontein College of Agriculture paid their annual visit to the laboratories and processing departments.

Easy-care finishing was the focal point of interest of a delegation of the Port Elizabeth Consumers Association which visited the Institute on September 8th. Ideas were exchanged as to which qualities of the end product the consumer considers important.

Medal Award to Dr D. P. Veldsman

The Director is to be awarded the Textile Institute Medal in recognition of distinguished services to the textile industry in general and to the Textile Institute in particular. The presentation of this medal will take place at the Institute's Annual Convocation to be held on the 25th November in Manchester. As it is unlikely that Dr Veldsman will be present for this occasion, arrangements are being made to have the presentation made at a similar occasion of the Textile Institute's S.A. Advisory Committee, of which Dr Veldsman is Chairman.

A section of the large number of guests at the official opening of the new building extensions.

SAWTRI to participate in Fabrics Fair

The Institute has decided to participate in this year's Textile Fabric Fair organised by the Textile Federation and to be held in the Carlton Hotel, Johannesburg, from September 27–29th. This is a unique opportunity as it will be the first time that SAWTRI will be exhibiting together with firms from the private sector. Dr Veldsman, Mr N. Vogt and Mr G. A. Robinson will attend the official opening on September 27th and the latter two gentlemen will be on duty at the SAWTRI stand for the rest of the Fair. On exhibit will be 100% wool lightweight suitings, 55/45 cotton/wool shirts, fabrics in 28gg double jersey produced from Repco wrapped core yarns, lightweight mohair suitings, jackets and frocks also produced from wrapped core yarns, and 100% wool leno lightweight safari suitings and shirting fabrics. Also part of the SAWTRI stand will be a photographic display of the Institute and its various activities.

South African Wool Board increases its contribution to contract research

The South African Wool Board has recently increased its contribution to SAWTRI's contract research programme by 10%. Research is not immune to escalating costs and it is extremely gratifying that an organisation such as the Wool Board not only acknowledges this fact, but also provides the means of extending the scope of research in order to keep abreast with the latest technological developments.

New appointments to Research Advisory Committee

Two new appointments to the SAWTRI Research Advisory Committee have been approved. The South African Cotton Board has nominated Mr D. J. E. Erasmus to the Committee while Dr K. Baird replaces Dr J. McPhee as International Wool Secretariat nominee. Dr Baird is Director of Research and Development at the IWS's Technical Centre in Ilkley. We would like to welcome these two new members of the RAC and to extend our appreciation to Dr McPhee for his invaluable contribution during his term of service.

The Director has been re-appointed to the Advisory Committee for Mohair Production for a further three-year term. This committee advises the Department of Agricultural Technical Services on matters relating to the improvement of mohair production in South Africa.

Highly successful Silver Jubilee Festivities

August 16th and 17th saw the highlights of SAWTRI's 25th Anniversary celebration with the official opening of the building extensions, a cocktail party and the SAWTRI/Textile Institute symposium on New Developments in Fabric Manufacture. On the 16th some 300 guests, including SAWTRI staff, were present at the official opening of the new CSIR Regional Offices and SAWTRI processing departments. Dr Schalk van der Merwe, Cabinet Minister responsible for the CSIR, gave a short history of SAWTRI and its activities over the past 25 years and stressed that the local textile industry should make full use of the services SAWTRI has to offer. "Textile research is the catalyst for product development and should be considered as important as fashion dictates, increased productivity and economic viability", Dr van der Merwe said. Officially opening the Symposium (which was held the following day, August 17th), he elaborated upon this line of thought and said that it is important for research staff, industrial technologists and textile technicians to get together from time to time to exchange ideas as to which developments are in the best interest of the local economy.

The symposium, held in the auditorium of the Port Elizabeth College for Advanced Technical Education, was attended by some 150 delegates from all over the country. It proved to be very successful and the question-and-answer sessions after each lecture were used to their full extend.

Copies of the lectures are still available at R1,00 per copy, especially to delegates perhaps unable to attend at the last minute or to any other interested parties.

A synopsis of these papers follow:

Needlefelt Floorcovering, by P. J. Honeyman (Romatex Floorcovering Ltd.)

A brief history of needlefelt floorcovering is given to illustrate how such a product, because of competitive market influences overseas, was not given adequate opportunity to develop beyond a limited extent before being overtaken by other processes. Due to different local circumstances this type of fabric has undergone further technological development in South Africa so that not only have new potential end-uses emerged but this type of floorcovering continues to penetrate the market.

Mr D. Uys of the Mohair Board, Mrs Uys and Dr D. Joubert, Vice President of the CSIR, inspecting some fabrics on display in SAWTRI's Weaving Department.

Wither Fibres to Fabrics? by R. J. Howe and N. D. Scott (S.A. Nylon Spinners, Ltd.)

The last decade has seen a great deal of research to establish techniques which bypass conventional processing in order to convert fibres and filaments directly to fabrics. Synthetics offer much scope in this respect, and industrial non-wovens are finding wide commercial application. Domestic use of these fabrics in upholstery, baggage, drapes, etc. is also increasing. Apparel fabrics, however, have not yet appeared. This paper reviews progress made in the different areas, with particular reference to the development of sheath/core heterofil fibres and heat bonding (welding) of these into fabrics. The factors affecting drape, handle and appearance are discussed. Other new methods of obtaining textile-like appearance on both textile and non-textile surfaces are also reviewed.

New Developments in Staple Yarn Spinning and the Properties of Knitted and Woven Fabrics Produced from these Yarns, by L. Hunter (SAWTRI)

New developments in staple fibre yarns over the past decade are reviewed. The performance of these yarns during knitting and weaving as well as the physical properties of the knitted and woven fabrics are compared with those of conventional ring-spun yarns.

Drs Brink, Veldsman and Van der Merwe discussing SAWTRI's research on the processing of *Phormium tenax*.

Fabrics from Repco Wrapped Core-spun Yarns, by G. A. Robinson and D. W. F. Turpie (SAWTRI)

A brief introduction to the Repco spinning technique is given and work carried out at SAWTRI on the spinning of mohair on the Repco is described. The wrapped core-spun yarns are compared with SELFIL yarns and the physical properties of yarns and fabrics are dicussed. Repco wrapped core yarns are stronger, more regular and less hairy than conventional ring-spun mohair yarns and the fabrics compare favourably with conventional fabrics. The advantages of using wrapped core yarns are:

(1) Much finer yarns can be spun.
(2) Higher spinning speeds and improved spinning performance.
(3) Less hairy yarns.
(4) Better performance during preparation and weaving.
(5) Lighter fabrics of finer construction possible.
(6) Improvements in certain physical properties of the fabrics.

Textiles AD 2 000, by D. P. Veldsman (SAWTRI)

A forecast is made of the position of textiles in AD 2 000 in the light of changes in human habits and trends in housing, leisure, travelling, etc. The demand is expected to increase from 3,5 kg to 8,5 kg per capita. Textiles is expected to remain an important activity in industrialised countries as a result of creative abilities. Deployment of sophisticated machinery and increased automation will reduce the wage component of production costs. Fashion will continue to play an important rôle, with a closer connection between fashion and leisure. Individualisation will increase the importance of textile designing as a facet of the production of textiles. Rising costs will force consumers to measure their requirements with greater care, thereby slowing down the rate of increase in the demand for textiles. Living comfort will increase the sales of domestic textiles. The industry will become more capital intensive, while automation, machine speeds and computerisation will increase. Small and large enterprises will continue to have a place in the industry. No marked shift towards non-wovens is expected, while recycling of chemicals and water and energy conservation will become of major importance. The use of solar heating systems in South Africa is advocated.

Current Trends in Warp Knitted Fabric Production, by R. Wheatley (On behalf of Karl Mayer GmbH)

The development of compound needle machinery for producing lingerie, elasticated fabrics automotive fabrics, upholstery and domestic textiles is discussed. Jacquard curtaining fabric produced by the fall-plate technique and the latest double guide arrangement in two colour patterns shows increased contrast between motifs and greater depth of designs.

Warp knitted pile fabrics also represent an area of considerable current development, from the loop raised and brushed velvets, velours and suedes with such diverse end uses as wearing apparel to upholstery, through the terry constructions used mainly for bed sheets and beach wear to the latest lush velvet constructions produced on double needle bar plush machines for drapes, upholstery and bedspreads. On these latter machines, as many as three pattern bars are available for the production of simple geometric designs while the latest developement is the use of a jacquard pile but for the production of elaborate motifs in areas of pile and no-pile or two colours.

Knitting versus Weaving, by R. Wheatley (On behalf of Karl Mayer GmbH)

Comparative costings between warp knitting, weft knitting and weaving reveal that meaningful comparisons are difficult to obtain and while the speed of production offers cost advantages in the ultimate fabric, other factors may have a greater influence on the final price. Current fashion, fabric weight and physical properties have a major influence on a fabric's appeal in a particular market and in specific areas each major means of fabric production holds specific advantages in some fields, while in other areas they compete on a more equal basis.

The use of continuous filament yarns and the introduction of new yarns by fibre producers has a major bearing on fabric types and machine performance and it is with the use of these modern yarns that the warp knitting machine shows its greatest potential, although its capability of handling spun yarns in specific areas cannot be ignored. The warp knitting trade has made more advancement in terms of new fabric construction in the last decade than either weft knitting or weaving and it has also been quick to respond to new fibre types and finishing techniques. It is this awareness of the ever-advancing state of textile technology that has been a major contributory factor to its continued success.

New subscribers

We welcome the following organisations as new subscribers:

J. P. Coats (Pty) Limited, Randfontein
S.A. Textiles (Thomson Publications), Johannesburg
Parow Textile Industries (Pty) Ltd.
Kontek S.A. (Pty) Ltd., Pinetown
Stroud Riley (S.A.) Pty Ltd., Port Elizabeth
Textile Mills (1947) Holdings Ltd., Bulawayo.

Staff matters

Mr J. G. Little has joined the Dyeing and Finishing Group as Chief Technical Officer. Mr Little holds a Higher National Certificate in Chemistry and a City and Guilds Diploma in Dyeing, and we wish to extend a hearty welcome to him.

SAWTRI PUBLICATIONS

Technical Reports

No. 353* : Turpie, D. W. F., Van der Walt, L. T., An Improved Method for the Rapid Determination of Nonionic Detergent in the Cream, Effluent and Sludge from Wool Scouring Liquors and in Recovered Wool Grease (July, 1977).

No. 354 : Turpie, D. W. F., The Processing Characteristics of South African Wools, Part XII: The Influence of Relatively Large Variations in Length on the Processing Performance of South African 64's Fleeces up to Spinning (June, 1977).

No. 355 : Hunter, L., The Processing Characteristics of South African Wools, Part XIII: The Influence of Relatively Large Variations in Length on Hosiery Yarn Properties (June, 1977).

No. 356 : Robinson, G. A., Cawood, M. P. and Dobson, D. A., Knittability of Short Staple Wool Blend Yarns Spun on Two Different Systems and Knitted on a 28 gauge Single Jersey Machine (July, 1977).

No. 357 : Van Rensburg, N. J. J. and McCormick, Shirley, A Study of the Surface and Total Trimer Content of Polyester Filament Yarns and Staple Fibres Available in South Africa (July, 1977).

No. 358 : Robinson, G. A., Cawood, M. P. and Dobson, D. A., Cotton in Fine Gauge Single Jersey, Part III : Fabrics From Unmercerised and Mercerised Plied Yarns – 60/40 *per cent* Cotton/Polyester Blends (July, 1977).

No. 359 : Turpie, D. W. F., Unconventional Scouring, Part X: The Effect of Certain Liquor Purification Procedures on Scouring Efficiency (August 1977).

No. 360 : Turpie, D. W. F., and Marsland, S. G., The Processing of Wool/Cotton Blends on the Worsted System, Part III: Some Spinning Trials on the Worsted Ringframe and the Repco Spinner (August, 1977).

No. 361 : Gee, E., Skewness and Kurtosis as Further Measures of Wool Fibre Distribution (August, 1977).

No. 362 : Barkhuysen, F. A., The Dyeing of Cotton in Liquid Ammonia, Part I: Preliminary Trials (August, 1977).

No. 363 : Turpie, D. W. F. Treatment of Wool Scouring Liquors, Part VII: Destabilisation of Industrial Sludges by Sea-Water (August, 1977).

No. 364 : Barkhuysen, F. A. and Leigh, R. A., Bleaching of 55/45 Wool/Cotton Blends, Part II: Using Sodium Chlorite and Various Reducing Agents (August, 1977).

* Replaces No. 353 by Hunter and Smuts as listed in *SAWTRI Bulletin* **11** (2), June, 1977

No. 365 : Weideman, E. and Grabherr, Hilke: Chemical Modification and Processing of *Phormium tenax* Fibres, Part I: A Preliminary Report (August, 1977).

No. 366 : Van Rensburg, N. J. J. and Du Plessis, Marilyn, The Autoclave Steam-Curing of Cotton Fabrics treated with Various Aminoplast Resins. (August, 1977).

No. 367 : Hunter, L. and Andrews, G., A Comparison of Open-end and Ring Spinning of Cotton, Part II: The Effects of Caustic Soda and Liquid Ammonia Mercerisation On Yarn Tensile Properties (August, 1977).

No. 368 : Turpie, D. W. F. and Hunter, L., The Spinning Potential and Yarn Hairiness of a Selection of Mohair Types Spun on a Ring Frame (August, 1977).

Papers Appearing in Other Journals

Strydom, M. A. Dimensional Stability of Fabrics Containing Natural Fibres – A Review, *Text. Ind. Southern Africa* **1** (1) 23, 1977.

Rotor Yarns with improved quality.

Knitting Yarns from Open End Spinning, Jack D. Towery, *Belg. Wet. Textilannalen* No. 2, 185 (1977).

The author discusses recent research done in this field at the Textile Research Centre at the Texas Tech. University, Lubbock, using a BD200 machine. It is shown that by using multiple carding, rotor yarns which are stronger than equivalent ring yarns can be spun after a sequence of three cardings followed by two drawing operations. An interesting observation has also been made, namely that there appears to be an exponential decrease in the turbine residue with an increase in yarn twist. A linear decrease in turbine residue with a decrease in yarn linear density was also observed, suggesting that the rotor actually functions as a centrifuge. It was also found that surface modification of the yarn exit tube obviates the necessity of high twist to achieve continuity of yarn formation. The author used metal oxides to obtain the proper topography of the yarn trumpets and has named them "Rubicon" trumpets. It is shown that these modified trumpets not only afford greater twist regularity but also delivers a stronger yarn.

(M.A.S.)

The effect of fibre parameters on the physical properties of knits.

Selection of Optimum Fiber Properties for Cotton Knits, G. G. Ruppenicher, E. C. Kingsberg, N. A. Bouquet, *Text. Res. J.* **47**, 239 (1977).

Cotton used to produce knitting yarns should be carefully selected. The effects of fibre fineness, strength and length on the properties of cotton and cotton/polyester knitting yarns and fabrics are discussed. Five cottons ranging from 4,9 to 5,2 micronaire and from $^{31}/_{32}$ to $1^{1}/_{8}$ inch staple length were evaluated. The yarns spun from the fine medium staple-length cotton were the most uniform and strengthwise compared favourably with those spun from the strongest cotton. Differences in the fibre properties had no significant effect on fabric abrasion resistance or shrinkage resistance. However, the high-strength cotton produced the strongest fabrics.

Blending of the cotton with 20% to 40% regular-tenacity polyester reduced yarn strength, whereas blending with high-tenacity polyester increased yarn strength. Blending with either type of polyester had a tendency to lower the twist required for maximum yarn strength. Fabrics produced from the cotton/polyester blends generally had a better abrasion and shrinkage resistance and showed smaller strength losses after resin treatment than the all-cotton fabrics.

(N.J.J.v.R.)

Carcinogens in finishing

Formation of Bischlorodimethyl Ether in Textile Finishing, H, Zollinger, *Text. Chem. Col.* 9 (5), 32/96 (1977).

In 1968 it was discovered that bischlorodimethyl ether (BCME) has carcinogenic properties. As BCME can be formed from formaldehyde and hydrochloric acid, it is obvious that it may be formed in textile finishing operations involving the use of formaldehyde and formaldehyde-forming compounds, together with compounds containing or forming chloride ions.

The author has studied the formation of BCME in systems containing formaldehyde precursors, hydrogen chloride, acetic acid or dioxane and relatively little water with the aid of NMR techniques. He found that up to 10% of the formaldehyde present in the system could be transformed into BCME. The author states that the Form D and other similar processes are too toxic to be used. He points out that this statement would appear to be superfluous as the Form D process is not used anywhere in the world. However, he considered it useful to publish the results because there could be a revival of interest in such formaldehyde systems. Furthermore, there is a danger that the finding by other workers, namely that *no measurable concentrations of BCME were found* using formaldehyde derivatives *under the conventional condition used today* (i.e. pad-dry-cure), may be generalised for *all* types of applications, if one is not aware of the results of the Form D process. (N.J.J.v.R.)

Production of synthetic fibres

Projekte der Ingenieurfirmen in Chemiefaser-Anlagenbau, *Chemiefasern/Textil-Industrie* 27/79, 484 (May 1977).

A survey is given of the number and the capacity of the plants which are being planned and built for the production of synthetic fibres. The projected increase in production will be as follows:

Western Europe 150 000, Eastern Europe 85 000, Latin America 14 000, Africa 48 000 and Asia 340 000 tonnes/year. Although 13 different firms are involved in the building of the 70 plants, more than 80 *per cent* of the market is held by only six of these engineering firms.

The increased production in Africa is mainly due to a new polyester plant in Egypt with a production capacity of 26 500 tonnes per annum.

(N.J.J.v.R.)

Recovery of sizing agents

Present-Day Problems Relating to the Recovery of Size, W. Schenk and H. Leitrer, *Textil-Praxis Int.*, 32, (5), XXXVI (May, 1977).

The authors point out that a pure polyacrylate size can be as effective in weaving performance as a blended size containing polyacrylate and a modified starch at an add-on level about one-third of that of the combination. This was demonstrated on cotton and cotton/polyester warp yarns.

It is shown that the size can be recovered by passing the woven cloth on a continuous basis through water. The authors stress, however, that through the use of too high temperatures during the drying the solubility of polyacrylate in water is

reduced, most likely due to the splitting off of ammonia to form free carboxyl groups which can esterify with the OH groups in the cellulose. An *alkali shock treatment,* however, will break this linkage and the resultant sodium salt is as soluble as the original size.
(D.P.V.)

Combustion of Ginning Wastes

Use of Ginning Waste as an Energy Source, W. H. Lalor and M. L. Smith (Presentation at 9th Annual Waste Management Conference Food, Fertilizer and Agricultural Residues, April, 1977, New York).

A combustible waste is produced in the process of ginning cotton. This heat of combustion can be used for drying the crop. When the crop is very moist, or the ambient RH too high, insufficient heat is available for a proper drying in the case of a low-efficiency heat exchanger. It is, however, suggested that a high-efficiency heat exchanger could provide ample heat for drying.
(D.P.V.)

Loss of lubricants during processing

Loss of Coning Oil in Winding, G. Redman, *Knitting Int.,* **84**, 60 (May, 1977).

This article summarises some work carried out on the problem of total oil loss during cone winding. It is stressed that for nylon, it is essential that the yarns always be properly conditioned when assessing oil losses or else grossly misleading results will be obtained. Furthermore, quite different results are obtained for the oil content of yarn from the different layers on the cone. For example, the oil content varied from 2,1% for yarn on the outside of the cone to 4,2% for yarn on the inside (i.e. inner layers) of the cone. It is, therefore, essential to average the results over the cross-section of the cone if reliable results are to be obtained. Non-splash/non-mist oils reduced the oil loss from a level of 9,3% for a low viscosity conventional oil to a level of 0,7%. – (L.H.)

Revival of ring driving

S. J. Warlick, New Life for the Living Ring, *Text. Ind.* **141**, 53 (February, 1977) and D. A. Bowen, The Living Ring, Who Says it Died? *Text. World* **127**, 103 (April, 1977).

These two articles refer to two newly designed living ring (i.e. ring driving) systems which appear to overcome drawbacks of the earlier system.

It is claimed that the refined living ring of M and M Textiles, which is to be offered to spinners later this year, will increase production by between 20 and 30%, reduce power requirements, cost around 20 American dollars (on a 50 mm ring) per spindle and will fit all frames with minimal installation cost or problems. The other system, called spintex, is claimed to increase speeds by between about 50 and 60% with very little additional power cost. The cost of converting a frame to the spintex system is estimated to be around 50 000 American dollars.
(L.H.)

MEAN AND CV OF FIBRE LENGTH OF A WOOL BLEND CALCULATED FROM ITS COMPONENTS

by E. GEE

ABSTRACT

Formulae for the mean and CV of fibre length of a blend of different wools have been derived from a knowledge of its component parts in a manner similar to that used for diameter.

By considering a range of values for the components the calculated values of the blend have been compared with those given by use of the Palmer equation.

THEORY

Introduction

Two of the attributes of natural fibres which must be considered during mechanical processing into yarn are their non-uniform length and diameter. The co-efficient of variation (CV) (of length or diameter) is a well-used parameter for quantifying these attributes but if the set of numbers do not form a normal population then the interpretation of the calculated value is not precise.

Derivation of equation: for mean and CV of a blend

The pattern of the distribution of fibre diameter and of fibre length is such that in general it can be represented approximately by the normal curve. Any normal curve can in fact, be represented by just two numbers. These are the average or mean value (μ) and the standard deviation (σ). The meaning of σ is that 68,2 *per cent* of the members forming the population lie between the limited of $\mu \pm \sigma$. If, for example, a population of fibre lengths has a mean value of 100 mm and a σ of 40 mm and is *normally* distributed then 68,2 *per cent* of the fibres will have lengths in the range 60 mm to 140 mm .

The standard deviation of a normal population can be defined in a second way namely:

$$\sigma^2 = \frac{\Sigma(x-\mu)^2}{n} \text{ or } \frac{\Sigma(x-\mu)^2}{n-1} \qquad \ldots\ldots\ldots (1)$$

The first definition applies *only* to a normal population. The second is an equation or mathematical operation which can be applied to *any set of numbers.* As mentioned before if the set of numbers do not form a normal population then the interpretation of the calculated value is not precise. Nevertheless, by use and experience it has become an accepted method of describing the variation. (Rather than standard deviation, the term coefficient of variation (CV) is often used. This is merely the standard deviation expressed as a percentage of the mean value).

It two or more populations (e.g. lots of wool of different mean values) are blended in, say, approximetely equal parts then, although each may have had a normal distribution separately, together they will not form a normal population. But it is a practical necessity to obtain a measure of the variation of the blend and the standard deviation or coefficient of variation is calculated for this purpose.

Various formula for deriving this from a knowledge of the components of the blend have been used. Palmer[1], for example, by considering the log form of the distribution of diameters, evolved the formula:

$$C_b = x_1 C_1^2 + x_2 C_2^2 + x_3 C_3^2 + \left[x_1 x_2 \left(\log \frac{d_1}{d_2} \right)^2 + x_2 x_3 \left(\log \frac{d_2}{d_3} \right)^2 + x_3 x_1 \left(\log \frac{d_3}{d_1} \right)^2 \ldots \right] 2{,}3^2 \ldots\ldots\ldots\ldots\ldots (2)$$

where C_1, C_2, C_3 represent the fractional CV's of the components
and C_b represent the fractional CV of the blend
and $d_1\ d_2\ d_3$ represent the mean diameters of the components
and $x_1\ x_2\ x_3$ represent the fractional parts by weight (or mass).

A sample taken from a supply of fibres will usually be length-biased or weight-biased depending on the particular method used for selection. Further, the ensuing measured distribution can be expressed in several forms, i.e. as number or length or diameter weighted distributions. Fell, Andrews and James[2] took account of this aspect when they considered the diameters of blends. By making use of Monfort's work[3] and Palmer's notation[4] they evolved a formula for the mean diameter of a blend. David and Andrews[5] expressed this more simply as:

$$d_b = \frac{\dfrac{P_1}{d_1(1 + C_1^2)} + \dfrac{P_2}{d_2(1 + C_2^2)}}{\dfrac{P_1}{d_1^2(1 + C_1^2)} + \dfrac{P_2}{d_2^2(1 + C_2^2)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where d_b, d_1, d_2 are the mean diameters of the blend and its components
C_1 and C_2 are the fractional CV's of the components
P_1 and P_2 are the fractional weights or masses of the components in the blend.

The latter workers also evolved a formula for the CV of the blend:

$$\frac{P_1 + P_2}{d_b^2(1 + C_b^2)} = \frac{P_1}{d_1^2(1 + C_1^2)} + \frac{P_2}{d_2^2(1 + C_2^2)} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where C_b is the fractional CV of the blend.

We, at SAWTRI, have found a need to express similarly the mean fibre length of a blend and its CV.

Blend diameter

According to the work of Fell *et al*[2] and of David and Andrews[5], equations (3) and (4) follow from relating the mean of the square of the diameter to the mean diameter and its standard deviation.

By definition, σ^2 = mean square – square of mean

$$= \frac{\Sigma d^2}{N} - \bar{d}^2$$

where N is the number of measurements.

However, $\left(\frac{\Sigma d^2}{N}\right)$ is $\overline{d^2}$, the mean of the squared diameters

therefore $\overline{d^2} = \sigma^2 + \bar{d}^2$

$$= \bar{d}^2 (1 + C^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where $C = \frac{\sigma}{\bar{d}}$ or coefficient of variations.

Now, if the mass of a sample is P and the total length of the fibres is L, then:

$P = \rho\pi \overline{d^2} \, . \, L$, where ρ = density of the fibre.

Using equation (5) : $P = \frac{\rho\pi}{4} \bar{d}^2 (1 + C^2) \, . \, L \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$

The mean of a property of a blend is given by $M = \frac{n_1 m_1 + n_2 m_2}{n_1 + n_2} \quad \ldots\ldots (7)$

where n_1 and n_2 are the numbers of each component and m_1 and m_2 are their mean values.

Thus for diameters, the mean of the blend, d_m is given by:

$$d_m = \frac{L_1 d_1 + L_2 d_2}{L_1 + L_2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

where L_1 and L_2 are total lengths of each component.

Combining equation (6) with equation (8), and putting $d_1 = \bar{d}_1$

then

$$d_m = \frac{\dfrac{4 \quad P_1 d_1}{\pi \rho d_1^2 (1 + C_1^2)} + \dfrac{4 \; P_2 d_2}{\pi \rho d_2^2 (1 + C_2^2)}}{\dfrac{4 \quad P_1}{\pi \rho d_1^2 (1 + C_1^2) C_1^2} + \dfrac{4 \; P_2}{\pi \rho d_2^2 (1 + C_2^2)}}$$

which simplifies to equation (3).

Also Total length of blend = Total length of component 1 + Total length of component 2

Therefore

$$\frac{4 (P_1 + P_2)}{\pi\rho \, d_m^2 (1 + C_m^2)} = \frac{4 P_1}{\pi\rho \, d_1^2 (1 + C_1^2)} + \frac{4 P_2}{\pi\rho \, d_2^2 (1 + C_2^2)}$$

which simplifies to equation (4).

Blend Length

Palmer's equation, with the same inherent assumptions, can be applied to the case of determining the CV of length of a blend from knowledge of its constituent parts. Also, a similar logic to that used by Fell *et al* and by David and Andrews, can be used to derive expressions for the mean length and fractional CV of length of a blend.

Consider a mass P having a mean diameter d, containing n fibres of varying length whose mean length is ℓ.

$$\text{Thus } P = \frac{\pi\rho\, d^2 .n.\ell}{4}$$

For two components

$$P_1 + P_2 = \frac{\pi\rho}{4}\left[d_1^2 n_1 \ell_1 + d_2^2 n_2 \ell_2\right]$$

but the mass of blend (Pm) is $P_1 + P_2$

$$\text{Also } Pm = \frac{\pi\rho}{4}\, d_m^{\,2}\,(n_1 + n_2)\,\ell_m$$

where d_m and ℓ_m are the average diameter and length respectively of the blend

$$\text{such that} \quad d_m^{\,2} = \frac{n_1\,\ell_1\,d_1^2 + n_2\,\ell_2\,d_2^2}{n_1\,\ell_1 + n_2\,\ell_2}$$

$$\text{therefore} \quad \frac{\pi\rho}{4}\,\frac{(n_1\,\ell_1\,d_1^2 + n_2\,\ell_2\,d_2^2).(n_1 + n_2)}{n_1\,\ell_1 + n_2\,\ell_2}\,\ell_m = \frac{\pi\rho}{4}\left[n_1\,\ell_1\,d_1^2 + n_2\,\ell_2\,d_2^2\right]$$

$$\text{giving} \quad \ell_m = \frac{n_1\,\ell_1 + n_2\,\ell_2}{n_1 + n_2}$$ which is equivalent to equation (7)

$$\text{Because} \quad n \propto \frac{P}{\ell d^2} \text{ and } n\ell \propto \frac{P}{d^2} \qquad \text{.......... (9)}$$

$$\ell_m = \frac{\dfrac{P_1}{d_1^2} + \dfrac{P_2}{d_2^2}}{\dfrac{P_1}{\ell_1\,d_1^2} + \dfrac{P_2}{\ell_2\,d_2^2}} \qquad \text{..........(10)}$$

Using equation (5) with length symbols instead of diameter

$$(n_1 + n_2)\,\ell_m^{\,2}\,(1 + c_m^{\,2}) = \Sigma\, nx^2 \qquad \text{..........(11)}$$

but $\Sigma nx^2 = \Sigma\, n_1\,\ell_1^2 + \Sigma\, n_2\,\ell_2^2$

i.e. the sum of the contributions from components 1 and 2

$$\text{Therefore } \Sigma nx^2 = \Sigma\, n_1\,\ell_1^2\,(1 + C_1^2) + \Sigma\, n_2\,\ell_2^2\,(1 + C_2^2) \qquad \text{..........(12)}$$

Relations (9), (11) and (12) combined give:

$$\left(\frac{P_1}{d_1\,\ell_1} + \frac{P_2}{d_2\,\ell_2}\right)\ell_m^2\,(1+C_m^2) = \frac{P_1\,\ell_1}{d_1}\,(1+C_1^2) + \frac{P_2\,\ell_2}{d_2}\,(1+C_2^2)$$

$$\text{Therefore } \ell_m^2\,(1+C_m^2) = \frac{\left[\dfrac{P_1\,\ell_1}{d_1}\,(1+C_1^2) + \dfrac{P_2\,\ell_2}{d_2}\,(1+C_2^2)\right]}{\dfrac{P_1\,.\,\ell_2}{d_1} + \dfrac{P_2\,.\,\ell_1}{d_2}} \quad \ldots\ldots\ldots\ldots (13)$$

From equation (10) and (13) the mean length and the fractional CV of a blend can be calculated from a knowledge of its constituent parts.

PRACTICAL APPLICATION

Comparison of various formulae to give the mean and CV of a blend

Consider a blend made from two components having mean diameters of d_1 and d_2, fractional CV's of C_1 and C_2 and used in proportions by mass of P_1 and P_2.

Table I shows various mean diameters and CV's, by Palmer's fomula and by the formulae given by Fell *et al* and David *et al*. The first component was given a diameter of 20 μm and a CV of 0,200. The second component was chosen to have, in turn, mean values of 20μm 22μm and 25μm with a CV of 0,200 or 0,250. Blends in different proportions were also considered. Ratios of 0.1/0.9, 0.5/0.5 and 0.9/0.1 by mass were used.

The table shows that when d_1 and d_2 differ by 5 μm the arithmetical weighted average can significantly overestimate the mean value of the blend, by as much as 0,6 μm. The difference is largest when d_1 and d_2 differ by a large amount and when the proportions of the blend are in the ratio of 0.5/0.5. Fell *et al* comment that the arithmetical average gives only a rough guide. Under these circumstances the difference between the CV's are also the largest, e.g. 0.200 v 0,230 or 20 *per cent* v 23 *per cent*. The difference in CV resulting from the Palmer and the David formulae is small. The largest difference is only 0,003 or 0,3 *per cent*.

Table II shows the results of similar calculations for the fibre length of a blend. The mean fibre length and its CV for the first component were given values of 60 mm and 0,400. Values for the second component were, in turn, 60 mm, 80 mm and 100 mm with CV's of 0,400 or 0,600. The formulae compared are again the arithmetical average, Palmer's and the above equations (10) and (13).

The largest difference in mean fibre length of the blend, given by the two formulae, is 5 mm for a blend of 60 mm with 100 mm in equal proportions. The arithmetical average again overestimates the mean. The arithmetical average gives a much lower value for CV than the other two formula, e.g. 0,400 v 0,474 v 0,487. The Palmer formula (as applied here to length measurements) gives lower CV's than equation (13), the largest difference being 0,519 v 0,545 which is a difference of 2,6 *per cent.*

TABLE I
DIAMETER BLENDS (FIRST COMPONENT HAVING A MEAN OF 20μm AND C.V. OF 0,200)

Mass Ratio	Formulae	Property	Second Component mean and CV				
			20/.25	22/.20	22/.25	25/.20	25/.25
0,1/0,9	Arith. Average	$\overline{x}$	20,0	21,8	21,8	24,5	24,5
		CV	0,245	0,200	0,245	0,200	0,245
	Palmer	CV	0,245	0,202	0,247	0,211	0,254
	Fell and David	$\overline{x}$	20,0	21,8	21,8	24,3	24,2
		CV	0,245	0,202	0,247	0,213	0,257
0,5/0,5	Arith. Average	$\overline{x}$	20,0	21,0	21,0	22,5	22,5
		CV	0,225	0,200	0,225	0,200	0,225
	Palmer	CV	0,226	0,206	0,231	0,229	0,252
	Fell and David	$\overline{x}$	20,0	20,9	20,9	22,0	21,9
		CV	0,226	0,206	0,231	0,230	0,253
0,9/0,1	Arith. Average	$\overline{x}$	20,0	20,2	20,2	20,5	20,5
		CV	0,205	0,200	0,205	0,200	0,205
	Palmer	CV	0,206	0,202	0,208	0,211	0,216
	Fell and David	$\overline{x}$	20,0	20,2	20,2	20,3	20,3
		CV	0,205	0,202	0,207	0,210	0,215

TABLE II

LENGTH BLEND (FIRST COMPONENT HAVING A MEAN OF 60 mm AND C.V. OF 0,400)

Mass Ratio	Formulae	Property	Second Component mean and CV				
			60/.5	80/.4	80/.5	100/.4	100/.5
0,1/0,9	Arith Average	$\bar{x}$ CV	60,0 0,400	78,0 0,400	78,0 0,490	96,0 0,400	96,0 0,490
	Palmer	CV	0,491	0,409	0,498	0,428	0,514
	eq (10) eq (13)	$\bar{x}$ CV	60,0 0,491	77,4 0,411	77,4 0,502	93,75 0,433	93,75 0,524
0,5/0,5	Arith. Average	$\bar{x}$ CV	60,0 0,400	70,0 0,400	70,0 0,450	80,0 0,400	80,0 0,475
	Palmer	CV	0,453	0,425	0,475	0,474	0,519
	eq (10) eq (13)	$\bar{x}$ CV	60,0 0,453	68,6 0,429	68,6 0,486	75,0 0,487	75,0 0,545
0,9/0,1	Arith. Average	$\bar{x}$ CV	60,0 0,400	62,0 0,400	62,0 0,410	64,0 0,400	64,0 0,410
	Palmer	CV	0,411	0,409	0,420	0,428	0,439
	eq (10) eq (13)	$\bar{x}$ CV	60,0 0,411	61,5 0,411	61,5 0,424	62,5 0,433	62,5 0,450

SUMMARY

As demonstrated by Fell *et al* and by David and Andrews the arithmetical weighted average diameter for a blend made from two components can be significantly in error. A difference of 0,6 μm has been demonstrated. The CV of the blend can also be in error (by up to 3 *per cent*). The preferred formula to calculate the CV of the blend is either Palmer's or that of David and Andrews.

In a manner similar to that used by Fell *et al* and David and Andrews, formulae for the mean fibre length and its CV for a blend of two components have been evolved. Again the arithmetic weighted average gave different values. The means differed by up to 5 mm and the CV by up to 8,7 *per cent.* Further, Palmer's formula which was originally devised for diameter applications, gave different values to the equation derived in this paper. A largest difference of 2,6 *per cent* was found for the range of components considered.

The equations for mean fibre length and for CV of a blend as derived in this paper are preferred to other fomulae because the basis of their derivation corresponds to the manner in which the values for separate components are calculated.

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SOME OBSERVATIONS ON THE EVENNESS CHARACTERISTICS OF REPCO WRAPPED CORE-SPUN WOOL YARNS

by D. W. F. TURPIE and S. G. MARSLAND

ABSTRACT

The use of nylon filaments improved the evenness characteristics of Repco-spun wool yarns which were spun at or beyond the designated spinning limit of the wool. Furthermore, the 'wrapped core' technique enabled 64's quality wool to be spun to a yarn linear density on the Repco of 9 tex which was equivalent to a worsted spinning count of 98's.

INTRODUCTION

The 'wrapped core' technique of spinning on the Repco was developed at SAWTRI during the course of some preliminary trials which were carried out to ascertain if *mohair* yarns could be spun on this machine[1]. It was demonstrated during these trials that a nylon multifilament yarn could in fact be used in two different ways to allow satisfactory spinning. In the first method a conventional type of core-spun yarn could be produced by introducing one multifilament yarn into each strand of mohair from a position behind the front rollers. In the second method only one strand of mohair was used, but the two multifilament yarns were positioned as before. This allowed the second nylon yarn to act as a binder thread by wrapping itself around the strand containing the core. The 'wrapped core-spun' yarn so produced had the appearance which could best be described as simulating a *singles* yarn after uptwisting. This was due to the very fine nylon binder thread being almost entirely hidden in the body of the yarn.

Further work using the technique demonstrated that wrapped core-spun mohair yarns could be spun to extremely low yarn linear densities and that lighter fabrics of finer constructions than ever previously produced from this fibre could be woven[2]. Spinning and weaving performances were excellent, yarn hairiness was reduced and there were other improvements in certain physical properties of the fabrics.

The above work was extended to include some spinning trials of a 55/45 wool/cotton blend (which had been prepared on the worsted system) and an uncombed 67/33 cotton/wool blend (which had been prepared up to the draw-frame stage on the cotton system)[3]. From this work it appears that wool-rich blends of wool and cotton, prepared on the worsted system, can be spun satisfactorily using the wrapped core technique, although the yarns will most likely be of poorer quality than similar yarns spun on the ring frame without assistance from the nylon. The recognised high productivity of the Repco on fine counts may, however, play an important role in the practical choice of the spinning method.

The increased versatility of the Repco brought about by the use of the wrapped core technique can, as can be seen from the above, be extended to many fibres of divergent physical properties. Although wool itself can be spun quite satisfactorily on the Repco, there are limitations with regard to mean fibre length, percentage of short fibre and mean fibre diameter. The wrapped core technique lends itself to use where yarns are required which fall outside these limitations, for example in the production of superfine yarns from 'bread and butter' type wools. No information is as yet available with regard to the evenness characteristics which could be expected from such yarns, and it was decided, therefore, to conduct a series of trials to gain some relevant information. For purposes of comparison some all-wool STT yarn and core-spun STT wool yarn were also produced.

EXPERIMENTAL

Raw materials:

Nylon multifilament yarn (22f7z300) and a 64's quality wool top having the specification set out below were selected for the trials.

Specification of wool top :	Mean fibre diamer	=	22,0 μm
	CV	=	23,2%
	Mean fibre length	=	76,7 mm
	CV	=	41,8%
	Fibre shorter than 25 mm	=	2,6%

Roving preparation

The wool top was subjected to four drawing operations. At the first operation the linear density of the slivers was reduced to 11,3 ktex using an NSC intersecting gill box type GNP. The second and third operations were carried out using an intersecting gill box type GN4, and the final operation was carried out on a Schlumberger double apron high draft draw frame type FM1. Four sets of rovings were produced having linear densities of 800, 440, 280 and 200 tex by appropriate selection of the drafts during these drawing operations. These specific linear densities of the rovings were selected in order that the drafts on the Repco could be held between the limits of 16 and 22, these being regarded as suitable for the processing of wool.

Spinning

Repco spinning was carried out using a Repco Spinner Mark I, set at the standard delivery speed of 220 m/min. Three types of yarns were produced, namely

TABLE I
DESCRIPTION OF VARIOUS YARNS SPUN

Type of Yarn	Linear Density of ST Yarn (tex)	Equivalent Worsted Count Description (in STT Form)	Approximate Number of Fibres in ST Yarn			
			Left Strand		Right Strand	
			Nylon fila-ments	Wool fibres	Nylon fila-ments	Wool fibres
ALL WOOL	50	2/36's	–	48	–	48
	42	2/42's	–	40	–	40
	36	2/50's	–	34	–	34
	28	2/64's	–	27	–	27
CORE-SPUN WOOL	50	2/36's	7	43	7	43
	42	2/42's	7	36	7	36
	36	2/50's	7	30	7	30
	28	2/64's	7	22	7	22
	25	2/70's	7	19	7	19
	21	2/84's	7	16	7	16
WRAPPED CORE-SPUN WOOL	50	1/18's	7	–	7	87
	42	1/21's	7	–	7	72
	36	1/25's	7	–	7	60
	28	1/32's	7	–	7	45
	25	1/35's	7	–	7	39
	21	1/42's	7	–	7	32
	18	1/49's	7	–	7	26
	16	1/55's	7	–	7	22
	14	1/63's	7	–	7	18
	12,5	1/71's	7	–	7	15
	10,5	1/84's	7	–	7	12
	9	1/98's	7	–	7	9

Standard, all-wool ST yarns
Core-spun ST wool yarn, and
Wrapped core-spun ST wool yarn.

An attempt was made to spin all-wool yarns of from 50 tex down to 28 tex, core-spun yarns of from 50 tex down to 21 tex, and wrapped core-spun wool yarns of from 50 tex down to 9 tex. It was decided to use a tex twist factor of 33 for the folding of these yarns (equivalent to a worsted twist factor of 2,8) since their ultimate purpose would be for the production of worsted-type cloth.

RESULTS AND DISCUSSION

The equivalent worsted count description of the various yarns spun are given in Table I. The all-wool and core-spun yarns have been described using a two-fold worsted notation, whereas the wrapped core-spun yarns have been described using a singles worsted notation. These descriptions are considered to be the most appropriate in this particular context.

The calculated number of fibres in the cross-section of the various yarns spun are also given in Table I. It can be seen that the number of wool fibres in one strand

TABLE II
TURNS PER HALF-CYCLE IN THE ST YARNS

Linear Density of ST Yarn (tex)	Folding Twist required (turns/M)	Limiting No. of Turns per half-cycle required for this folding twist		Actual No. of Turns per half-cycle		
		Maximum	Minimum	All-Wool	Core-spun	Wrapped Core-spun
50	464	24,1	15,3	23,2	23,2	23,1
42	506	26,3	16,6	24,4	25,6	20,3
36	546	28,3	17,9	26,4	28,5	23,2
28	620	32,2	20,4	30,3	34,0	28,0
25	656	34,0	21,6		31,8	30,0
21	716	37,2	23,5		34,7	33,9
18	773	40,1	25,4			37,9
16	820	42,5	27,0			43,9
14	876	45,4	28,8			43,6
12,5	928	48,2	30,5			46,7
10,5	1012	52,5	33,3			47,9
9	1093	56,7	35,9			52,4

of yarn was as low as 27 for the all-wool yarn, 16 for the core-spun wool yarn and 9 for the wrapped core-spun yarn. With regard to the all-wool yarn this was at the designated spinning limit of the wool tops, namely 64's spinning count, and would never be attempted commercially. In the present case the machine could only be run for one or two minutes for the sake of obtaining a sample for testing. All the other yarns, including the core-spun and wrapped core-spun wool yarns could be spun on the machine without difficulty.

For the production of satisfactory weaving yarn on the Repco the manufacturers state that sufficient turns must be inserted into the ST yarn to avoid pairing, but the number must not be too high or streakiness will result in the fabric[4]. These optimum conditions correspond to a twist factor between 0,75 and 1,5 above the pairing twist, the latter being defined as the self twist multiplied by 1,55. The maximum and minimum number of turns per half-cycle required for the ST yarns in the present case have been calculated as shown in Table II, and the actual number of turns per half-cycle is also given. It can be seen from these results that the yarns complied with these requirements in practically every case, there being

TABLE III
EVENNESS CHARACTERISTICS OF THE VARIOUS YARNS
(EXPRESSED PER 1 000 METRES)

Yarn Linear Density (tex)	All-Wool Yarn			Core-spun Wool Yarn			Wrapped Core-spun Wool Yarn		
	Thick Places	Thin Places	Neps	Thick Places	Thin Places	Neps	Thick Places	Thin Places	Neps
50	18	14	8	10	14	4	10	18	10
42	32	38	2	18	26	14	30	16	6
36	56	68	10	22	22	10	60	38	10
28	82	178	24	98	138	4	62	70	10
25				152	235	25	116	138	18
21				296	372	74	208	254	24
18							260	522	48
16							548	774	228
14							478	746	206
12,5							761	977	459
10,5							1184	1258	814
9							1294	1328	1006

room for very much *lower twist levels* if so desired, and provided of course that the strength of the ST yarns would be satisfactory at such lower twist levels.

Some evenness characteristics of the various yarns are given in Table III. It is immediately clear that in the case of all the yarns a very rapid deterioration in thick places, thin places and neps occurred with decrease in yarn linear density. For linear densities which could be described as being within the designated spinning limit of the raw material, there was not much to choose between the results for the different types of yarn. At linear densities approaching or beyond the designated limit it is clear that the use of the nylon filaments improved these evenness characteristics to a certain extent, and it is also clear that the wrapped core-spun yarns were superior to the core-spun yarns. When the yarn linear densities approached exceedingly low values, as in the case of the wrapped core-spun yarns it became clear that a thick place, a thin place and a nep occurred in just about every metre of yarn produced. It was nevertheless highly significant that such a fine yarn could still be spun from a straightforward 64's wool, and that this could take place at commercial speeds on the Repco machine.

The irregularity of the various yarns has been depicted in Fig. 1, together with a theoretical curve obtained by extrapolation from a recent formula derived by Hunter and Gee[5] for singles ring yarns. The length and diameter characteristics of the wool top used in the present investigation were substituted in their derived formula in its log form. The curves in Fig 1 show quite clearly that for a given yarn linear density the all-wool Repco yarn had the highest irregularity, followed by the core-spun wool yarn with the wrapped core-spun yarn the most even. The latter was slightly poorer than what may have been expected from an all-wool ring yarn made from the same wool if it were *possible* to extrapolate the performance of such a yarn from performance data accumulated on commercial yarn linear densities. It is certain, in any event, that ring spinning would not be regarded as a proposition, and could well be quite impossible from this particular wool at the extreme end of the range considered here.

SUMMARY AND CONCLUSIONS

A series of trials was conducted to gain some information with regard to the evenness characteristics of Repco wrapped core-spun wool yarns spun from 64's quality wool by the 'wrapped core' techique recently developed at SAWTRI, and to compare these, where possible, with those pertaining to core-spun Repco wool yarns and all-wool Repco wool yarns spun from the same raw material. For linear densities which could be described as being within the designated spinning limit of the raw material, there was not much to choose between the results for the different types of yarn. At or beyond this limit the use of nylon filaments improved the evenness characteristics, the wrapped core-spun yarns being the most even. The experiment also served to demonstrate that although the commercial spinning limit of this 64's wool on the Repco was not as good as 64's (14 tex) per strand, the

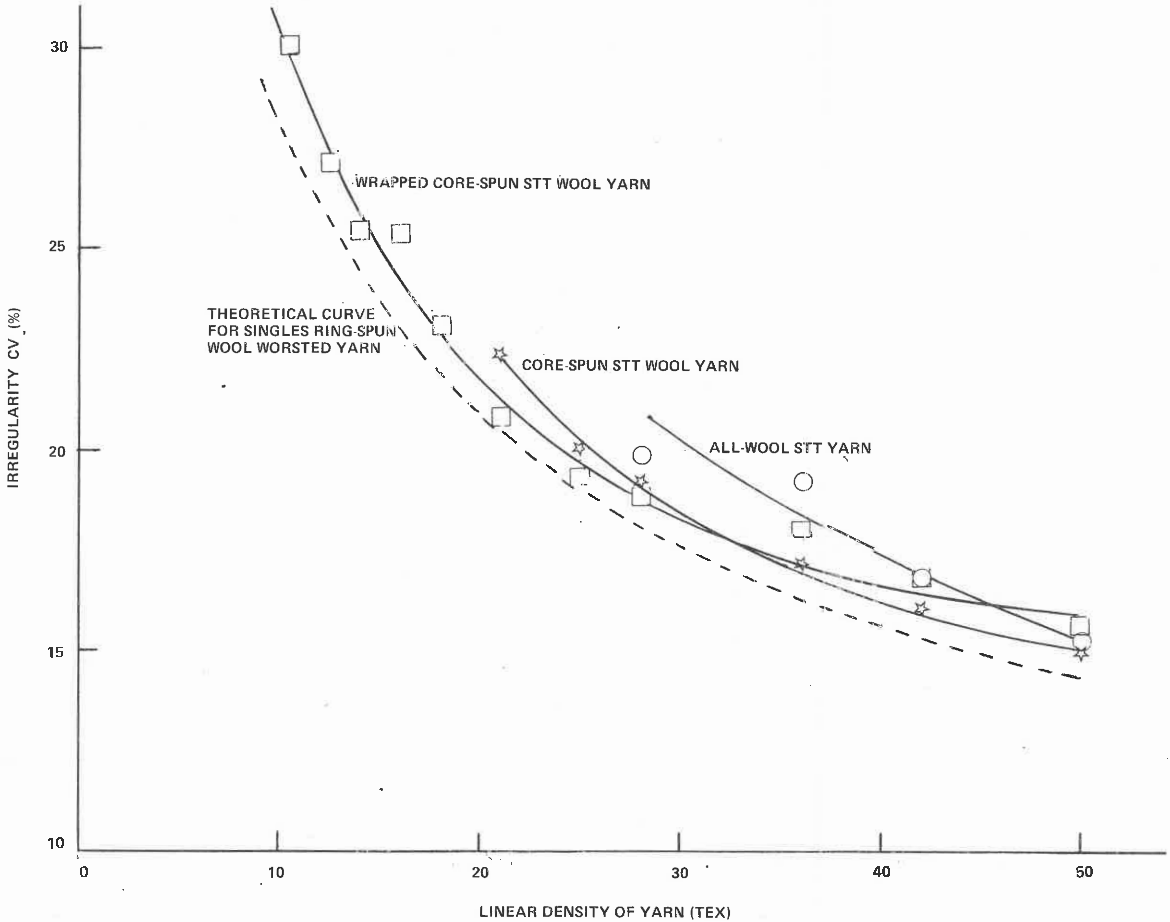

FIGURE 1
Irregularity of the Various Repco Yarns

'wrapped core' technique could be used to spin this same wool to a yarn linear density of 9 tex, equivalent to a worsted spinning count of 98's. This would be regarded as quite impossible on the ring frame from wool of this quality.

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SOME OBSERVATIONS ON THE DYEING CHARACTERISTICS OF MOHAIR RELATIVE TO CORRIEDALE WOOL

by M. B. ROBERTS and E. Gee

ABSTRACT

The dyeing characteristics of mohair were compared with those of lustrous Corriedale wool of similar fibre diameter. The rate of dyeing and equilibrium exhaustion for the mohair were found to be greater than those for wool.

Visual assessments of depth of shade indicated little difference between respective fibres dyed to the same nominal depth. An instrumental method for depth assessment gave similar results.

The results tend to support the contention that the lustre associated with the mohair fibre is responsible for its apparently greater depth of shade when compared with other less lustrous wools, e.g. merino.

INTRODUCTION

Dyers accustomed to dyeing mohair frequently assert that, for a given depth of shade, less dye is needed for mohair than for wool. Such a broad statement must necessarily be interpreted with caution since many factors may influence the visual appearance of textiles apart from the fact that the means of assessment may be less than perfect in its accuracy.

Swanepoel[1] compared the dyeing behaviour of mohair and merino wools of various diameters and contended that the faster rate of dyeing of mohair was a consequence of the larger ratio of ortho-cortex in mohair relative to merino wool. Depths of shade were assessed visually and described in terms of hypershading which was defined as the percentage increase in dyestuff concentrations required to equate the depth of shade of the reference sample to that of the hypershaded one. Hypershading of some 20–25 *per cent* between wool and mohair fibres of similar diameter was observed. This difference in apparent visual strength was ascribed to differences in lustre of the respective fibre surfaces.

In the course of recent work[2] on other comparative aspects of mohair and wool it was considered worthwhile re-examining this topic. Wool and mohair of similar fibre diameter were available, the wool being a Corriedale and thus differences in lustre would be expected to be much reduced. With the development of instrumental methods of colour measurement, it has been observed that the variations in depth of dyeing can be followed by observing changes in the L and C co-ordinates of ANLAB colour space; C being the polar form of the more familiar

Cartesian coordinates of A and B. Interconversion is given by the formulae:

$$C = (A^2 + B^2)^{1/2}$$

and $$H = \tan^{-1} (B/A)$$

Cooper and McLaren[3] have indicated that increasing strength causes an increase in the C coordinate with yellows, a decrease in the L coordinate with blues and a combination of both with all other colours. Some dyes exhibit a maximum C value before the greatest depth has been achieved and thus increasing depth beyond this point may cause a continuing decrease in L and a decrease in C.

The purpose of this work, therefore, was to examine the dyeing characteristics of the two fibres and to determine whether the methods outlined above, based upon instrumental colour measurement, gave similar strength differences to those obtained visually.

EXPERIMENTAL

Purification:

Mohair fibre (young goats), of mean diameter 32 μm and Corriedale wool fibres of the same mean diameter were used in this investigation. Corriedale wool was selected because of its lustre. Thus differences in this property between mohair and the wool would be expected to be minimal. The fibre was purified by successive extraction with diethyl ether and ethanol. After the ether extraction, the fibres were dried and shaken to remove grit and other extraneous material. Following the alcohol extraction the fibres were washed in running water for 24 hours to remove suint and further dirt. Drying was carried out at ambient temperature. The fibres were finally passed through an F.O.R. worsted card which served to further clean the bulk and to produce homogeneous samples.

Dyeing:

Dyeing trails were carried out in an Ahiba Turbomat TM 6 machine using a fibre mass of 5 g and a liquor-to-goods ratio of 100 : 1. Three dyes from the ®Lanasol range were used, namely Red 6G (Reactive Red 84) Yellow 4G (Reactive Yellow 39) and Blue 3G (Reactive Blue 69). The dyeing methods employed were those recommended by the manufacturer including a method of dyeing at 85°C in order to protect the lustre of the mohair. In those trials designed to yield information on the rate of dyeing, dyeings were carried out at a depth of 1 *per cent* (omf) and aliquots were removed from the bath at regular intervals for colorimetric analysis, this being carried out on a Beckman DB spectrophotometer.

The assessment of depth of shade of dyed fibres was carried out by first preparing one series of dyeings of respective depths 0,4 0,45, 0,5, 0,55, and 0,6 *per cent* (omf) and another of respective depths 2,4, 2,7, 3,0, 3,3 and 3,6 *per cent* (omf) for each fibre. Tristimulus coefficients X, Y and Z were determined on a Harrison Shirley Digital Colorimeter and these values were converted to LCH co-ordinates, using the CIELAB formulae[4].

Visual assessments of the depth of mohair fibres were made by asking a panel of six assessors to select, from the series of wool dyeings, the closest match to the 0,5 *per cent* (omf) and 3 *per cent* (omf) mohair dyeings. The wool dyeings were assigned the percentage values of –20, –10, 0, +10, and +20 respectively in order of increasing depth. The mean value of the ratings was calculated. Thus a rating of zero indicated that the apparent depth of the mohair dyeing was equal to that of its wool counterpart, whereas a positive value indicated that the mohair was stronger than, and a negative value weaker than, its wool counterpart.

RESULTS AND DISCUSSIONS

Rates of dyeings and equilibrium exhaustions are shown for Reactive Red 84 in Fig. 1, this dye giving results typical of those found for other dyes in this work. Clearly mohair has the higher rate of dyeing and a higher equilibrium exhaustion.

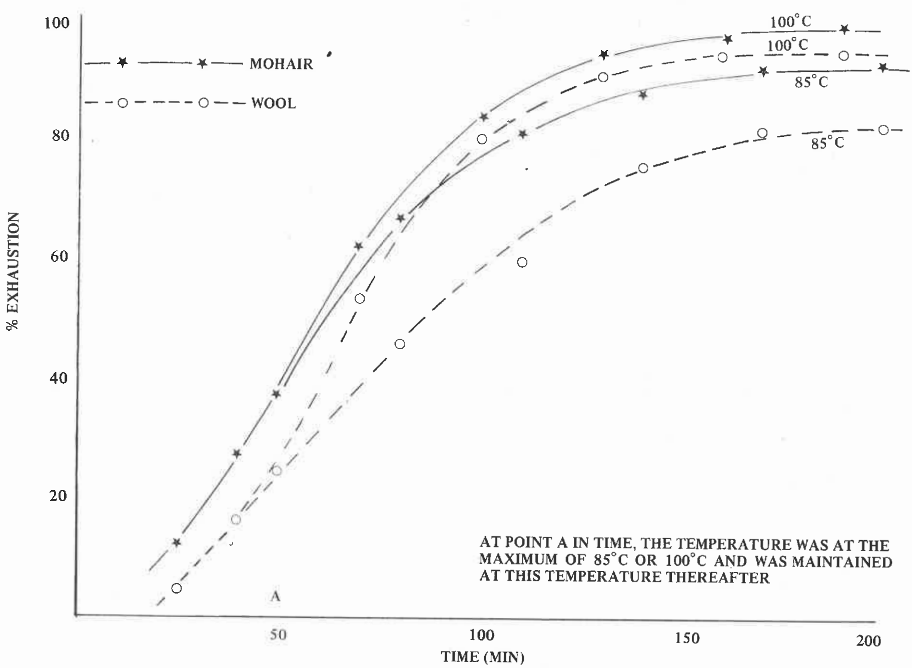

FIGURE 1
Rate of exhaustion of reactive Red 84 (Lanasol Red 6G) at 1 per cent (omf) on mohair and Corriedale wool

The times of half dyeing of mohair at 100°C and 85°C are both 59 minutes while those of the wool at the same temperatures are 66 and 73 minutes respectively. These results are in agreement with those of Swanepoel[1]. The equilibrium exhaustion values for mohair are higher than for wool. At 100°C there is a difference of some 5 *per cent* and at the lower temperature the difference is 10 *per cent*. It would be expected that the higher equilibrium exhaustion of the mohair would contribute to a heavier depth of shade.

Quadratic regressions for each set of experimental L and C values were calculated and are shown in Figs. 2 – 9. The confidence limits of any predicted L or C values are such that in no case can the results for the mohair be said to be different from the corresponding results for wool. It is clear from Figs. 6 and 7 that a maximum C-effect exists for the Reactive Red 84 at an applied dyestuff concentration of between 0,6 *per cent* o.m.f. and 2,4 *per cent* o.m.f.

Changes in L and C values arising from changes in hue which occur as a result of variations in strength have not been taken into account on the grounds that both mohair and wool are likely to be equally affected. A difference of one unit in the

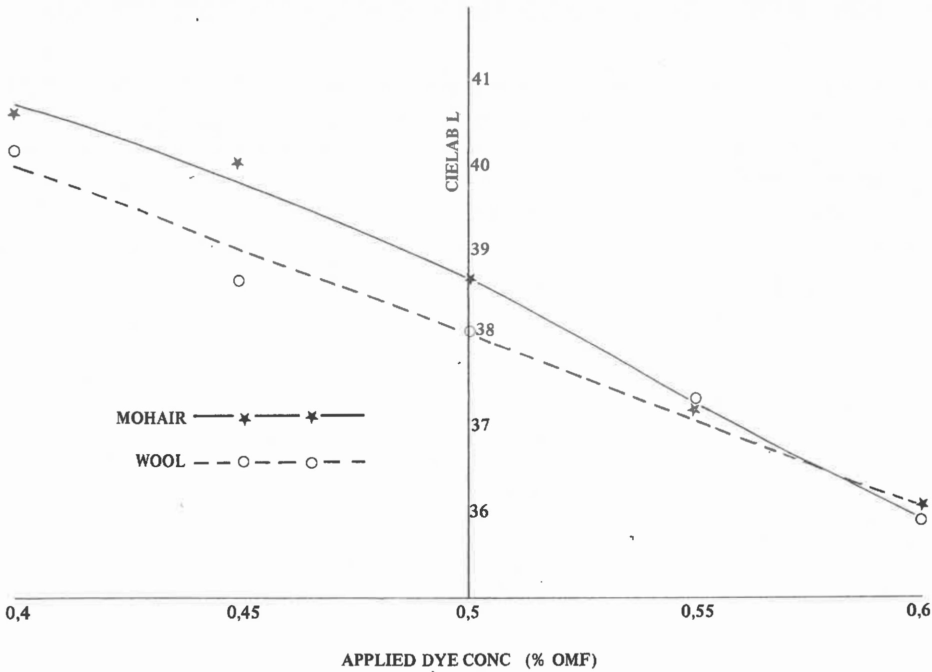

FIGURE 2
Plot of applied dye concentration against CIELAB L for reactive Blue 69 at ± 0,5 per cent (omf) on Mohair and Corriedale wool

yellowness index of the fibres, as calculated from the Hunter formula[5], has been regarded as of little significance in this instance.

The results of the visual strength assessment, displayed in Table I, suggest that the strength differences between mohair and Corriedale wool are very small. These results are in agreement with those derived from the instrumental strength assessment and together, they support the conclusions drawn by Swanepoel[1].

TABLE I

MEAN VISUAL DEPTH RATING OF 0,5 PER CENT AND 3 PER CENT MOHAIR DYEING AGAINST STANDARD CORRIEDALE WOOL DYEINGS

Dye	Concentration (% OMF)	Mean Percentage Difference*
Reactive Red 84	0,5	+2
	3,0	−2
Reactive Blue 69	0,5	+2
	3,0	0
Reactive Yellow 39	0,5	−5
	3,0	−2

* Positive values indicate mohair appearing of greater depth than the wool. Negative values indicate the reverse.

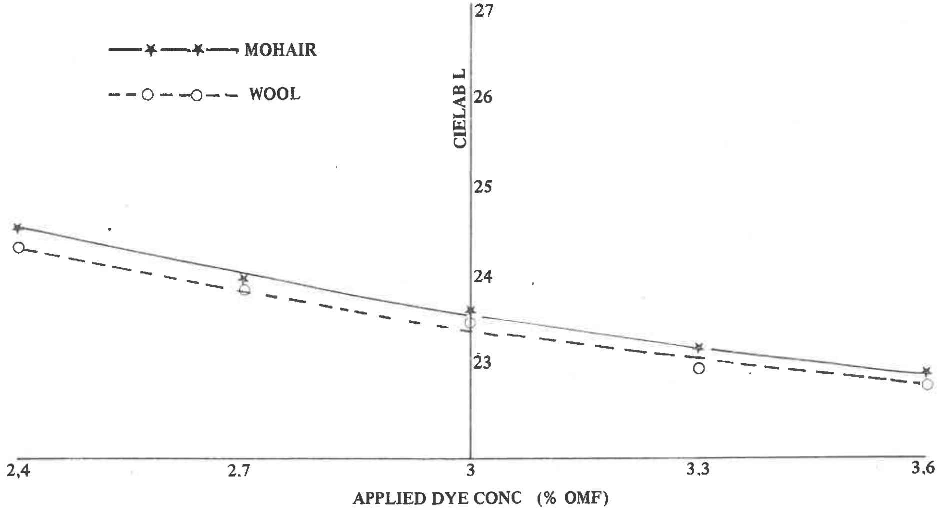

FIGURE 3
Plot of apllied dye concentration against CIELAB L for reactive Blue 69 at ± 3 per cent (omf) on Mohair and Corriedale wool

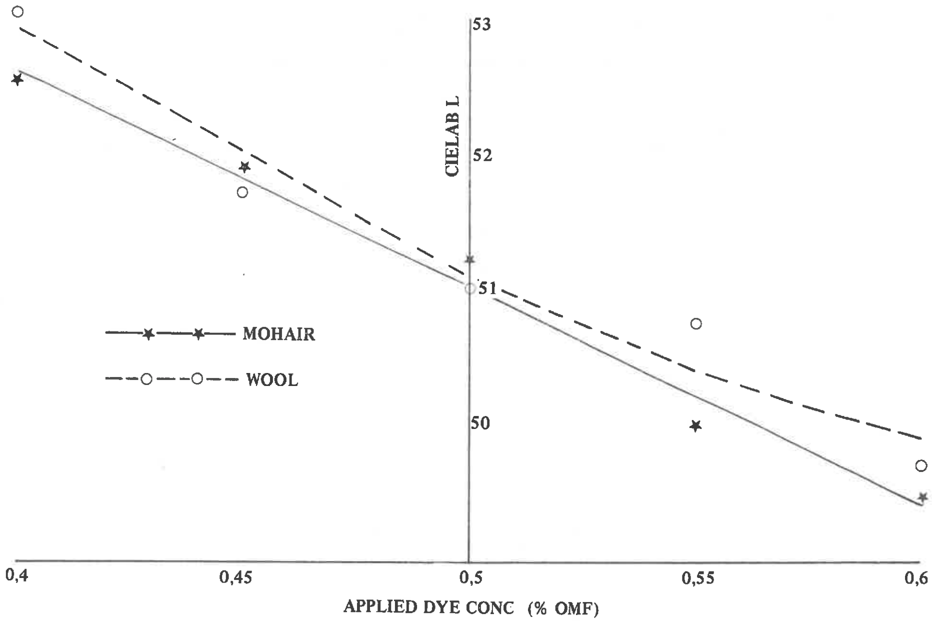

FIGURE 4
Plot of applied dye concentration against CIELAB L for reactive Red 84 at ± 0,5 per cent (omf) on Mohair and Corriedale wool

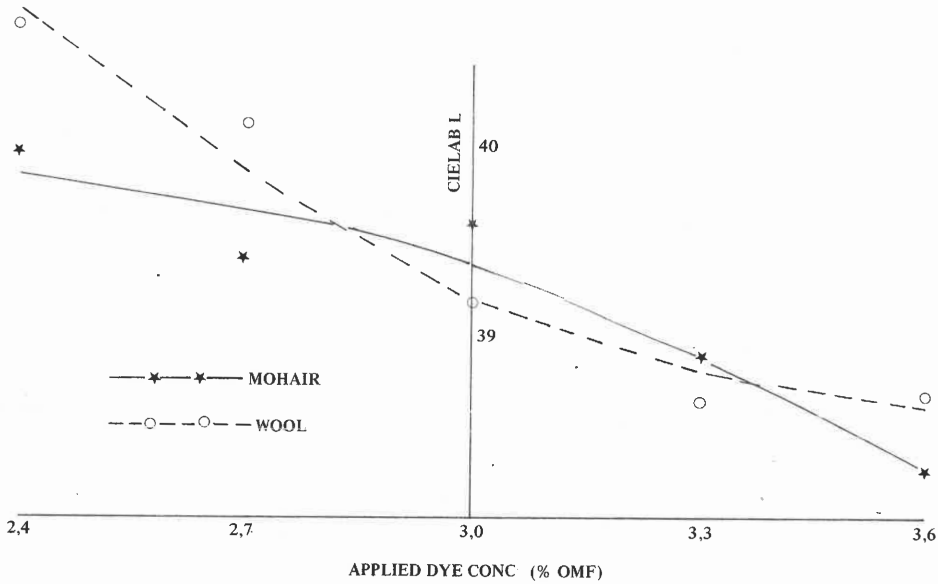

FIGURE 5
Plot of applied dye concentration against CIELAB L for reactive Red 84 at ± 3 per cent (omf) on Mohair and Corriedale wool

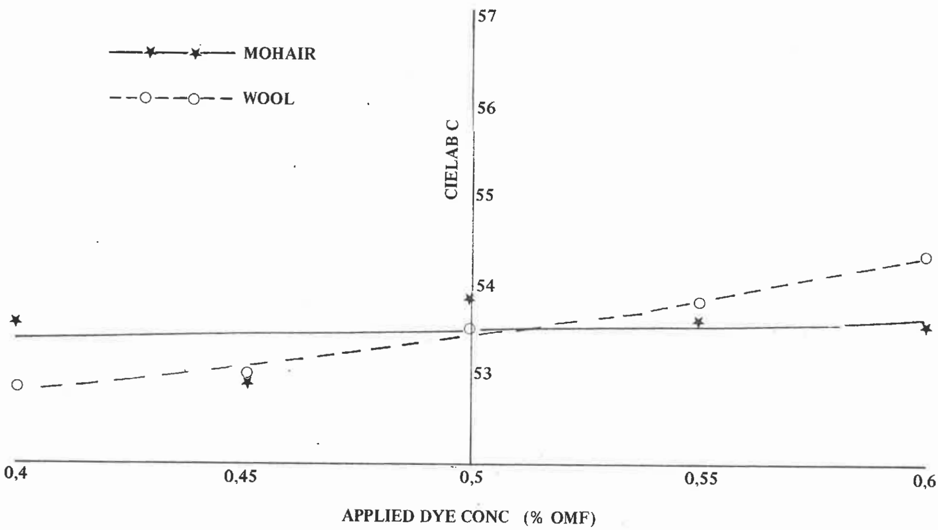

FIGURE 6
Plot of applied dye concentration against CIELAB C for reactive Red 84 at ± 0,5 per cent (omf) on Mohair and Corriedale wool

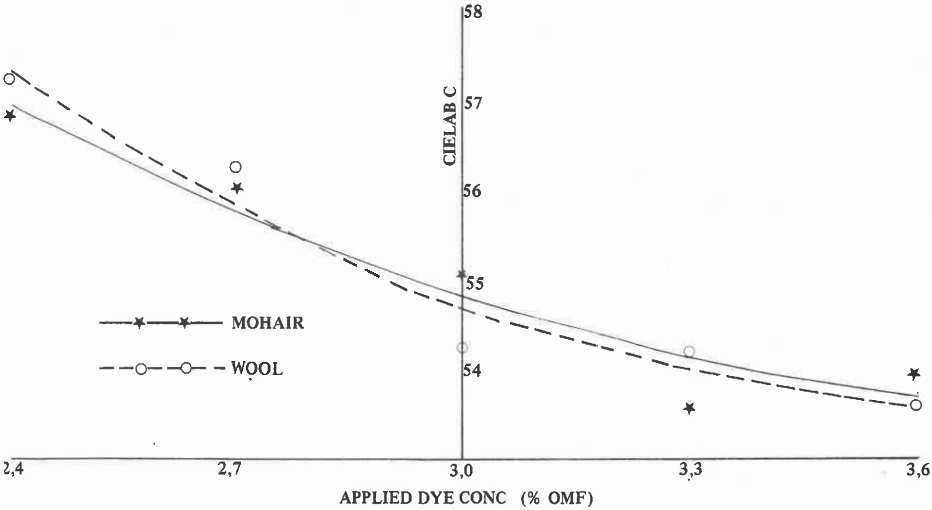

FIGURE 7
Plot of applied dye concentration against CIELAB C for reactive Red 84 at ± 3 per cent (omf) on Mohair and Corriedale wool

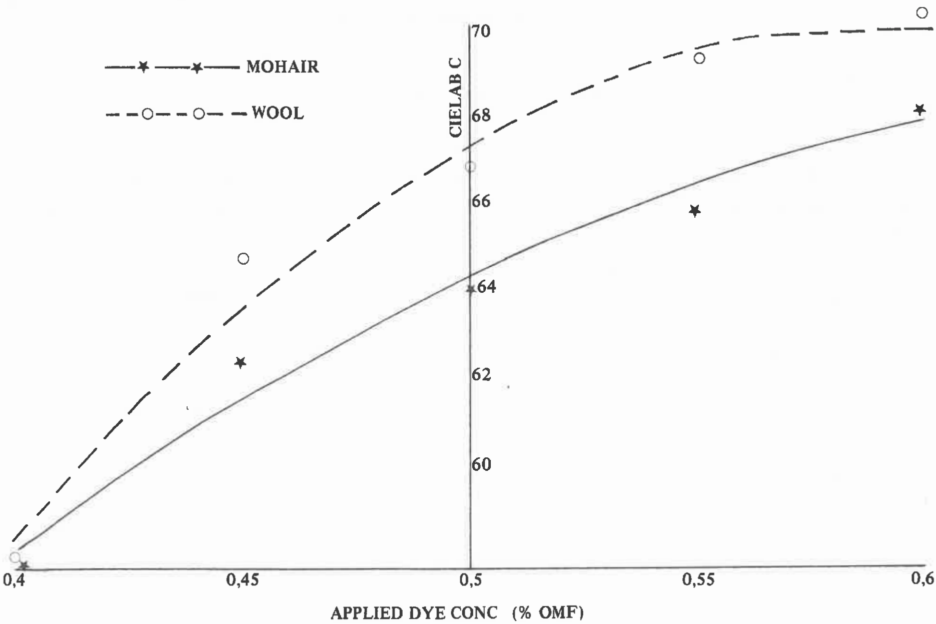

FIGURE 8
Plot of applied dye concentration against CIELAB C for reactive yellow 39 at ± 0,5 per cent (omf) on Mohair and Corriedale wool

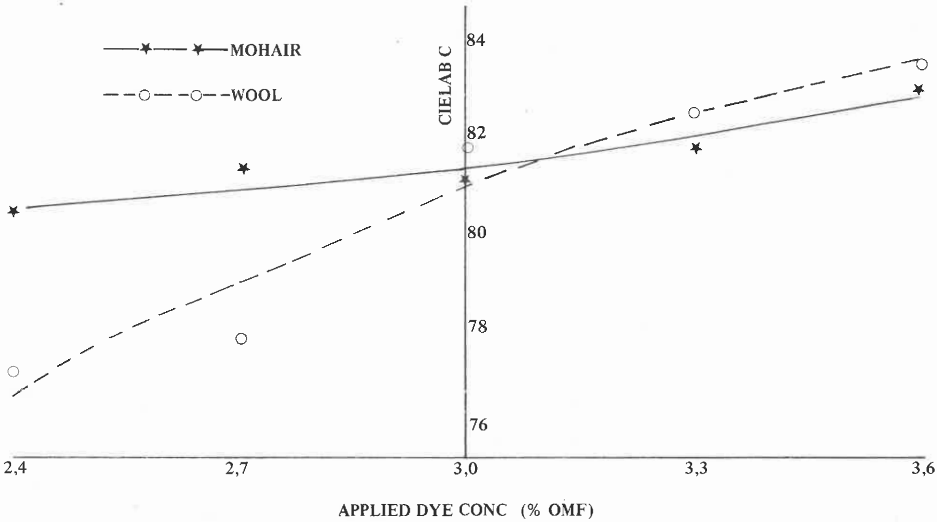

FIGURE 9
Plot of applied dye concentration against CIELAB C for reactive yellow 39 at ± 3 per cent (omf) on Mohair and Corriedale wool

SUMMARY AND CONCLUSIONS

The rate of dyeing of mohair was found to be greater than that of a Corriedale wool of similar diameter, this conclusion being in line with that of Swanepoel[1]. In addition the equilibrium exhaustion was found to be higher in the case of the mohair.

When mohair and the Corriedale wool were dyed to the same nominal depth of shade, differences in apparent depth of shade were very small when assessed both visually and by an instrumental technique. It is likely that the frequently claimed greater depth of shade obtained on mohair relative to wool is caused by the greater lustre of mohair relative to that, for example, on merino wool and that, when this lustre difference is absent, the apparent strength difference also falls away.

The instrumental method gave results which supported the visual assessment. The usefulness of this analytical technique can only be assessed by further work to establish confidence limits of predicted strength.

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