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PREPARATORY ASSISTANCE - TEXTILE DYEING AND FINISHING INDUSTRY SERVICE CENTRE

DP/ROK/82/027/11-52

REPUBLIC OF KOREA

Technical report: The dyeing and finishing research centre in Daejeon,  
Equipment, Laboratory Facilities, and Training-  
Second mission\*

Prepared for the Government of the Republic of Korea  
by the United Nations Industrial Development Organization,  
acting as executing agency for the United Nations Development Programme

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ABSTRACT

The second month of a planned three-month-long mission has been completed. The objective of the mission is to establish a Dyeing and Finishing Research Center at the Korea Research Institute of Chemical Technology(KRICT), at Daejeon.

The equipment needed has been ordered and, with the exception of four instruments, has been delivered. The construction work to provide laboratory space for the new equipment has been completed and the equipment is now ready for installation. Training of the Staff to operate the equipment will follow.

The success of the project hinges on adequate support with technical know-how by UNIDO consultants. During the period covered by this report, the author presented a lecture series on the theory and practical aspects of textile dyeing. It became evident that the training program is essential and has to be continued.

## INTRODUCTION

The job description of the Post DP/RGK/82/027/11-52/31.7.8. gives the following background information:

During the past ten years Korea established itself as a reputable exporter of industrial and consumer products through the efforts of many technically and business oriented entrepreneurs assisted by the Government, domestic and foreign investors.

However, mainly caused by a lack of advanced technology and insufficient knowledge of the demand in the world market, the Korean textile industry, and the small to medium-size companies in particular, are operating in that part of the world market where the competition is growing stronger very fast: the market of low quality products. This trend of growing competition will extend itself in the future caused by a rapid industrialization that is taking place in other countries.

To raise the quality of Korean textiles to the level of the more profitable market of quality goods, the textile dyeing and finishing processes of the Korean industry have to be improved. In order to reach this goal, a project was funded to establish a Dyeing and Finishing Research Center at the Korean Research Institute of Chemical Technology (KRICT), at Daejeon.

In-depth information on the Korean textile industry can be found in a report by A.S. Nasir, Project Manager and UNIDO Coordinator, April 1984, and in a report by Ahmed Hassan (DP/ID/Ser. A/710, 23 June 1986).

It is important to realize that the progress made by the Korean textile industry has been very rapid by utilizing imported technology. However, the research and development capability has not developed to the same extent and the industry lacks the technical support needed to solve technical problems of supplying the industry with dyes and chemicals, and develop new modern technology. Hence a competitive position cannot be maintained for a long time without a substantial improvement of the research and development capability. It is therefore essential to complete the project of establishing a Dyeing and Finishing Research Center at KRICT and support the Center with technical assistance until the Center becomes self sufficient and functions independently.

The demonstrated ability of the Korean peoples to develop a modern industry at a very rapid rate assures that the technical assistance provided by UNDP/UNIDO will be a productive investment. Furthermore, the Korean experience in adapting imported technology to the local conditions can serve as an example to underdeveloped countries and stimulate progress in other areas of the world.

## CONCLUSIONS

The Dyeing and Finishing Research Center project is viable. The management of KRICT is adequately supporting the project.

The equipment needed has been purchased and, with the exception of four instruments awaiting delivery, is ready to be installed.

The construction work to provide space for the new equipment has been completed.

The space provided is adequate for installing the equipment, but inadequate for grouping the equipment in a functionally effective way. The space shortage will affect the efficiency of operations and possibly the quality of work.

The study tours to U.K., U.S.A., and Switzerland have been worthwhile but too short. A language barrier may have been a problem.

A lecture program on dyeing theory and technology, presented by the author and translated to Korean, was well received and apparently effective.

Once the equipment is installed, training is needed to operate the instruments. Start up instruction will be provided by the manufacturers.

Training by outside consultants will be needed for utilizing the new equipment in practical problem solving and

development of dyeing, printing and finishing technology. The future of the Center hinges on sufficient infusion of technical knowledge until the Center becomes self-sufficient in developing the know-how needed for adapting imported technology to the Korean industry, solving technical problems and developing new technology.



## RECOMMENDATIONS

- Provide start up instruction for the use of the instruments purchased (by the manufacturers of the instruments).
- Continue training of the Staff of the Dyeing and Finishing Research Center by UNIDO consultant, to provide.
  - know how of efficient and competent operation of new equipment
  - theoretical and practical knowledge essential for identifying and solving dyeing and finishing problems, and
  - help the Center to become selfsufficient in supporting Korean textile industry and developing new technology.
- Assist the Center with technical assistance by UNIDO consultants until the Center becomes independent and efficient in doing research and development.

## DISCUSSION

### 1. Background

The background of this project has been described in the UNDP Project Document DP/ROK/82/027/D/01/37, in a report by Antero Eräneva, and in a report, entitled "Textile Dyeing and Finishing Industry", by Gert Bremhorst, DP/ID/Ser.A/513, 4 May 1984. The report states that dyeing and finishing is one of the most important sectors determining the quality of textiles produced in Korea. The Project Document and the report by Gert Bremhorst conclude that a Dyeing and Finishing Research Center should be established to assist the Korean textile industry in raising the quality of textiles to a higher price level. The location at the KRICT(Korea Research Institute of Chemical Technology) in Daejeon was considered to be appropriate since it is situated in the most important dyeing and finishing industrial area(Seoul/Daegu). Lists of equipment needed for establishing a dyeing and finishing center at KRICT were compiled by Dr. Ahmed Hassan(17 March 1986, ref. ROK-82-027.3 and ROK-82-027.5) and Gert Bremhorst(see the reference of his report above).

The purpose of the project DP/ROK/82/027/11-52/31.7.B. subject this report, is to assist and guide the development of the Korean textile industry through the introduction of advanced production methods with the objective of improving the quality and competitive position of Korea's textiles and

increasing textile exports.

The author concluded after his first visit (Report DP/ID/SER.A/703, 22 May 1986) that the dyeing and finishing industry in Korea has technical problems it is not equipped to solve without outside technical assistance. The existing infrastructure of textile institutes and testing laboratories is apparently inadequate for solving all of the technical problems and providing sufficient technical assistance in the dyeing and finishing sector.

The Textile Technology Promotion Institute in Daegu does not conduct research and development in the dyeing and finishing sector.

Although a substantial growth of the Korea's textile industry is unlikely in the near future, technical assistance to the dyeing and finishing industry, especially to the smaller companies, is essential for staying competitive and maintaining the existing market share and increasing the value of textile exports.

The planned Dyeing and Finishing Research Center of the Korea Research Institute of Chemical Technology (KRICT) at Daejeon has a practical and useful purpose. With proper equipment and sufficiently trained manpower the Center can become an important asset of the Korea's textile industry.

The Dyeing and Finishing Research Center at KRICT will need intensive technical input from the outside, mainly from experts of UNIDO, to expedite its development into a vital

and effective technical research and development support organization for the dyeing and finishing industry.

The author recommended (Report DP/ID/SER.A/703, 22 May 1986) that

- A Dyeing and Finishing Research Center, at the KRICT Institute in Daejeon, should be established, as planned
- The recommended equipment and instruments should be purchased as soon as possible.
- The Center should be provided with suitable laboratory rooms, one of these climate controlled.
- Training of the technical staff for the Center should start as soon as equipment is available. For training abroad, dye manufacturers supplying the Korean textile industry with dyes should be approached.  
The Textile Technology Promotion Institute in Daegu and the textile mills in Korea should also be utilized for training purposes.
- Intensive input by UNIDO consultants will be needed to develop the technical expertise of the staff assigned to the Center.
- The new Center should be primarily a research and development facility with the objective of providing technical support to the dyeing and finishing industry. Routine testing and quality control of dyes and finishing agents should remain the responsibility of the producers and existing testing institutes.
- The Center should provide the dyeing and finishing industry with test methods for quality control.

- The Center should function as a technical information source for the dyeing and finishing industry and review regularly technical development and international trends of textile industries.
- The Center should assist the dye producers in maintaining consistent dye quality by developing standardization procedures, if needed, and test methods.
- The Center should assist the dyeing industry in developing dyeing processes to improve dye utilization and the quality of dyeings, with the desired shade and fastness properties. For this purpose the Center should have the needed technical know-how and skills in color measurement, color matching and dye in fiber analysis.
- The Center should become thoroughly familiar with finishing technology, in order to recommend finishing agents to the finishing industry and develop processes for the application of finishes. The Center should perform analysis of finishing agents and finishes on fabric.

## 2. Equipment

The purchase of equipment for the Center was suggested in the Project Document and listed in reports by Gert Bremhorst and Ahmed Assan. Some of the equipment was ordered, but the needs of equipment changed somewhat as a result of redefining and pinpointing the objectives of the Center. Limitations of funds necessitated setting priorities for purchasing equipment. The equipment listed in the previous report of the author (DP/ID/SER.A/703, 22 May 1986) was considered to be the bare minimum needed for the Center to function.

The planned purchases have been made and the equipment listed in Table I is now available at the Dyeing and Finishing Center, with the exception of the Launder-O-meter dyeing unit and the lightfastness tester, both ordered from the Atlas Electric Co., the electrical resistance tester and softness-stiffness tester, which just have arrived in Korea.

The equipment purchased with UNIDO funds is listed in Table II. The AHIBA Turbocolor dyeing apparatus was purchased with Korea Government funds because of a shortage of UNIDO funds. For the same reason, a Roaches padder was purchased instead of the more expensive Mathis Model HP padder recommended, although the rollers of the Roaches padder are not as resistant to solvents and chemicals as those of the Mathis padder.

Plans to purchase additional equipment in the near future, probably by Korean funds, include an AHIBA Texomat dyeing apparatus for exhaust dyeing of piece goods, permitting visual observation of the dyeing process, and a printing apparatus.

The laboratory does not have equipment for controlled drying of fabrics dyed in a laboratory. The purchase of a home appliance type electric dryer has been recommended and is being considered(Korean funds).

The construction work to provide laboratory space for the new equipment has just been completed and installation of the equipment will follow. The practical value of the new equipment in use will depend largely on the know-how of the personnel operating the equipment and the effective placement of the equipment in the laboratory. At the present, the personnel of the Center is not adequately trained and the Center will depend on start up instruction provided by the manufacturers and additional training by UNIDO consultants. A follow up of the training program, to assure effective and troublefree operation of the equipment and high quality results, is essential.

### 3. Laboratory Facilities at KRICT

The new Dyeing and Finishing Research Center at KRICT has to be competent and efficient in solving technical problems of the textile dyeing and finishing industry and providing the technical support needed. Hence suitable laboratory facilities are needed for housing the equipment in a proper environment.

The author recommended (DP/ID/SER.A/703) that the dyeing and finishing laboratory for research and development should consist of four sections which are not quite compatible and are better kept as separate areas:

- Dye "kitchen" for preparing dyebaths and formulations of finishes. A laboratory cabinet assembly with storage facilities, equipped with stirring hotplates, balances, and a sink with distilled water and process water faucets. A small fume hood with a cup sink would be useful.
- Area for applying dyes or finishes, including storage facilities for fabrics and table or cabinet for sorting and labeling dyeings. The dryer and steamer should be ventilated to the outside.
- A room for evaluation dyeings and finished fabrics. This room should have facilities for controlling temperature and humidity and tables or cabinets laboratory benches for the equipment and storage.
- An analytical laboratory for analyzing dyes, determining dyes in solution or in fibers and for analyzing finishes on fibers. A fume hood is mandatory for chemical analysis.



The support of the project by the management of KRICT has been substantial. In spite of the very obvious shortage of laboratory space at the Institute, two large laboratory rooms, total area of 160m<sup>2</sup>, have been added the Dyeing and Finishing Center and remodeled accordingly. One of the rooms is to be used for dye application. The other room, with a constant humidity control, will house the color measurement system, an infrared (FTIR) spectrograph and various testing equipment. However, the total area fell short of the recommended laboratory area of 290m<sup>2</sup>. Although sufficient space is available for installing the equipment purchased, the compatibility of equipment is a problem. For example, equipment which generates heat and steam interferes with test equipment requiring a constant environment. Consequently, the available space is not adequate for functional grouping of the equipment in accord with the effective sequence of dyeing operations. Clearly, the situation is far from ideal. However, KRICT is considering to construct a new building which would provide ample space for the Dyeing and Finishing Research Center.

#### 4. Training Program

Training of the new Dyeing and Finishing Research Center personnel, was envisaged by UNDP experts, fellowships for training abroad, and study tours for the research staff.

In accord with the UNIDO training program training tours of the staff members of the Dyeing Finishing Research Center, Young-Suk Kim, Jung-Hwan Mo, and Hee-Moon Park, visited in U.S.A. the Applied Color System Inc.(Color Measurement), Analect Instruments (FTIR spectroscopy), Gaston Country Dyeing Machine Co (Dyeing Machinery), Sandoz Chemical Co (dyes and chemicals), ICI (dyes and chemicals) and the North Carolina Vocational Textile School. A staff member, Jongil Shin spent six weeks at the Shirley Institute in U.K and 3 weeks with by Ciba-Geigy in Switzerland. The general comments of the participants were that the training was very useful, but the time was too short for accumulating in-depth knowledge. The training encompassed mainly practical aspects of dye application and testing, and (the U.S.A. tour) operation of instruments for coloristic measurements and FTIR spectroscopy.

To provide a more comprehensive overview of dyeing and finishing theory and technology, the author presented a lecture program on the fundametal theory of dyeing, the properties and use of dyes, dyeing machinery and processes,

and the theory and practical aspects of dyeing polyester, polyamide, acrylic, and cotton fibers. Lectures were presented also on finishing with repellent, durable press and soil release finishes. The lectures were translated to Korean by Dr. Oh, sentence by sentence. Discussion periods following each lecture showed a lively interest in the lecture program.

Undoubtedly, more teaching and training is needed. On site start up instruction for operating new equipment will be provided by the manufacturers.

In addition to learning the techniques needed to operate instruments, the staff of the Center has to become efficient in utilizing the new equipment for identifying and solving technical problems the Korea textile industry may have.

The involvement of outside consultants will be essential until the Dyeing and Finishing Research Center has become selfsufficient in formulating and developing technology needed to support Korean textile industry.

Table I. Equipment at the Dyeing and Finishing Research Center

Dye "Kitchen"

Electronic balance - 160g range  
Electronic balance - 1600g range  
Pipettors, 1 to 5 mL capacity, with disposable tips  
Stirring hotplates

Application Area

2-bowl laboratory padder(Roaches Model BVAP-350)  
Laboratory steaming, curing and heat setting unit  
(Mathis Model DHE)  
High temperature dyeing unit(Laundry-O-meter, model  
L-Pl, Dyeing System, Atlas Electric Co)  
Dyeing apparatus for exhaust dyeing, adaptable to cone  
dyeing, microprocessor controlled(Ahiba Turbocolor)

Evaluation of Dyeings(Climate controlled "dry" area).

Color measurement system for color matching and color  
difference measurement, computer controlled, Applied  
Color System, Model 3100  
Color assessment cabinet  
Microtome for cutting cross-sections of dyeings  
Microscope, equipped with a 35mm camera  
Crock(rubbing) fastness tester  
Crease recovery tester  
Abrasion tester  
Lightfastness tester(Atlas Xenotest 450 LF), has been  
ordered.

Scorch tester for testing fastness of dyeing to heat (sublimation and shade change)

Tensile strength tester

Softness-stiffness tester

Eppendorf repeater pipet, with 2.5 mL combitip, for oily soil application(Fisher Scientific Co).

Test equipment for oil repellency testing

Water repellency test equipment, spray type, AATCC specifications

#### Equipment for Dye and Finish Analyses

Constant temperature heating bath, temperature range from ambient to 150°C, with a rack for holding extraction flasks(Silicone oil used as the heating medium needs to be ordered).

Refrigerator

Centrifuge, IEC Clinical Model

Flammability tester

Scanning electron microscope

Equipment for elemental analysis: C,H,N,S,Cl,Br,P,F (if water/oil repellent finishes are analyzed), alkali metals, alkaline earth metals, Fe, Al, Also in trace quantities.

Gas chromatograph

High performance liquid chromatograph(HPLC), with ion chromatography capability

Equipment for acid/base and redox titrations manual or automatic

Spectrophotometer, UV/visible spectral range

Infrared spectrophotometer(FTIR), Analect Model FX 6160

Nuclear magnetic resonance(NMR) spectrograph

Mass spectrometer(GC/MS)

Thin layer chromatography equipment

A die, about 12mm diameter, and a plastic covered block, for cutting disks from dyed fabrics for analysis

Table II. Equipment Purchased with UNIDO Funds

Padder, 2 Bowl Swivel Model BVAP-350, Roaches Engineering Ltd., was purchased instead of the recommend Mathis Model HF to reduce cost.

Steamer. Model Mathis DHE

Launder-o-meter L-Pl Dyeing System(Atlas Electric Co, USA).

Color evaluation cabinet,(Macbeth Division, Kollmorgen Corp., USA)

Lightfastness tester, Atlas Weather-o-meter, Model 25-18-WT (Atlas Electric Co, USA).

Crock(rubbing) fastness tester(Tokyo Testing Machine MFG, Co, Ltd).

Crease recovery tester(Tokyo Testing Machine MFG, Co, Ltd)

Abrasion fastness tester(Shirley Developments Ltd, Manchester, England)

Scorch(thermo)fastness tester(Tokyo Testing Machine MFG Co, Ltd)

Perspiration fastness tester(James H. Hal & Co, Ltd, Halifax, England)

Flammability tester, Custom Scientific Instruments, Inc. Model CS-186

Electrical resistance tester, Custom Scientific Instruments, Inc. Model CS-51

Water repellency(spray) tester(James H. Hal & Co, Ltd. Halifax England)

Infrared(FTIR) spectrograph, Analect Instruments, Model FX-6160

Softness-stiffness tester

The AHFBA Turbocolor dyeing apparatus was purchased with Korea Government funds, in view of shortage of UNIDO funds.