PURDUE UNIVERSITY
International Education and Research
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PORTUGAL UNIVERSITY INSTITUTES DEVELOPMENT PROJECT

(Contract AID/NE-C-1701)

REPORT ON
SHORT-TERM STAFF ASSIGNMENT

Submitted by
DR. HASSAN M. BEHERY
Clemson University
Clemson, South Carolina

June 1 - July 15, 1982

PORTUGAL UNIVERSITY INSTITUTES DEVELOPMENT PROJECT

(AID Contract--AID/NE-C-1701)

REPORT ON
SHORT-TERM STAFF ASSIGNMENT

at the

Instituto Universitario da Beira Interior
Covilha, Portugal

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THE INSTITUTO UNIVERSITARIO DA BEIRA INTERIOR
COVILHA, PORTUGAL

INTRODUCTION

This report covers the activities rendered as part of the technical advice and assistance to the IUBI as required under agreements between the Government of Portugal and the Government of the United States, and Prime Contract No. AID/NE-1701 for the purpose of developing and strengthening the IUBI, formerly the polytechnical institute.

The activities comprised of courses offered, seminars and workshops, installation and training on testing equipment, mill visits, discussions of revised programs, and serving as long-term advisor.

AREA OF CONSULTANCY

The major area of consultancy requested was Textile and Fiber Physics. Aid was also given in the installation of testing equipment received by IUBI as part of this project.

OBJECTIVES OF THE VISIT

The specific objectives of the visit were to perform the following services:

1. Teach a Fiber and Textile Physics Course

   Part of the assignment was to teach a course on Fiber and Textile Physics to graduating seniors at the institute together with other interested personnel.

2. Seminars and Workshops

   A function always requested by IUBI is the organization of several seminars and workshops for industries to help build up and strengthen the relations between IUBI and the textile industry. Three seminars and three workshops were organized during the consultancy period.

3. Installation of Testing Instruments and Training on Their Use

   It was requested by IUBI in a letter dated February 8, 1982 that, "We should like that you will help us both with the setting up and working of some equipment recently obtained and the teaching of our staff members in order to be able to work with it."

4. Revision of the Program to be Executed by Clemson University

   Before departure to Portugal and upon receipt of a memorandum from Purdue University, it was noticed that there were some ammendments to the original man-months to be executed by Clemson University. It was planned to discuss this revised program as part of the objective of this assignment.

5. Mill Visits

During my previous assignment to Covilha (May 15 - July 15, 1981) I was unable to visit all the textile mills in the near vicinity of Covilha. It was planned to visit the other mills which were not visited before.

6. Reference Material

IUBI pointed out their desire to initiate research work in the areas of electrical properties, abrasion properties, and friction behavior of textile material. As a basis of these activities, reference material was collected and presented to the library.

DURATION OF THE ASSIGNMENT

The activities outlined above were performed between June 1, 1982 and July 15, 1982.

COUNTERPARTS

Due to the diversity of the activity during this assignment, several of IUBI's faculty worked very closely with Dr. Behery in the various areas. The following is the summary of these activities and the counterpart in each one.

A. Professor José Miquel Fiadeiro aided in coordinating the activities in the textile area. He also contributed effectively in the organization of the seminar on "Problems of Production and Use of Acrylic and Polyester Fibers." He served as a moderator in this seminar.

B. Engineer Mário Figuiredo Nunes worked very closely with Dr. Behery during the classes on Fiber and Textile Physics. He also assisted as technical interpreter in the three seminars and workshops, which made these seminars more useful.
Engineer Nunes assisted Dr. Behery in the installation of the new instruments and he acquired enough training to train other technicians. He had already practiced that during the workshops.

C. Mr. Mário Alberto de Prato Barros worked with Dr. Behery on the administrative activities concerning the ammendments and changes in the program.

D. Engineer Manuel José dos Santos Silva also worked actively in organizing and moderating the seminar on "Spinning Technology and Quality Control in Textile Industry."

E. Engineer Mário Tavares assisted effectively in organizing the workshop on "Training on New Textile Testing Instruments." He also moderated the workshops. He regularly attended the course on Fiber and Textile Physics as he is presently in charge of teaching this course.

ACCOMPLISHMENTS DURING THE ADVISORY PERIOD

1. FIBER AND TEXTILE PHYSICS COURSE

A. Course Schedule and Content

The course was scheduled for six weeks, beginning Monday, June 7, 1982 and ending Monday, July 12, 1982. Classes met every Monday and Wednesday from 5:00 pm - 7:00 pm.

The course outline was as follows:

MECHANICAL PROPERTIES OF FIBERS

i. Tensile Properties

a. Factors Determining the Results of Tensile Tests

b. Quantitative Expression of Tensile Tests

c. Tensile Experimental Tests

d. Experimental Results of Tensile Tests for Various Fibers

ii. Elastic Recovery

a. Definitions and Experimental Methods

b. Experimental Results

iii. Creep and Relaxation Properties of Textile Materials

a. Creep - Definition and Method of Measurement

b. Relaxation - Definition and Method of Measuremen .

c. Combined Creep and Relaxation Effect and Its Practical Application

THEORIES OF MECHANICAL PROPERTIES OF FIBERS

i. Molecular Theories

a. Extension and Recovery of Fibers

b. Effect of Molecular Orientation

c. Mechanism of Breakage

d. Molecular Enterpretation of Torsional Behavior of Fibers

ELECTRICAL PROPERTIES

i. Theoretical and Physical Concepts of Electrical Properties

a. Dielectric Properties

b. Electrical Resistance

c. Static Electricity

ii. Static Electricity

a. Measurement of Static Electricity

b. Explanation of Static Phenomena

c. Experimental Results for Different Textile Fibers

B. Participants

The course was attended regularly by senior class students who took the final exam for the course. These students were:

1. António José Pinto Barbosa
2. Joao Eduardo da Costa P. Navega
3. Maria João Taborda Caetano
4. António Fernando Marques Aguilar

5. Francisco José Podão Abrantes

6. Francisco Gomes Ferreira Franco

Their percentage of attendance was from 89% to 100%. Also, some faculty members of IUBI and other students attended the course, but not on a regular basis. These were:

1. Eng. José Miquel Fiadeiro
2. Eng. José dos Santos Silva
3. Eng. Mário Figueiredo Nunes
4. Eng. Mário Tavares
5. Miss Maria José Geraldes
6. João Paulo Domingues
7. Rui Manuel Fonseca Santos Costa
8. Ilidio Fernandes

C. An examination was prepared and given to Eng. Mário Tavares to include in the final examination for the course under his supervision.

2. <u>SEMINARS AND WORKSHOPS</u>

A. <u>Topics of the Seminars</u>

Three seminars were organized. The topics and dates of these seminars were as follows:

1. "Problems in Fabrication and Application of Polyester and Acrylic Fibers." Monday, June 28, 1982. A copy of the brochure is shown in Attachment 1.

2. "Spinning Technology and Quality Control in Textile Industry." Friday, July 9, 1982. A copy of the brochure is shown in Attachment 2.

3. "Technical Report Writing." Thursday, June 24, 1982, at 4:00 pm. This seminar was offered to the seniors and juniors to assist them in writing their research projects. These research projects are a requirement for graduation.

B. Topics of the Workshops

Three workshops were organized basically for laboratory technicians and supervisors in the textile mills. The purpose of these workshops was to train the technicians and supervisors in the use of the new equipment received by IUBI. A copy of the brochure is shown in Attachment 3. Each workshop was held for one day and training was directed towards four instruments as outlined in the brochure. The dates for the workshops were July 6, July 13, and July 20, 1982.

C. Seminar Attendance

The first seminar was well attended. Over 30 technical personnel from textile fiber industries as well as 30 IUBI faculty members and students were in attendance. The presentations were well received and the comments on the seminar were very favorable. A list of the participants is given in Appendix A.

The second seminar was carried out in conjunction with Professor Kirchner of the National School of Textile Industries (Mulhouse, France). Forty participants attended the seminar. The text of my presentation is given in Appendix B.

The third seminar was attended by most of the seniors. Only about 15 students were able to attend since the scheduled time conflicted with a final examination.

D. <u>Workshop Attendance</u>

The workshops were not very well attended. The reason for the poor attendance was due to the fact that the workshops were directed to technicians. In fact those who participated were primarily from middle to top management.

3. <u>INSTALLATION OF TESTING INSTRUMENTS AND TRAINING ON THEIR USE</u>

IUBI received a large number of testing instruments. Some of them were unpacked and some were in the boxes. The list in Attachment 4 shows the instruments that were completely commissioned and put to work. Eng. Mário Nunes became well acquainted with the scope, function, and procedure of these instruments. Two copies of American Standards for Testing and Material (ASTM), Parts 32 and 33, which are devoted to textile material, have been submitted to the library. These volumes are essential for performing the test according to the recognized standards.

Several other instruments need to be installed. Due to the shortage of time, it was difficult to complete the installation. Two days per week (Thursdays and Fridays) were only devoted to this work.

4. <u>REVISION OF THE PROGRAM TO BE EXECUTED BY CLEMSON UNIVERSITY</u>

Prior to my departure for the assignment, a memorandum was received from Purdue indicating changes in the activities requested at IUBI. Several meetings were held at IUBI and the AID office in Lisbon to investigate the segment of the program to be executed by Clemson. Upon returning to Clemson contact was made with Purdue to discuss this point in a meeting scheduled for Friday, August 27, 1982.

5. <u>MILL VISITS</u>

Two textile mills were visited at Siea, which is a nearby town. The first mill visited was Fercol Alcatifac, Seia. The company's main production is tufted carpet and the maximum capacity is 3.0 million square meters. The company also produces its own carpet yarn from polypropylene. In addition, it has facilities for stock dyeing as hand knitted yarn is also produced.

The second mill visited was Vodratex. The general impression on the company is that it has gone through different stages of expansion. This was obvious from the variety of machine types as well as the diversity of the products. The main production of the company is directed towards outerwear for ladies, men and children. The maximum capacity is 3.5 million square meters per year.

6. REFERENCE MATERIAL

To assist in initiating research work in the areas of electrical properties, abrasion properties and friction behavior of textiles, a reference search was made and a computer printout was obtained. Several articles of interest and reference books were obtained and submitted to IUBI library. A list of this material is given in Appendix C.

7. OTHER ACTIVITIES

A. Special Assistance to Students

Two of the graduating seniors, Miss Maria José Geraldes and Mr. Joao Paulo, were working on their research project, "Design of Economical Spinning Mill and Comparison Between Conventional Ring Spinning and Open-End Spinning." Assistance was given to these two students in the calculation and design of the project. The seminar on "Technical Report Writing," which was offered to all the students, stemmed from working with these two students.

B. Acting Long-Term Advisor

Due to the absence of a long-term advisor and also to aid in getting the program at Clemson underway, Reitor Morgado requested that Dr. Behery function as Acting Long-Term Advisor. A lot of office work was needed to prepare the IPOP forms for two short-term trainees scheduled to go to Clemson in August. By late June, 1982, no action had been taken to start the usual procedures. These were taken care of with regard to ELIGUE test, PIOP forms, etc. Also, procedures were initiated for four other candidates for long-term training for a Master of Science degree. They are scheduled to begin their program in January, 1983. The PIOP forms were completed together with the application forms to the Graduate School at Clemson University. These were submitted to Clemson and action is underway for their acceptance.

8. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

It could be concluded from the accomplishments described in this report that the objectives of this short-term advisory on fiber and textile physics were very well fulfilled. In addition to the course presented on fiber and textile physics, two industrial seminars and workshops were presented at IUBI. Such activities were highly appreciated by the industry and has helped strengthen the relationship between IUBI and the textile industry.

In addition to the fulfillment of the original objectives, other duties were performed in order to keep the program underway. Preparation of the details for activities needed for the two short-term trainees and four long-term trainees were prepared. Assistance was also provided in following the necessary procedures prior to departure for the U.S.A. As a result of this effort, two short-term trainees are scheduled to come to Clemson in late August, 1982, and five long-term trainees will be arriving early January, 1983.

B. <u>Recommendations</u>

1. The presence of a long-term advisor is highly recommended. The lack of a long-term advisor resulted in an enormous amount of extra work to be carried out on my part, specially for preparation of the two short-term trainees scheduled to arrive in the U.S.A. in August, 1982. Also, the preparation for the procedures required for the four long-term trainees needed to be started.

The proper coordination of the program at IUBI is difficult to achieve without the presence of the long-term advisor.

2. Several technical areas need to be considered as part of the short-term consultancy. These are in the fields of yarn and fabric formation. This is suggested to be included in the two man-months on instrumentation. This period could be extended to two and one-half months and include textile technology. This one-half month extension is taken from the difference between the two man-month period allocated to fiber and textile physics which was changed to a period of six weeks only (June 1, 1982 - July 15, 1982).

3. Due to the pace of the progress of this program, it seems essential to consider, at this early stage, a possible extension to a fifth year with an expiration date of August 15, 1985.

O SEMINÁRIO

LÍNGUA

O Seminário será dado, parte em Português e parte em Inglês. Os docentes do IUBI participantes, poderão fazer um resumo em Português das exposições, quando se julgar necessário.

TEMAS

O Seminário discutirá os aspectos práticos e aplicação das duas fibras sintéticas mais utilizadas na Indústria Têxtil Portuguesa: Acrílica e Poliéster. Entre outros temas tratar-se-á das causas de defeitos, da variação do encolhimento das fibras e da afinidade tintorial. Apresentar-se-á a relação entre a estrutura e os processos de fiagem e de consolidação da fibra e a forma como aquela afecta as propriedades físicas e mecânicas das fibras.

QUEM DEVE ASSISTIR

O Seminário destina-se a supervisores, quadros intermédios e gestores. O treinamento universitário será útil mas não é indispensável para a frequência deste Seminário. Todas as pessoas que queiram frequentar este Seminário devem estar familiarizadas com os processos de fabrico da Indústria Têxtil. Este Seminário será útil a todas as empresas que trabalham com fibras sintéticas ou mistura de fibras sintéticas com outras fibras.

CUSTO

A inscrição será de [illegible].

ATTACHMENT 1

O Instituto Universitário da Beira Interior foi criado pela lei 44/79, de 11 de Setembro e nele são ministrados actualmente os seguintes cursos; além de outros que se esperam venham entrar em funcionamento no próximo ano lectivo.

Licenciatura em Gestão

Ramos: Gestão de Empresas

Gestão Regional

Licenciatura em Engenharia Têxtil

"Preparatórios de Engenharia":

Engenharia Mecânica

Engenharia Electrotécnica

Engenharia Civil

Engenharia Química

No âmbito de um acordo de cooperação assinado pelos Governos Português e dos Estados Unidos da América, foi estabelecido entre o IUBI e as Universidades Americanas de Purdue e Clemson, um Convénio de Cooperação, ao abrigo do qual se encontram de momento no IUBI dois professores daquelas Universidades, tendo por fim colaborarem com a nossa Escola no âmbito do Ensino, da Investigação e dos Serviços de Apoio à Comunidade.

São esses dois professores os dinamizadores do Seminário "PROBLEMAS DA FABRICAÇÃO E APLICAÇÃO DE FIBRAS ACRÍLICAS E DE POLIÉSTER" os quais pela sua experiência e conhecimentos muito contribuirão para o bom êxito do mesmo.

INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR

RUA MARQUÊS D'ÁVILA E BOLAMA

TELEF. 25141/2

6200 COVILHÃ

BENVINDOS AO SEMINÁRIO

sobre

"PROBLEMAS DA FABRICAÇÃO E APLICAÇÃO

DE

FIBRAS ACRÍLICAS E DE POLIÉSTER"

O tema será apresentado por técnicos especialistas da Indústria da Produção das Fibras Sintéticas e por Professores da Universidade de Clemson, Consultores do Programa AID.

ALOJAMENTOS:

Por favor reserve o seu hotel.

Algumas sugestões:

	Quarto duplo c/Banho
Pensão Solneve	1.105$00
Residencial Montalto	1.500$00
Residencial Floresta	800$00
Hotel Samasa (Fundão)	1.680$00
Hotel Torralta	1.630$00

	Quarto Simples c/banho
Pensão Solneve	710$0
Residencial Montalto	700$/750$/800$
Residencial Floresta	-
hotel Samasa (Fundão)	1.200$00
Hotel Torralta	1.115$00

PROGRAMA

SEGUNDA-FEIRA - 28 DE JUNHO DE 1982

MODERADOR - DOUTOR J.M.P.FIADEIRO

9.30 - ABERTURA

PROF.DOUTOR C.M.PASSOS MORGADO, Reitor do Instituto Universitário da Beira Interior

9.45 - EVOLUÇÃO DO MERCADO DAS FIBRAS SINTÉTICAS

- APLICAÇÃO E CUIDADOS A TER NA UTILIZAÇÃO DE FIBRAS ACRÍLICAS

ENGº J.D.DAVID - FISIPE

10.45- PROBLEMAS NA FABRICAÇÃO DE FIBRAS ACRÍLICAS

ENGº A.P.DOMINGUES - FISIPE

11.45- INTERVALO PARA CAFÉ

12.00- PROBLEMAS NA FABRICAÇÃO E APLICAÇÃO DE FIBRAS DE POLIÉSTER

ENGº V.[illegible] - FINICISA

13.00- ALMOÇO

14.30- "THREADLINE PHYSICS AND FIBER QUENCHING"

PROF.DOUTOR DAN EDIE, Professor da Universidade de Clemson - USA (AID-ADVISOR)

15.30- PROPRIEDADES FÍSICAS E MECÂNICAS DAS FIBRAS

PROF.DOUTOR HASSAN M.BEHERY, Professor da Universidade de Clemson - USA (AID-ADVISOR)

16.30- VISITA AO IUBI

(corte, preencha e devolva)

FICHA DE INSCRIÇÃO

Para assistir ao Seminário, agradecemos que preencha correctamente as informações que se seguem e remeta, com o valor da respectiva inscrição, para o seguinte endereço:

INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR
GABINETE DO PROF.HASSAN BEHERY
RUA MARQUÊS DE ÁVILA E BOLAMA
6200 COVILHÃ CODEX

Nome: ______________ Função: ______________

Organismo/Empresa: ______________

Direção: ______________ Telefone: ______________

[illegible]

LÍNGUA

O Seminário será dado em Português, Francês e Inglês. Haverá tradução pelos Docentes do IUBI participantes, quando se julgar necessário.

TEMAS

Durante este Seminário discutir-se-á o fenómeno da migração de fibras durante o processo de fiação tendo em atenção as diferentes propriedades das fibras, as características das máquinas e dos fios.

Esta informação destina-se especialmente ao processamento de mistura de fibras.

Na segunda parte do Seminário será apresentado e discutido sob variados aspectos o problema do controlo de qualidade na indústria têxtil de um modo geral e mais especialmente na fiação.

Na terceira parte serão apresentadas as propriedades das fibras de poliéster e o controlo de qualidade na sua fabricação.

[illegible]

O Seminário destina-se a supervisores, quadros intermédios e gestores. A formação universitária será útil mas não é indispensável para a frequência deste Seminário. Todas as pessoas que queiram frequentar este Seminário devem estar familiarizadas com os processos de fabrico da Indústria Têxtil. Este Seminário será útil a todas as empresas têxteis em geral e em particular às de fiação.

[illegible]

A inscrição será de [illegible].

ATTACHMENT 2

O Instituto Universitário da Beira Interior foi criado pela Lei 44/79, de 11 de Setembro e nele são ministrados actualmente os seguintes cursos; além de outros que se espera venham entrar em funcionamento no próximo ano lectivo.

Licenciatura em Gestão:
- Ramos: Gestão de Empresas
  - Gestão Regional

Licenciatura em Engenharia Têxtil:
- "Preparatórios de Engenharia":
  - Engenharia Mecânica
  - Engenharia Electrotécnica
  - Engenharia Civil
  - Engenharia Química

No âmbito de um acordo de cooperação assinado pelos Governos Português e dos Estados Unidos da América, foi estabelecido entre o IUBI e as Universidades Americanas de Purdue e Clemson, um Convénio de Cooperação, ao abrigo do qual se encontra de momento no IUBI um Professor daquela Universidade, tendo por fim colaborar com a nossa Escola no âmbito da Investigação e dos Serviços de Apoio à Comunidade.

A Escola Nacional das Indústrias de Mulhouse foi desde o início do nosso Instituto uma das Escolas que mais colaborou na sua organização.

Desde 1976 que se têm deslocado ao IUBI dois ou três especialistas por ano, integralmente subsidiados pelos serviços culturais da Embaixada Francesa.

É dentro desta colaboração que temos mais uma vez entre nós o Prof. A.KIRCHNER.

INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR
RUA MARQUÊS D'ÁVILA E BOLAMA
TELEF. [illegible]
6200 COVILHÃ

SEMINÁRIO

sobre

TECNOLOGIA DE FIAÇÃO

E

CONTROLO DE QUALIDADE NA INDÚSTRIA TÊXTIL

O tema será apresentado pelo Prof.Hassan Behery da Universidade de Clemson, Estados Unidos, Pelo Prof. A.Kirchner da Escola Nacional das Industrias Texteis de Mulhouse-Universidade da Alta Alsácia-França e pelo EngºV.Sphor da Finicisa-Portalegre-Portugal

ALOJAMENTOS:

Por favor reserve o seu hotel.

Algumas sugestões:

	Quarto Duplo c/Banho
Pensão Solneve	**1.105$00**
Residencial Montalto	**1.500$00**
Residencial Floresta	**800$00**
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Hotel Torralta	**1.630$00**

	Quarto Simples c/Banho
Pensão Solneve	**710$00**
Residencial Montalto	**700$/750$/800$**
Residencial Floresta	**-$-**
Hotel Samasa (Fundão)	**1.200$00**
Hotel Torralta	**1.115$00**

PROGRAMA

SEXTA-FEIRA - 9 DE JULHO DE 1982

MODERADOR: ENGº M.SANTOS SILVA

9.30 - ABERTURA
PROF.DOUTOR C.M.PASSOS MORGADO, REITOR DO INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR

9.45 - A MIGRAÇÃO DE FIBRAS EM FIOS
- PROBLEMAS NAS MISTURAS DE FIBRAS -
PROF. DOUTOR HASSAN BEHERY

11.15 - INTERVALO PARA CAFÉ

11.30 - CONTROLO DE QUALIDADE NA INDÚSTRIA TÊXTIL
PROF.KIRCHNER

12.30 - ALMOÇO

14.30 - CONTROLO DE QUALIDADE NA INDÚSTRIA DA FIAÇÃO
PROF. KIRCHNER

15.30 - INTERVALO PARA CAFÉ

15.45 - PROPRIEDADES DAS FIBRAS DE POLIÉSTER E CONTROLO DE QUALIDADE DA SUA FABRICAÇÃO
ENGº V.SPNUR

17.30 - VISITA AO TUBI

(Corte, preencha e devolva)

FICHA DE INSCRIÇÃO

Para assistir ao Seminário, agradecemos que preencha correctamente as informações que se seguem e remeta, com o valor da respectiva inscrição, para o seguinte endereço:

INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR
GABINETE DO PROF.HASSAN BEHERY
RUA MARQUÊS DE ÁVILA E BOLAMA
6200 COVILHÃ

NOME: ____________________ FUNÇÃO: ____________________

ORGANISMO/EMPRESA: ____

DIRECÇÃO: ____________________ TELEFONE: ____________________

ATTACHMENT 3

WORKSHOP

LÍNGUA

O "workshop" será dado em Português.

TEMAS

O "workshop" destinar-se-á, principalmente, ao treino de técnicos que trabalham em laboratórios de controle de qualidade na indústria têxtil e visa a utilização correcta dos aparelhos de modo a obter-se resultados mais precisos e seguros.

Serão apresentados os novos instrumentos recebidos pelo IUBI para apoio à indústria no controlo de qualidade dos seus produtos.

O programa de treino incluirá uma explicação [illegible] dos métodos de ensaio, do funcionamento do aparelho e da análise e interpretação dos resultados.

Os participantes realizarão ensaios nos vários aparelhos.

QUEM DEVE ASSISTIR

O "workshop" será útil para técnicos e supervisores de laboratórios de ensaio de empresas têxteis envolvidas em processos de fiação e tecelagem.

Somente serão aceites 12 participantes [illegible] deste "workshop".

CUSTOS

O custo do "workshop" será de [illegible] por dia [illegible] 11.500$00 [illegible] que deverão ser pagos no acto da inscrição.

O Instituto Universitário da Beira Interior foi criado pela lei 44/79, de 11 de Setembro e nele são ministrados actualmente os seguintes cursos; além de outros que se espera venham entrar em funcionamento no próximo ano lectivo.

Licenciatura em Gestão

Ramos: Gestão de Empresas

Gestão Regional

Licenciatura em Engenharia Têxtil

"Preparatórios de Engenharia":

Engenharia Mecânica

Engenharia Electrotécnica

Engenharia Civil

Engenharia Química

No âmbito de um acordo de cooperação assinado pelos Governos Português e dos Estados Unidos da América, foi estabelecido entre o IUBI e as Universidades Americanas de Purdue e Clemson, um Convénio de Cooperação, ao abrigo do qual se encontram de momento no IUBI dois professores daquelas Universidades, tendo por fim colaborarem com a nossa Escola no âmbito do Ensino, da Investigação e dos Serviços de Apoio à Comunidade.

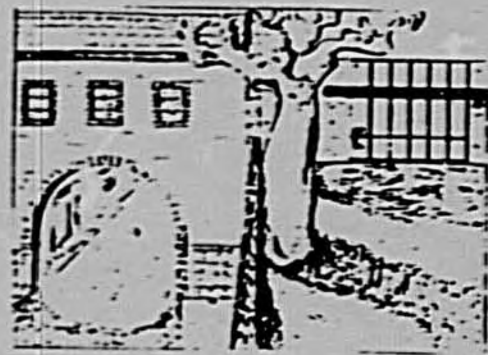
São esses dois professores os dinamizadores do workshop "APLICAÇÃO E UTILIZAÇÃO DE APARELHOS PARA ENSAIOS SOBRE TÊXTEIS" os quais pela sua experiência e conhecimentos muito contribuirão para o bom êxito do mesmo.

INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR

RUA MARQUÊS D'ÁVILA E BOLAMA

TELEX 53461[illegible]

6200 COVILHÃ



BENVINDOS AO WORKSHOP

SOBRE

"APLICAÇÃO E UTILIZAÇÃO DE APARELHOS

PARA ENSAIOS SOBRE TÊXTEIS"

O tema será apresentado por técnicos especialistas do Acondicionamento e Laboratório Têxtil (L.T.), por professores da Universidade de Clemson, Consultores do Programa AID e por docentes do IUBI, sobre a moderna aparelhagem para controle de fibras, fios e tecidos têxteis.

ALOJAMENTOS

Por favor reserve o seu hotel.

Algumas sugestões:

	Quarto duplo c/Banho
Pensão Solneve	**1.105$00**
Residencial Montalto	**1.500$00**
Residencial Floresta	**800$00**
Hotel Samasa (Fundão)	**1.680$00**
Hotel Torralta	**1.630$00**

	Quarto simples c/Banho
Pensão Solneve	**710$00**
Residencial Montalto	**700$/750$/800$**
Residencial Floresta	**-**
Hotel Samasa (Fundão)	**1.200$00**
Hotel Torralta	**1.115$00**

PROGRAMA

DATAS:

3a.FEIRA, 6 de Julho de 1982 - ENSAIOS SOBRE TECIDOS

3a.FEIRA,13 de Julho de 1982 - ENSAIOS SOBRE FIOS

3a.FEIRA,20 de Julho de 1982 - ENSAIOS SOBRE FIBRAS

***MODERADOR:* Dr. MÁRIO TAVARES**

O PROGRAMA PARA CADA DIA SERÁ O SEGUINTE

DIA \ GRUPO	GRUPO Nº1	GRUPO Nº2	GRUPO Nº3	GRUPO Nº4
9.00-10.30	APAR.Nº1	APAR.Nº2	APAR.Nº3	APAR.Nº4
10.30-11.00	INTERVALO PARA CAFÉ			
11.00-12.30	APAR.Nº2	APAR.Nº3	APAR.Nº4	APAR.Nº1
12.30-14.00	INTERVALO PARA ALMOÇO			
14.00-15.30	APAR.Nº3	APAR.Nº4	APAR.Nº1	APAR.Nº2
15.30-16.00	INTERVALO PARA CAFÉ			
16.00-17.30	APAR.Nº4	APAR.Nº1	APAR.Nº2	APAR.Nº3

Cada grupo será composto de 3 participantes, pelo que o número total de participantes será de 12.

Serão apresentados nas 3 sessões 12 aparelhos.

(Corte, preencha e devolva)

FICHA DE INSCRIÇÃO

Para assistir ao Workshop, agradecemos que preencha correctamente as informações que se seguem e remeta, com o valor da respectiva inscrição, para o seguinte endereço:

INSTITUTO UNIVERSITÁRIO DA BEIRA INTERIOR
GABINETE DO PROF.HASSAN BEHERY
RUA MARQUÊS DE ÁVILA E BOLAMA
6200 COVILHÃ

NOME: ______________________ **FUNÇÃO:** __________

ORGANISMO/EMPRESA: ______________________

DIREÇÃO: ______________________ **TELEFONE:** __________

ATTACHMENT 4

LIST OF INSTRUMENTS IN THE
TESTING LAB FOR INSTALLATION

June 1 - July 15, 1982

1. Celanese Wrinkle Tester,

   Controllable Clinched Fist Type Wrinkle Test

   Model CS-43-047

   Custom Scientific Instruments (CSI)

   Whippany, New Jersey

2. The Mullen Bursting Strength Tester

   Motor Driven Model

   Manufactured by: B. F. Perkins

   Division of Roehlen Industries

   Serial No. 8215-81-1552

   TMI, Amityville, New York

3. Atlas Random Tumble Pilling Tester

   Model PT-4

   Serial No. PT-898

   Feb., 1981

   Atlas Electric Devices Company

   Chicago, Illinois

4. Scorch Tester

   Model SO-15

   Serial No. 57-1225

   Instruction Booklet No. OP-5015

Atlas Electric Devices Company

4114 N. Ravenswood Avenue

Chicago, Illinois

5. Fabric Streak Analyzer

Model SA-1

Serial No. SA-306

Instruction Booklet No. FSA-110

Atlas Electric Devices Company

6. The Elmendorf Tearing Tester

Thwing - Albert Instrument Company

10960 Dutton Road

Philadelphia, Pennsylvania

7. Color Chex

Model No. CC-2

Serial No. CC-574

Wiring Diag. No. CC-1(a)0397

Instruction Booklet No. Cc-101

DR: 9029078

Atlas Electric Devices Company

8. Accelerotor

Model No. AB-7

Serial Number AR-998

Wiring Diag. No. AB-382-230

REU: 11-22-72

Instruction Booklet No. AR-2

Atlas Electric Devices Company

9. Fabric Streak Analyzer

Model SA-1

Serial Number SA-306

Wiring Diag. No. SAI-0267

DR. 7-3-79

Instruction Booklet No. FSA-110

Atlas Electric Devices Company

10. The CSI Stoll Quartermaster Universal Wear Tester

Model CS 22C

Serial Number

Custom Scientific Instrument, Inc.

13 Wing Drive, Whippany, New Jersey

11. A.A.T.C.C. Crockmeter

Model No. CM-5

Serial Number CM-5448

Atlas Electric Devices Company

APPENDICES

APPENDIX A

PHYSICAL AND MECHANICAL PROPERTIES

OF

TEXTILE FIBERS

Presented at the Seminar

on

"PROBLEMS IN FABRICATION AND APPLICATION OF
POLYESTER AND ACRYLIC FIBERS"

Monday, June 28, 1982

PROPRIEDADES FÍSICAS E MECÂNICAS DAS FIBRAS TÊXTEIS

PHYSICAL AND MECHANICAL PROPERTIES OF TEXTILES FIBERS

Hassan M. Behery

IUBI - COVILHÃ

June 28, 1982

1a.PARTE

PROPRIEDADES FÍSICAS DAS FIBRAS E SEU SIGNIFICADO TÉCNICO

1. Propriedades dimensionais

   A. Comprimento

   B. Diâmetro (Denier, Tex, Micrômetro)

   C. Secção transversal

   D. Frisura

   E. Características de superfície

PART I

PHYSICAL PROPERTIES OF FIBERS AND ITS TECHNICAL SIGNIFICANCES

1. Dimensional Properties

   A. Length

   B. Diameter (Dernier or Tex)

   C. Cross-Section

   D. Crimp

   E. Surface characteristics

A. SIGNIFICADO TÉCNICO DO COMPRIMENTO DAS FIBRAS

i - Afinações das máquinas

ii - Pilosidade dos fios

iii - Penteação ou Repenteação

iV - Características dos tecidos; Toque; Quente

A. TECHNICAL SIGNIFICANCE OF FIBER LENGTH

i - Machine Settings

ii - Yarn Hairiness

iii - Combing or Recombing

iV - Fabric Characteristics; Softness; Warm-handling

B. SIGNIFICADO TÉCNICO DA FINURA DAS FIBRAS

i - Toque do tecido, rigidez, ornamento

ii - Regularidade do fio

iii - Resistência à torção

iV - Reflexão da luz

V - Absorção de líquido e vapor

Vi - Coesão das fibras e torção

B. TECHNICAL SIGNIFICANCE OF FIBER FINENESS (DIAMETER)

i - Fabric handle, stiffness and drape

ii - Yarn Uniformity

iii - Torsional Rigidity

iV - Reflection of Light

V - Absorption of Liquids and Vapours

Vi - Fiber Cohesion and Twist

C. SIGNIFICADO TÉCNICO DA FORMA DA SECÇÃO DA FIBRA

i - Toque do tecido

ii - Propriedades mecânicas das fibras

iii - Resistência à Torção

iV - Reflexão da Luz

V - Absorção de líquidos e vapor

Vi - Coesão das Fibras e Torção

C. TECHNICAL SIGNIFICANCE OF FIBER CROSS-SECTIONAL SHAPE

i - Fabric Softness

ii - Fiber Mechanical Properties

iii - Torsional Rigidity

iV - Reflection of Light

V - Absorption of Liquids and Vapours

Vi - Fiber Cohesion and Twist

D. SIGNIFICADO TÉCNICO DA FRISURA E DAS CARACTERÍSTICAS DE SUPERFÍCIE

i - Processamento

ii - Toque do Tecido

iii - Coesão das fibras

D. *TECHNICAL SIGNIFICANCE OF FIBER CRIMP AND SURFACE CHARACTERISTICS*

i - Processing

ii - Fabric Feel

iii - Fiber Cohesion

2. A HUMIDADE DAS FIBRAS E SUAS RELAÇÕES

A. Fenômeno de Absorção de Humidade

B. Relação entre a Estrutura das Fibras e a Absorção de Humidade

C. Efeito da Absorção de Humidade nas Proprie dades das Fibras

D. Relação entre a Absorção de Humidade das Fibras e e as suas Propriedades de Conforto

2. *MOISTURE RELATIONS OF FIBERS*

A. Pheanomena of Moisture Absorption

B. Relation Between Fiber Structure and its Moisture Absorption

C. Effect of Moisture Absorption on Fiber Properties

D. Relation Between Moisture Absorption of Fiber and its Comfort Property

A. FENÔMENO DA ABSORÇÃO DE HÚMIDADE

A. PHEANOMENA OF MOISTURE ABSORPTION

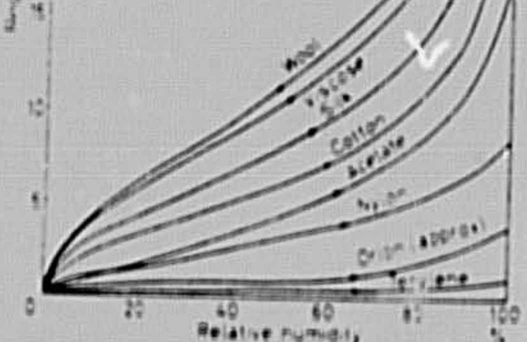


Figure 7.7. Regain-r.h. relations for cotton [14], viscose rayon [15], acetate [15], silk [16], wool [17], nylon [18], Orlon acrylic fibre [19], and Terylene polyester fibre [19]

B. RELAÇÃO ENTRE A ESTRUTURA DAS FIBRAS E ABSORÇÃO DE HÚMIDADE

B. RELATION BETWEEN FIBER STRUCTURE AND ITS MOISTURE ABSORPTION

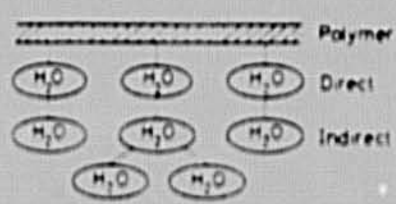


Figure 12.1. Direct and indirect absorption of water molecules by a polymer molecule

and

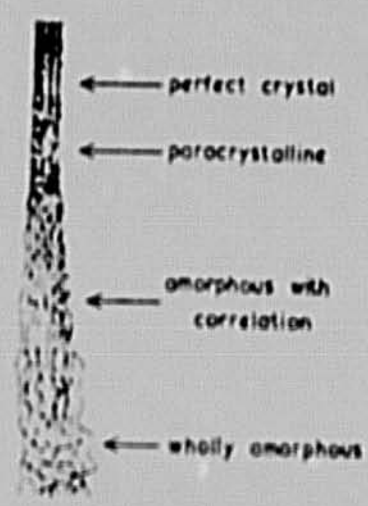


Figure 1.11 Range of degrees of order of packing of chain molecules, as drawn by Howsmon and Sisson [27], with identification of forms by Hearle [25]

C. EFEITO DA ABSORÇÃO DE HÚMIDADE NAS PROPRIEDADES DAS FIBRAS

i. Propriedades mecânicas

C. EFFECT OF MOISTURE ABSORPTION ON FIBER PROPERTIES

i - MECHANICAL PROPERTIES

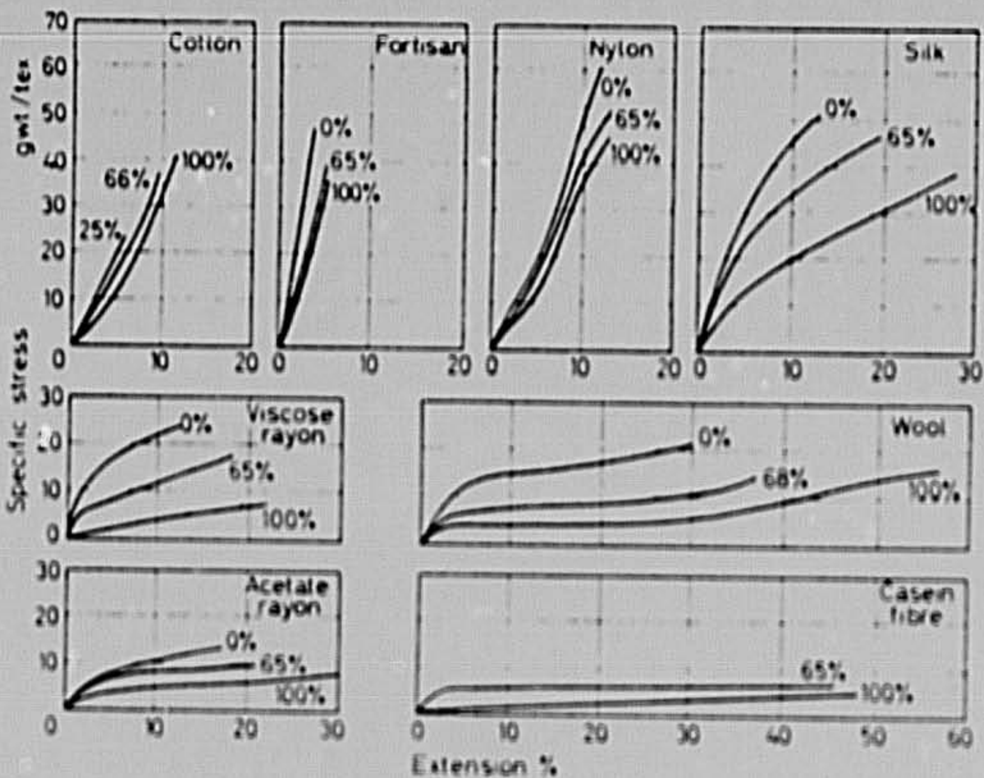


Figure 13.26. Stress-strain curves at various humidities [17]

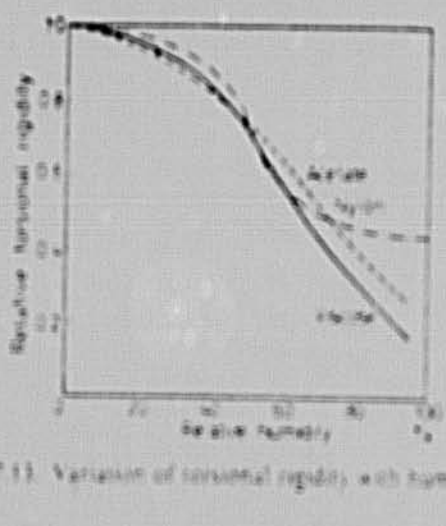


Figure 13.13. Variation of torsional rigidity with humidity [27]

ii. PROPRIEDADES ELECTRICAS

ii. ELECTRICAL PROPERTIES

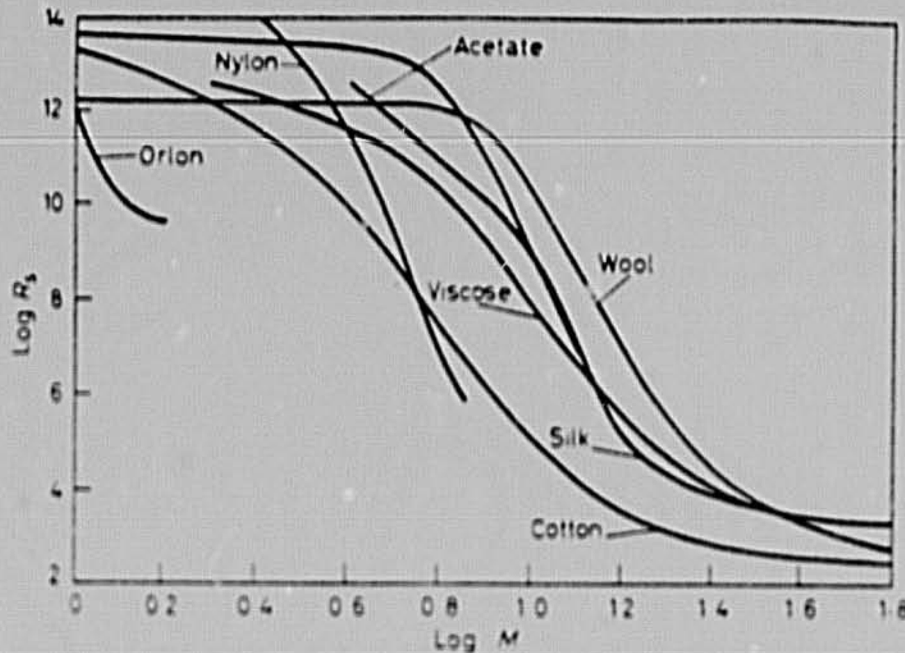


Figure 20.6 Variation of resistance of fibres with moisture content [2, 6]

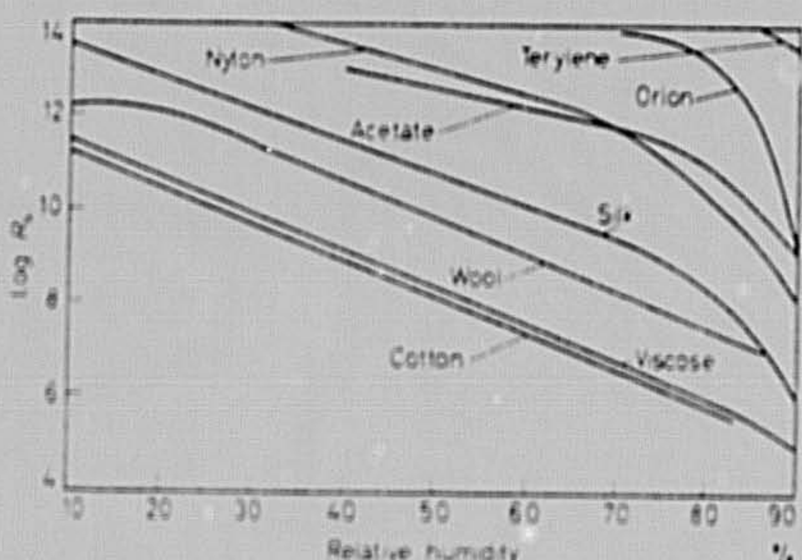


Figure 20.7 Variation of resistance of fibres with relative humidity [2, 19]

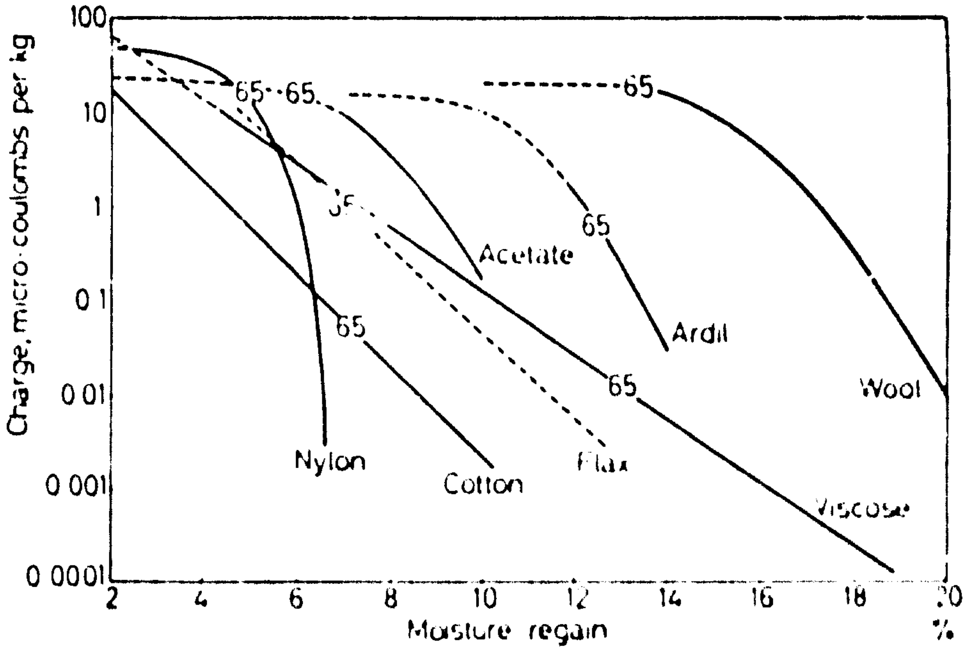


Figure 21.6 Charge left on sliver after carding (after Keggin *et al.* [?])

D. RELAÇÃO ENTRE A ABSORÇÃO DE HUMIDADE DAS FIBRAS E AS SUAS PROPRIEDADES DE CONFORTO.

i. Conforto como fenômeno de calor

ii.Conforto como um fenômeno de superfície

D. RELATION BETWEEN MOISTURE ABSORPTION OF FIBERS AND ITS CONFORT PROPERTY

i. Confort as a heat phenomena

ii.Confort as surface phenomena

II - PARTE

PROPRIEDADES MECÂNICAS DAS FIBRAS E O SEU SIGNIFICADO TÉCNICO

1. Propriedades de resistência
   - A. Tenacidade
   - B. Alongamento de ruptura
   - C. Módulo inicial
   - D. Ponto de cedência - tensão - alongamento
   - E. Trabalho de ruptura

PART II

MECHANICAL PROPERTIES OF FIBERS AND ITS TECHNICAL SIGNIFICANCE

1. Tensile properties
   - *A. Tenacity (Regular, Medium and High Tenacity)*
   - *B. Breaking elongation*
   - *C. Initial Modulus*
   - *D. Yield stress and strain*
   - *E. Work of ruption*

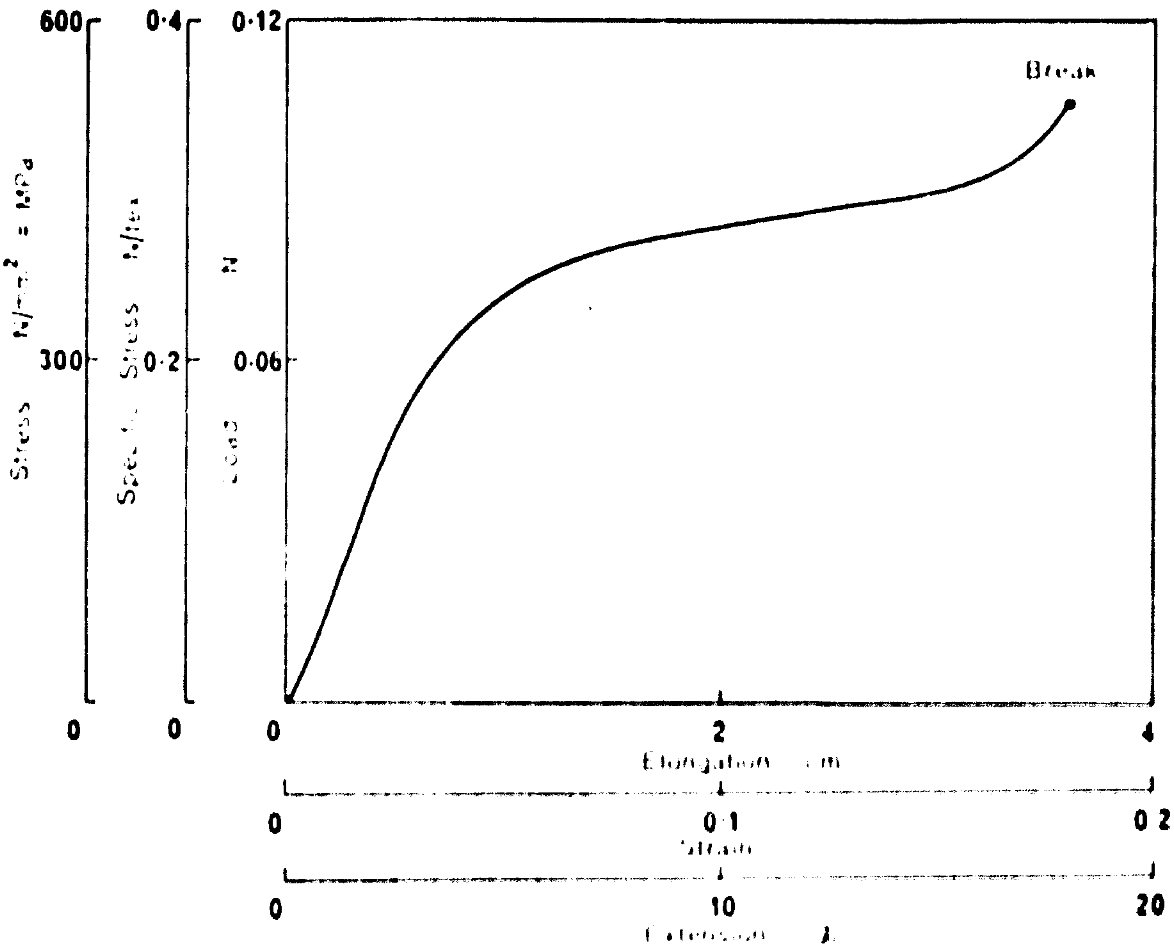


Figure 11.1 Load elongation curve for 20 cm specimen of 0.3 tex filament with density of 1.5 g/cm³

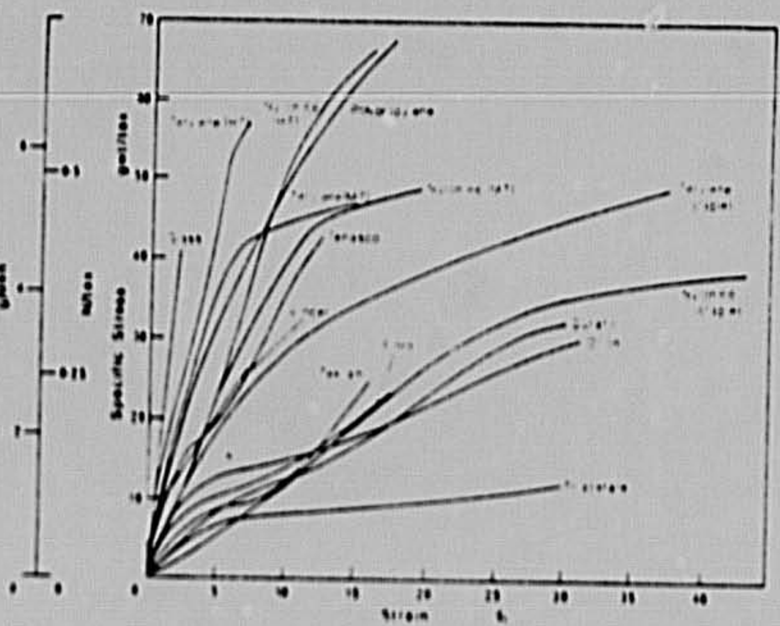


Figure 13.16 Stress-strain curves of various fibres (from Farrow [19, 20] and Ford [21])

Note: Viscose rayon variants are Fibro (regular-staple), Vincel (high-wet-modulus), and Tenasco (high-tenacity, industrial). Teklan is modacrylic; Terylene is polyester fibre; Orion is acrylic fibre

iii. RELAÇÃO ENTRE A TENACIDADE DA FIBRA E A SUA ESTRUTURA

A micela

A fibrila

O grau de cristalinidade

iii. RELATION OF FIBER TENACITY TO ITS STRUCTURE

The micelle

The fibril

The degree of cripstallinity

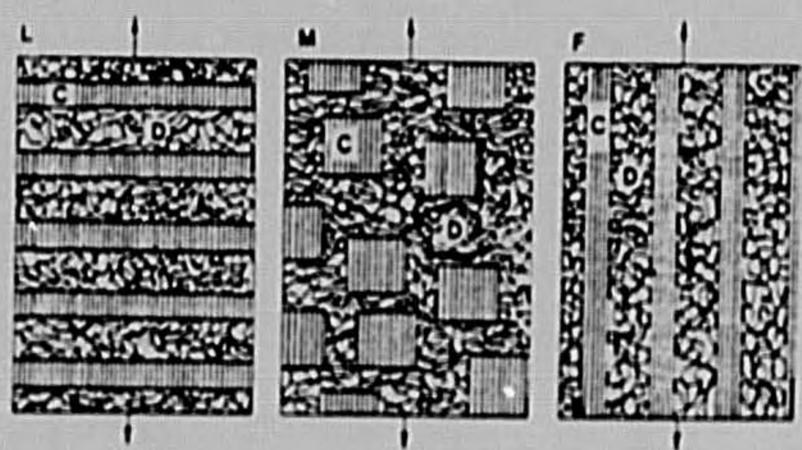


Figure 19.2 Structural models: two-thirds crystalline, one-third amorphous: (a) lamellar; (b) micellar; (c) fibrillar

IV - RELAÇÃO ENTRE A TENACIDADE DA FIBRA E A SUA ORIENTAÇÃO MOLECULAR

IV - RELATION OF FIBER TENACITY TO ITS MOLECULAR ORIENTATION

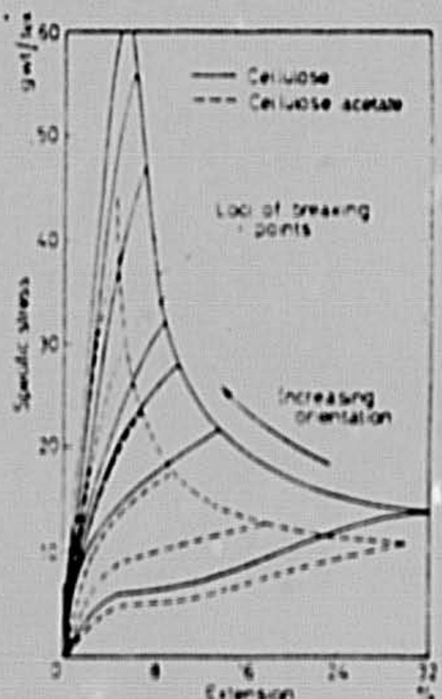


Figure 13.19 Stress-strain curves of filaments of varying degrees of orientation. The dotted curves are acetate, and the full curves are cellulose fibres regenerated from acetate. The lowest curve in each set is for unoriented material (after Work [29]).

B. EFEITOS DO ALONGAMENTO DE RUPTURA DAS FIBRAS SOBRE O USO E FINALIDADES

i. Misturas

ii. " Pilling "

iii. Toque dos artigos

B. EFFECT OF FIBER BREAKING ELONGATION ON ITS END - USES

i. Blends

ii. Pilling

iii. Fabric feels

C. O MÓDULO INICIAL DAS FIBRAS E A SUA IMPORTANCIA TÉCNICA

i. Processamento

ii. Rigidez dos artigos

C. FIBER INITIAL MODULUS AND ITS TECHNICAL SIGNIFICANCE

i. Processing

ii. Fabric stiffness

A. A TENACIDADE DAS FIBRAS E A SUA IMPORTANCIA TECNICA

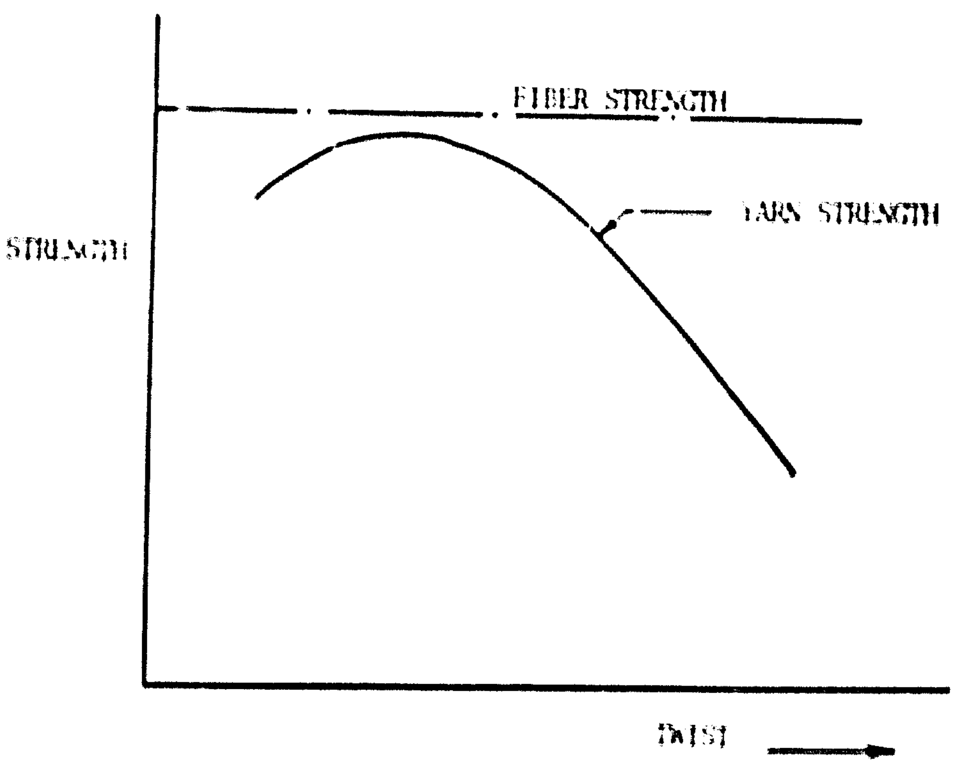
i. Processamento

ii. Resistência de artigos e fios

A. FIBER TENACITY AND ITS TECHNICAL SIGNIFICANCE

i. Processing

ii. Yarn and fabric strength



D. PONTO DE CEDÊNCIA TENSÃO - ALONGAMENTO E O SEU SIGNIFICADO TÉCNICO

i. Processamento

ii. Poder de cobertura do tecido

D. FIBER YIELD STRESS AND STRAIN AND ITS TECHNICAL SIGNIFICANCE

i. Processing

ii. Fabric recovery

E. SIGNIFICADO TÉCNICO DO TRABALHO DE RUPTURA

i. Capacidade de resistência à aplicação súbita de cargas

E. TECHNICAL SIGNIFICANCE OF WORK OF RUPTURE

i. Ability to resist sudden loading

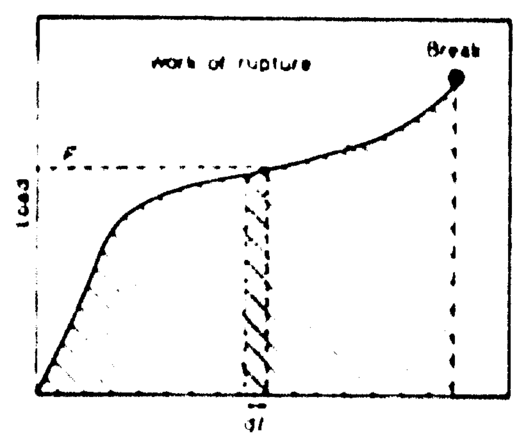


Figure 11.2 Work of rupture

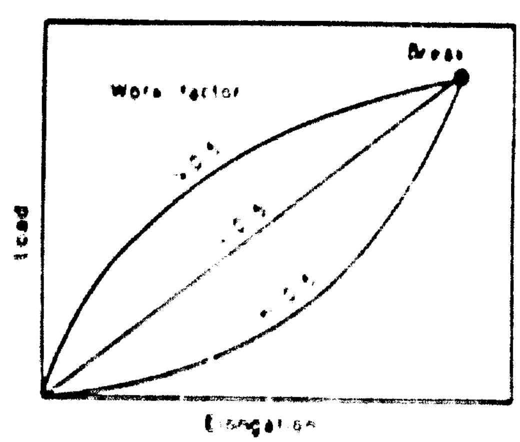


Figure 11.4 Work factor

2. OUTRAS PROPRIEDADES MECÂNICAS

A. Recuperação elástica

B. Resistência à flexão

C. Rigidez à torsão

D. Enrugamento

E. Relaxação

2. OTHER MECHANICAL PROPERTIES

A. Elastic recovery

B. Bending resistance

C. Torsion regidity

D. Creep

E. Relaxation

3. OUTRAS PROPRIEDADES FÍSICAS

A. Propriedades eléctricas

B. Propriedades ópticas

C. Propriedades térmicas

D. Propriedades de fricção

3. OTHER PHYSICAL PROPERTIES

A. Electrical properties

B. Optical properties

C. Thermal properties

D. Frictional properties

LISTA DOS PARTICIPANTES DO SIMPÓSIO
"PROBLEMAS DA FABRICAÇÃO E APLICAÇÃO DE FIBRAS
ACRÍLICAS E DE POLIÉSTER"

Nº	NOME	EMPRESA
1	ENGº JERÓNIMO PINTO DA SILVA	MONDOREL
2	JOÃO DA COSTA SARAIVA	FIPER
3	JÚLIO FAZENDA RAINHA	FIPER
4	JOSÉ MANUEL PEREIRA NINA	NINAFIL
5	CAMILO FAZENDEIRO	NINAFIL
6	ENGº JOÃO CARMONA	M. CARMONA LDA.
7	JOÃO JOSÉ AFONSO ABRANTES	EMPRESA TRANSFORMADORA DE LÃS
8	ENGº LOURENÇO	FILOR
9	RUI PAULO RATO	ÁLVARO PAULO RATO & Fºs
10	JOSÉ CIPRIANO DOS SANTOS	ESTEVES, SANTOS & BOTELHO LDA.
11	GÉRARD GUENOT	PARQUE INDUSTRIAL
12	JOSÉ CURTO	PENTEADORA
13	DRA. MARIA TERESA LOURENÇO	PENTEADORA
14	PARDAL DUARTE	TÊXTIL LOPES DA COSTA
15	VALDEMAR MODA	TÊXTIL LOPES DA COSTA
16	ENGº JOSÉ MORAIS	TÊXTIL LOPES DA COSTA
17	ENGº JORGE RAMOS	NOVA PENTEAÇÃO
18	ENGº CARLOS M.MESQUITA NUNES	CIL

Nº	NOME	EMPRESA
19	ENGº JOSÉ PINTO DE SOUSA	LUSOTUFO
20	ENGº MANUEL LEMOS DOS SANTOS	SOTAVE
21	GUILHERME SALGUEIRO	PAULO DE OLIVEIRA LDA.
22	JOÃO PRATA	PAULO DE OLIVEIRA LDA.
23	ENGº MANUEL SANTOS SILVA	IUBI
24	ENGº MÁRIO NUNES	IUBI
25	ENGª CONCEIÇÃO CAMISÃO	IUBI
26	DRA. MARIA TERESA AMORIM	IUBI
27	DR. JOÃO LISBOA	IUBI
28	FRANCISCO FRANCO	IUBI
29	MARIA JOSÉ GERALDES	IUBI
30	JÚLIO PINTO	ESTUDANTE
31	RAÚL CASTRO	FISIPE
32	ENGº BORGES TERENAS	I.T.

APPENDIX B

FIBER MIGRATION AND CHARACTERISTICS IN OPEN-END SPUN COTTON-RICH BLENDED YARN

Presented at the Seminar

on

"SPINNING TECHNOLOGY AND QUALITY CONTROL IN TEXTILE INDUSTRY"

Friday, July 9, 1982

Reprinted from the JOURNAL OF ENGINEERING FOR INDUSTRY, *Vol. 102, No. 1, February 1980.*

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Fiber Migration and Characteristics in Open-End Spun Cotton-Rich Blended Yarn

This study is mainly directed towards blends of cotton and polyester which are cotton-rich blends. Measurements taken from dyed tracer fibers within the yarn and from physical testing indicate that only yarn count significantly affects several of the migration parameters. Coarser or lower count yarns exhibit slower rates of migration as measured by the mean migration intensity, and also showed a reduced tendency towards migration as measured by the root-mean-square deviation. Yarn count was the most significant parameter affecting yarn quality. Fiber fineness significantly affected thick places, break factors, single-end strengths and elongations. Polyester staple length significantly affected evenness and imperfections. Blend level significantly affected thick places, elongations, neps, and break factors.

Introduction

The internal structure in spun yarn determines many of its physical as well as aesthetic properties. The structure also plays a major role in the characteristics of the finished product formed from the yarn. Several methods have been used to analyze the structure of spun yarn. These methods include cross sectional analysis, and several different tracer fiber techniques.

The present study utilizes a tracer fiber technique to determine the fiber migration, which is the periodic movement of fibers within the yarn. The tracer fiber technique involves dyeing a small quantity of the fiber stock and processing the dyed fibers along with the undyed fibers. Individual dyed fibers in the yarn can be seen using a microprojector. To characterize the movements of the dyed fibers several migration parameters have been developed. These include the mean fiber position, mean migration intensity, and the root-mean-square deviation. These parameters are useful in determining the effects of fiber type, fiber length, and fiber denier on the movement of fibers within various yarns.

The blending of component fibers has become increasingly important in the textile industry due to the demand for more versatile end-products. Polyester and cotton blends, widely used currently, offer not only the high strength characteristics of polyester, but also the soft hand and absorption properties of the cotton.

The structure of open-end yarns has proven to be different than ring yarns as characterized by the various migration parameters. Open-end yarns are generally known to be weaker, more bulky, and more extensible than ring yarns. However, it shows more uniformity and exhibits better resistance to abrasion.

Most of the work reported in the literature was the study of yarn structure and/or the yarn quality of polyester/cotton blends which were polyester-rich blends. This work is directed mainly to study the structure and quality of cotton-polyester blended yarn which is cotton-rich blend.

Review of Previous Work

Fiber Positioning and the Structure of Yarn. The study of yarn structure and fiber position within yarns has been a major research area for the technologist. As early as 1934, Klingsohr [1] theorized that short fibers migrate to the core of the yarn. Early work in the area of yarn structure can be traced to several assumptions expressed by Pierce [2] in 1947.

El-Behery [20] offered a summary of the work done on migration and the subsequent theories put forth by the various workers [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19]. He listed in detail the factors which affected migration and grouped them into three categories: fiber factors, yarn factors, and spinning process factors. He noted that the migration work was not systematic enough to draw specific conclusions concerning fiber migration. El-Behery suggested that work be continued using man-made fibers where the physical properties can be more carefully controlled. Finally, the author pointed to the absence of work relating the arrangement of fibers to the physical properties of yarns and cloth and also the lack of work on the effect of geometry of the spinning frame on fiber migration. He also summed up the various parameters introduced by the various workers.

Of the several parameters characterizing the fiber migration, the correlogram method of analyzing the migratory patterns of fibers has been extensively discussed by Hearle and Goswami [21]. They noted that when migration is relatively regular, the interpretations of the

Contributed by the Textile Engineering Division and presented at the Textile Engineering Conference, Greenville, S. C., Oct. 16-17, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Manuscript received at ASME headquarters July 24, 1979. Paper No. 79-TEX-1.

correlograms are fairly simple; but when the migration is less regular, some problems are encountered in interpreting the meaning of the correlograms. They stated that other migration parameters used previously are more beneficial than the correlogram method of analysis. However, most of the work referred to above was carried on ring spinning frames.

Several workers have recently studied fiber migration in open-end spun yarns. Rana [22], in his work with rayon and polyester open-end spun yarns, found that neither rotor speed nor spinning tension had a significant effect upon the migration parameters. He also noted that the migration parameters were not significantly affected by the fiber fineness. Rana explained that yarn twist had a significant effect on the migration parameters, and that fiber length had no effect on the mean fiber position or root-mean-square deviation, but did affect the migration intensity.

Hearle, Lord and Senturk [23], in their work with tangential and radial fiber fed open-end spun yarns, concluded that open-end spun viscose rayon is significantly different in character from ring-spun rayon. Open-end yarns have been found to be weaker and bulkier than ring yarns [24, 25, 26, 27]. Since open-end spinning is done with very low tension on the fibers, as compared to ring spinning, the fibers are separated to a degree so that prior processing has a smaller effect on migration than found in ring-spun yarns. The open-end spinning system tends to cause hooks or other fiber deformations to occur as part of the process. These mechanisms have a significant effect on the strength and bulk of open-end spun yarns.

A new parameter was introduced by Kasparek [28] to describe the characteristics of internal staple yarn structure. The fiber spinning-in coefficient, K_i, described the proportions of an average fiber spun into the actual yarn as opposed to the portion of an average fiber which leaves the boundaries of the yarn.

Wolf [31] discussed the influence of fiber length on open-end yarns. As the fiber length increases, two super-imposed effects occur. Both a consolidation of the yarn and non-uniformity of the twist thickness occur with increased fiber length. The two effects seem to depend upon the type of spinning unit employed, especially the ratio of the rotor diameter to the fiber length.

Fiber fineness also influences the properties of open-end yarn. Keller [34] stated that the shape of the fiber cross-section is as important as the staple length distribution in open-end spinning. Also, since fiber stiffness increases with fiber diameter, higher bulk elasticity is achieved.

Brian [33] explained that fineness can have a significant effect on open-end spinning performance. The finer denier polyester fibers yield more rotor deposit, while 1.5 denier fibers show fewer ends-down than either finer or coarser fibers.

Objectives of the Present Investigation

The general objective of the present research was to investigate the effects of polyester fiber denier, polyester fiber length, cotton/polyester blends, and yarn count on the positioning of polyester fibers in yarns produced from cotton-rich blends.

Specific objectives included the study of the following parameters on the migration parameters and quality characteristics of the yarn:

(1) the effect of 1.5 and 2.25 denier polyester;
(2) the effect of 32 and 38 mm polyester;
(3) the effect of three cotton/polyester blends (90/10, 80/20, 70/30);
(4) the effect of three yarn counts (74, 59, 49 Tex).

The migration parameters considered are the mean fiber position, migration intensity, and root-mean-square deviation.

The yarn quality characteristics studied are: yarn break factor, single-end strength and elongation, evenness, and imperfections.

Experimental Procedure

Material Used. The cotton was obtained from research stock used by the United States Department of Agriculture, Agricultural Research Service, at Clemson, South Carolina. The polyester was obtained from Hoechst Fibers at Spartanburg, South Carolina.

Experimental Design. Two levels of polyester denier, two levels of polyester length, three levels of cotton/polyester blend, and three levels of yarn count were investigated. Their main effects and interactions were studied using a four factor randomized block factorial design.[1] The randomized block was used to block out the effect of the different spinning deliveries. As control condition, 100 percent cotton yarns of 74, 59 and 49 Tex were spun.

Dyeing Polyester Fibers. The dyeing procedure was performed on a Gaston County Two Pound Package Dye Machine. Seventy-gram samples of each polyester condition were placed in four knitted tubes and the ends of the tubes were sewn to avoid losing fibers. The four packages were placed in the dyeing cylinder and wetted-out with a solution of Trycol DA-4 and water. Ten milliliters of acetic acid and 0.1 percent Duponal RA were then added to the liquor. The dyestuff, 5.5 grams (2 percent by weight) of Disperse Blue 123 (Eastman polyester blue 4R-LSW), was combined with 4.5 grams of Trycol DA-4 and 350 milliliters of boiling water and stirred in a beaker. The dye-bath temperature was set at 52°C.

Fiber Preparation. Approximately four kilograms of each polyester length and denier were processed on a Saco-Lowell One Process Picker to obtain four laps at 434 grams/meter each.

Addition of Dyed Fibers to the Laps. One of the polyester laps formed on the picker was unrolled and divided into six equal sections. One section was designated for a 90/10 blend, two sections for an 80/20 blend, and three sections for a 70/30 blend.

The amount of dyed fibers added to each section was calculated as a percentage (0.15 percent) of the weight of the cotton and polyester in the final blend.

Carding and Drawing. The cotton was carded on a conventional flat-top carding machine while the polyester was carded on a Saco-Lowell roller top carding machine. Blending was then performed during the drawing process to ensure accurate blend levels.

Spinning. The yarns were spun on a Platt 883 Rotospin 20 delivery open-end frame. To ensure randomness of the actual spinning conditions, the order of the three yarn counts was selected from a table of random numbers so that all conditions within each yarn count could be processed with a minimum amount of mechanical adjustments. A table of random numbers was also used to determine the actual order of spinning for the twelve conditions with a yarn count of 49 Tex spun first, followed by the 59 and 74 Tex yarn count.

Five replications of each condition were spun on successive rotors following the order of spinning previously determined. For example, the first selected condition was spun on rotors one through five, the second on rotors six through ten, the third on rotors eleven through fifteen, the fourth on rotors sixteen through twenty, and the process was repeated until all twelve conditions under each yarn count were completed.

Determination of Migration Parameters. To observe the tracer fibers within the yarn, it was necessary to make the cotton fibers somewhat transparent. Previous studies have found that regenerated cellulose fibers and man-made fibers are fairly easy to make transparent by immersing them in liquids of refractive indices which match the fibers' refractive indices. Cotton, on the other hand, is quite different in structure and therefore a pre-treating process as adopted by Kasparek [28] must be used to make the dyed fibers distinguishable in the yarn when immersed in a liquid of suitable refractive index. This treatment involves the removal of waxes, fats, and pectins from the fibers.

Methyl salicylate was used as the immersion media. Ten tracer fibers were measured for each yarn condition. Since thirty-six different conditions were studied, a total of three hundred and sixty fibers was measured.

The equations used by Wagle [36] were employed to characterize the migration parameters. The factor f, the tracer fiber diameter, was added to the equations to correct the migration profile. The mean fiber position, $\bar{Y}$, gives the average radial position of the tracer fiber

[1] The "F" values and model were computed as shown in Hicks [35] for a factorial experiment.

in the yarn. The values of $\bar{Y}$ can range from 0, which describes a fiber exhibiting no migration and lying totally along the yarn axis, to 1, which describes a fiber lying entirely on the surface of the yarn. For ideal migration, the value of $\bar{Y}$ is 0.5. The mean fiber position is expressed as follows:

[4] indicated the same phenomena in ring spinning. However, in open-end spinning this effect may be more pronounced due to the laying of the fibers in the collecting grooves.

However, the yarn count had no significant effect on the mean fiber position as shown in Fig. 1.

$$\bar{Y} = \frac{1}{(Z_n + Z_{n-1}) - (Z_1 + Z_2)} \left[\sum_{i=3}^{n} \left(\frac{Z_i - Z_{i-2}}{2}\right) \left\{ \frac{\left(\frac{r_i}{R_i - f} + \frac{r_{i-1}}{R_{i-1} - f}\right)^2}{2} + \frac{\left(\frac{r_{i-1}}{R_{i-1} - f} + \frac{r_{i-2}}{R_{i-2} - f}\right)^2}{2} \right\} \right] \quad (1)$$

where

- Z_n = total length of the yarn incorporating the tracer fiber,
- Z_{n-1} = total length alone the yarn excluding the last value for Z,
- Z_1 = axial distance between the first peak and trough measured for tracer fiber,
- Z_2 = the first plus the second value for Z,
- r_i = radial distance of the fiber from the yarn axis,
- R_i = yarn axis,
- f = tracer fiber radius,
- n = number of observations taken from tracer fiber.

The mean migration intensity, I, is a parameter which represents the rate of change of radial position of the fiber within the yarn. The smaller the value of the mean migration intensity, the slower is the migration. The mean migration intensity is expressed as follows:

Effect of Staple Length. Varying the staple length of the polyester fibers had no significant effect on the three migration values studied. These conclusions agree with those obtained by Rana [22] for the mean fiber position and r.m.s. deviation, but disagree with his findings concerning the migration intensity.

Fig. 1 illustrates the relationship between the migration intensity and mean fiber position and r.m.s. deviation versus yarn count and staple length. This figure shows that at all three yarn counts and both staple lengths, the mean fiber position values were higher than the ideal migration value of 0.5. This shows that the fibers have a tendency to be closer to the surface of the yarn rather than the yarn core or axis. These results disagree with those found by Hearle [23].

The migration intensity was not significantly affected by the staple

$$I = \left[\frac{2}{(Z_n + Z_{n-1}) - (Z_1 + Z_2)} \sum_{i=3}^{n} \left\{ \frac{\frac{\left(\frac{r_i}{R_i - F} + \frac{r_{i-1}}{R_{i-1} - f}\right)^2}{2} - \frac{\left(\frac{r_{i-1}}{R_{i-1} - f} + \frac{r_{i-2}}{R_{i-2} - f}\right)^2}{2}}{\left(\frac{Z_i - Z_{i-2}}{2}\right)} \right\}^2 \right]^{1/2} \quad (2)$$

All parameters represent the same values as those found in computing the mean position.

The magnitude of the deviations from the fiber position or the amplitude of migration is described by the r.m.s. deviation, D. A fiber exhibiting ideal migration will have an r.m.s. value which has been worked out to be 0.2887. The r.m.s. deviation is calculated as follows:

$$D = \left[\frac{1}{2(Z_k - Z_1)} \sum_{i=2}^{k} (Z_i - Z_{i-1})((Y_i - \bar{Y})^2 + (Y_{i-1} - \bar{Y})^2) \right]^{1/2} \quad (3)$$

where k is the total number of points, n, plus the number of points where the migration profile intersects with the mean fiber position.

The three migration parameters were calculated using the Clemson University IBM 370/158 computer.

Testing Procedure for Yarn Quality. The single end strength and elongation, the evenness and imperfections, and the adjusted break factor were measured to determine the physical properties of the yarn.

Results and Discussion

The Effect of Fiber and Yarn Parameters on Migration Values. The migration of fibers in open-end yarns has been found to be different than in ring yarns. Therefore, the results obtained in the present investigation will be comparable only with the findings of previous work done on migration in open-end yarns. To find possible explanations for the effects of fiber length, fiber denier, blend level, and yarn count on the migration parameters, studies of both ring and open-end yarns will be incorporated.

Effect of Yarn Count. Yarn count was the only significant factor which affected the migration patterns. Yarn count significantly affected the migration intensity and the r.m.s. deviation values as shown in Fig. 1. These two parameters increased as the yarns became finer. A possible explanation is that as the yarn gets thicker, the fibers must overcome greater obstruction to migrate through the yarn. Morton

length and this does not concur with Rana's [22] findings. However, this agrees with the characteristic structure of open-end spun yarn in which the yarn shows a two-zone structure and the wrapping of some fibers at the surface.

Effect of Fiber Fineness. Fiber fineness was found not to significantly affect any of the three migration parameters. These results agree with those found by Rana [22]. Fig. 2 indicates that both 1.5 and 2.25 denier polyester fibers migrate more towards the surface of the yarn.

Effect of Blend Level. Blend level had no significant influence on any of the migration characteristics as shown in Fig. 3. This agrees with Keller [34]. He pointed out that open-end yarns have a higher degree of homogeneity than ring yarns. Therefore, the polyester fibers will not have any prevential positioning in the yarn caused by segregation or resistance to blending.

Fig. 3 presents the three migration parameters as related to the three blend levels studied. The fibers are more inclined to migrate toward the surface rather than the core of the yarn. No trends are evident for the mean fiber position versus the blend level employed, but a slight trend towards an increase in migration intensity was observed at 90/10 cotton/polyester blends at 59 Tex and 49 Tex yarns showing a slower rate of migration. This could also be explained as due to the less chance or probability for 10% of polyester fiber to fight its way against 90% of the cotton fiber which will constitute the main body of the yarn. A similar trend was also observed for the r.m.s. deviation values with the blend ratio.

The Effect of Fiber and Yarn Parameters on Yarn Quality Characteristics. (Effect of Yarn Count). Yarn count was the most highly significant factors affecting the yarn quality. Yarn count significantly affected Uster evenness, thin places, thick places, neps, break factor, and elongation at the 99 percent confidence level.

Effect of Fiber Fineness. Fiber denier significantly affected thick places and break factor at the 99 percent level, and single-end strength and elongation at the 95 percent level. The number of thick places per 115 meters of yarn was found to be lower for the higher denier fibers contrary to what should be expected, especially at finer yarn counts. Yarns with lower denier fibers exhibited higher break factors than yarns using higher denier polyester. This is in agreement with expectation as due to larger number of fibers in yarn cross-sections.

The single-end strength values were significantly higher at the lower denier level. Yarns spun using lower denier polyester fibers have higher elongation than yarns spun from higher denier polyester fibers. Also, coarser yarns exhibited higher elongation than the finer count yarns. This is in agreement with previous theories exploring the mechanism of failure of yarns and could be related to the presence of more fibers in coarser yarn to slip than in finer ones.

Effect of Staple Length. Polyester fiber length significantly affected the evenness, thin places, and thick places at the 99 percent level. At the 95 percent confidence level, only neps were significantly affected by the fiber length. Blended yarns spun using shorter polyester fibers are significantly more even than yarns utilizing longer fibers. Also, the number of thin places per 115 meters was lower for shorter polyester fibers. Thin places were lowest at the 74 Tex, increased dramatically at the 59 Tex, and then decreased at the 49 Tex yarn counts.

Blended yarns using shorter fibers contained fewer thick places

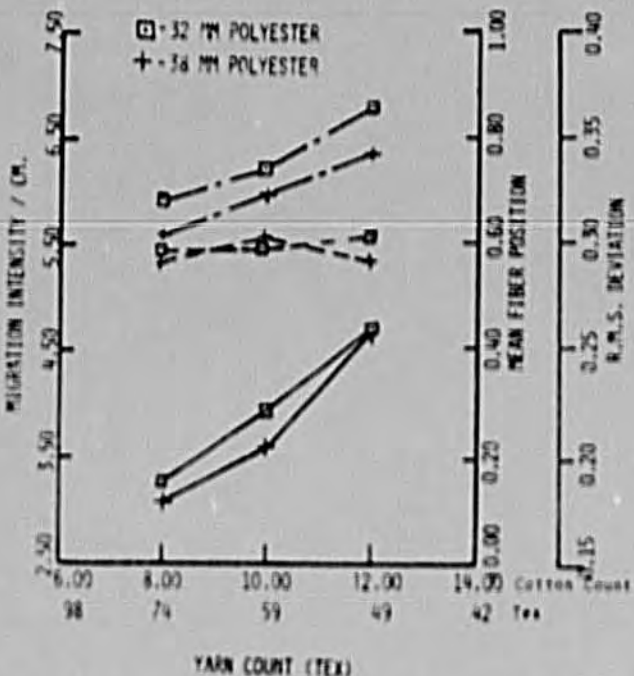

Fig. 1 The relationship between migration intensity and count for two polyester lengths

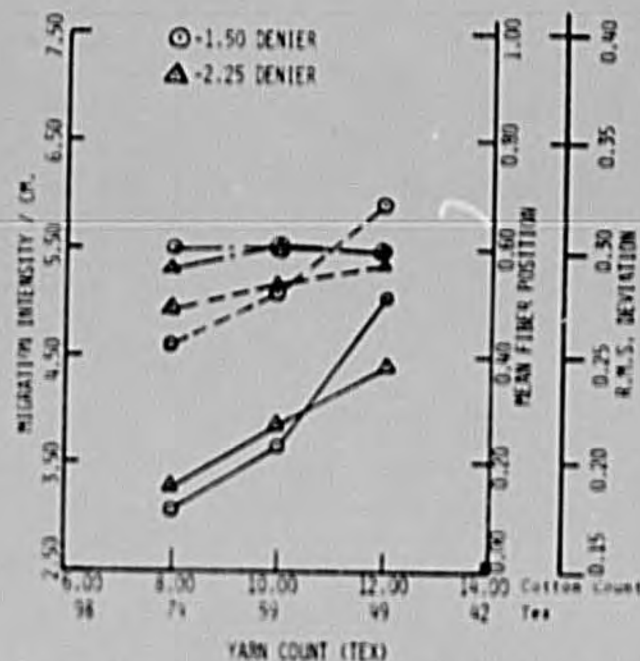

Fig. 2 The relationship between migration intensity and count for two polyester deniers

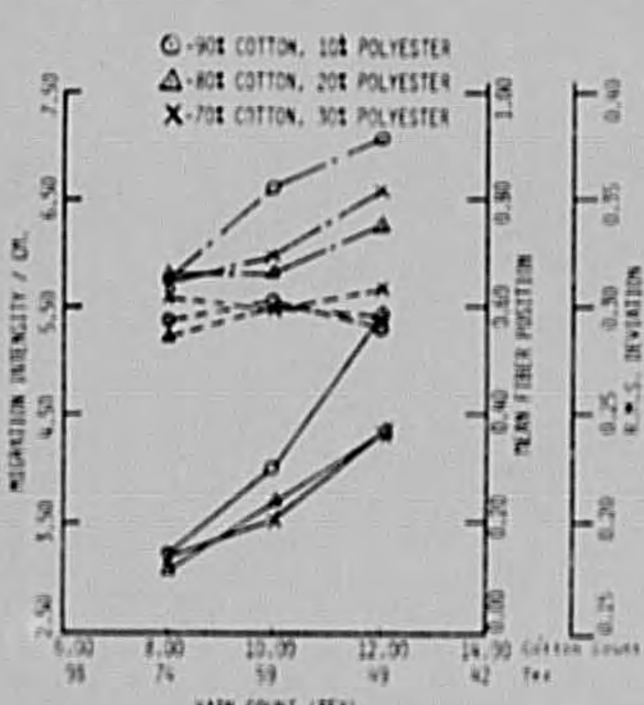

Fig. 3 The relationship between migration intensity and count for three cotton/polyester blends

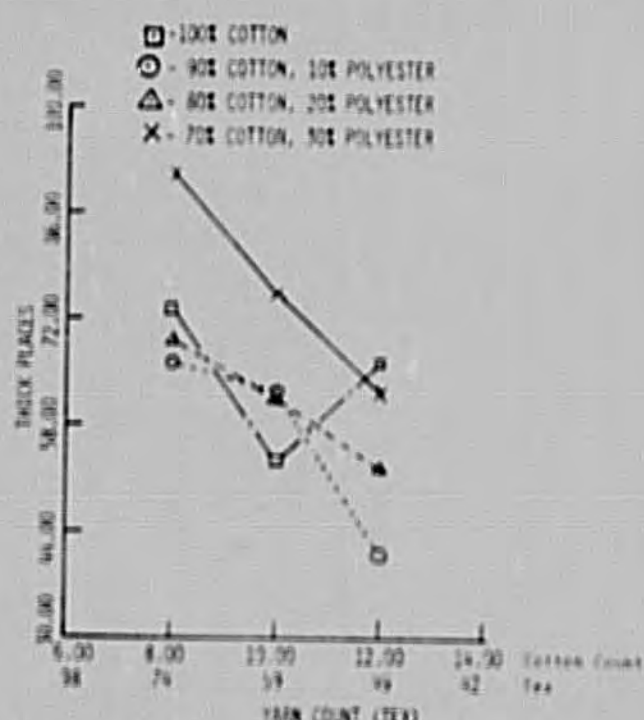

Fig. 4 The relationship between thick places and count for 100% cotton and three cotton/polyester blends

than yarns employing longer fibers. Also, as the yarn count increased, the number of thick places decreased significantly. Neps were lower for the shorter fibers at the 74 Tex and 49 Tex counts.

Effect of Blend Level. Thick places and elongation were significantly affected by blend level at the 99 percent level, while neps and break factor were significant at the 95 percent level.

Fig. 4 illustrates that as the yarn count increased, the number of thick places decreased for every blend level with the exception of the 100 percent cotton which showed an increase from the 59 Tex to the 49 Tex count levels. Fig. 4 also shows that at all yarn counts there is a tendency for an increase in the thick places as the percentage of polyester increases. Fig. 5 illustrates that elongation decreased as the yarns became finer, and also shows that, for blends, elongation increased with increased amounts of polyester.

The number of neps found in the different blended yarns increased from the 74 Tex to the 59 Tex count level. From the 59 Tex to the 49 Tex count level, the 100 percent cotton and the 80/20 blend showed increased neps while the 90/10 and 70/30 blends slightly decreased. These trends are shown in Fig. 6(*a*). Also, the 100 percent cotton yarns exhibited the highest number of neps while the 90/10 blends yielded the lowest. This shows that the addition of some percentage of polyester fibers to cotton improves its processability and results in reduction in number of neps in the yarn.

Fig. 6(*b*) shows, as would be expected, that the break factor decreased with increased yarn count. This figure also illustrates that the break factor of the 90/10 blend was highest and the 70/30 blend the lowest.

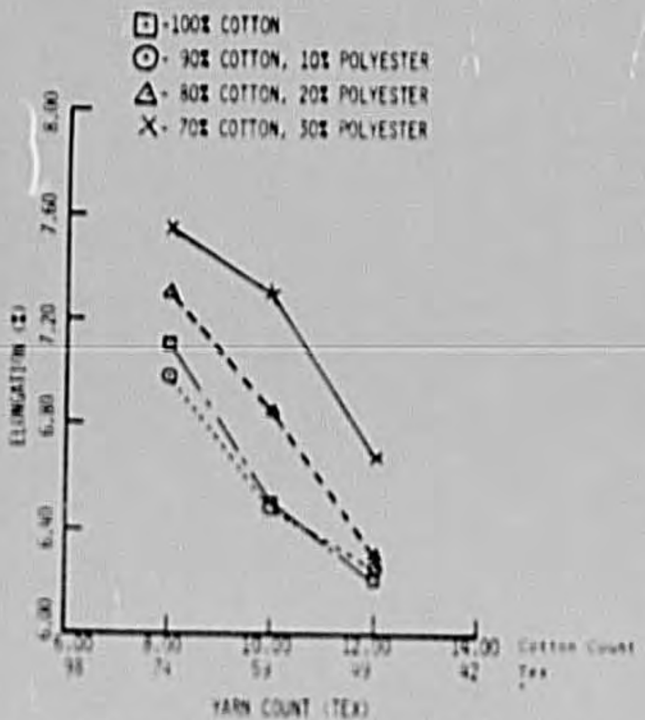

Fig. 5 The relationship between single-end elongation and count for 100% cotton and three cotton/polyester blends

Conclusions

From the previous results and analyses, it can be concluded that yarn count was the only factor which significantly affected the migration of fibers in open-end spun yarns. Also, fiber denier, fiber length, yarn count, and blend level significantly affect the physical properties of open-end spun yarns.

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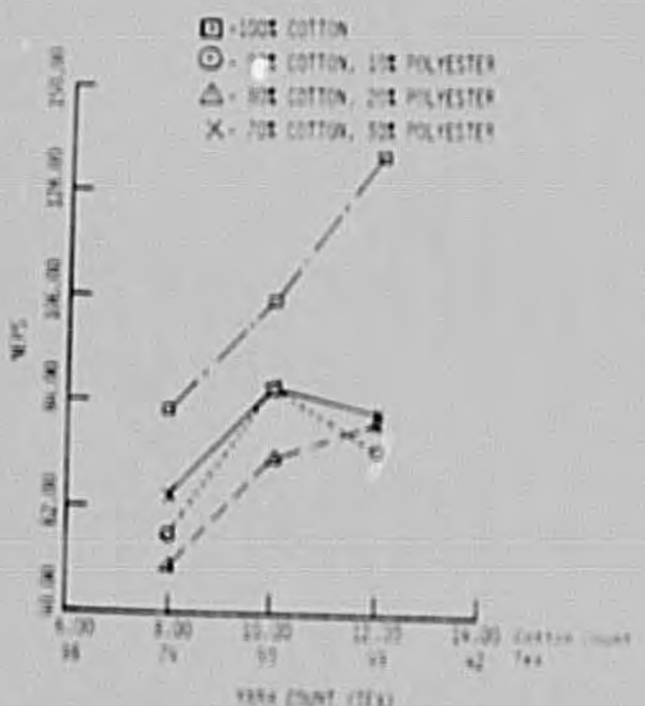

Fig. 6(a) The relationship between neps and count for 100% cotton and three cotton/polyester blends

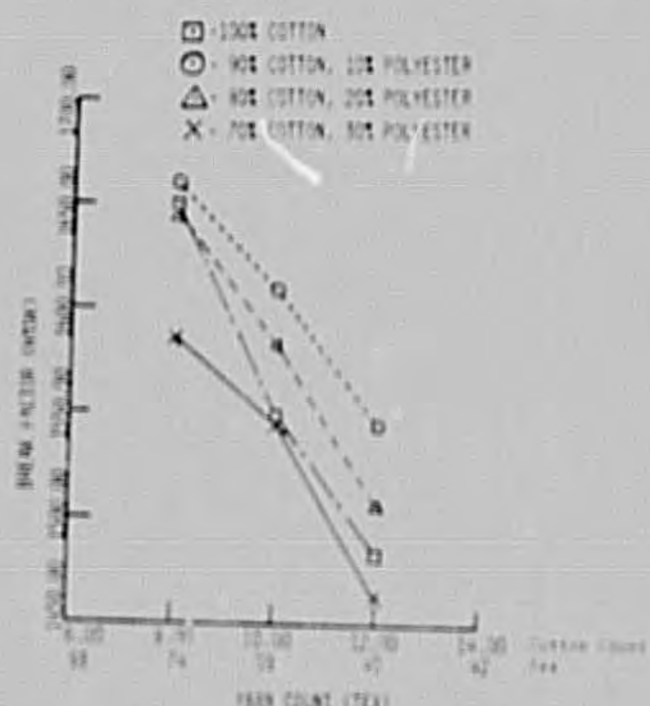

Fig. 6(b) The relationship between neps and count for 100% cotton and three cotton/polyester blends

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APPENDIX C

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