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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-  
Third 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

Based on the work of Erik Kissa  
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#### ABSTRACT

The third month of a planned three-month-long mission has been completed. The objective of the mission was 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 installed. The construction work to provide laboratory space for the new equipment has been completed and the equipment is now in use. The Staff has been trained to operate the equipment.

During the third period covered by this report, the author presented a lecture series on color measurement quality control, the theory and practical aspects of textile dyeing and hydrophilic finishing of polyester. The training program is essential for raising the quality of the research and development work conducted by the staff and is an ongoing learning process to be continued.

#### INTRODUCTION

The job description of the Post DP/ROK/82/027/11-52/31.7.B. 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.

## CONCLUSIONS

The UNIDO project DP/ROK/82/027/11-52 has been successfully completed. Laboratory equipment and instruments have been purchased, mostly with UNIDO funds and installed. Technical personnel has been trained to operate the equipment. The technical knowledge of the Staff has been substantially increased by lecture programs and study tours.

The UNIDO program has been cost and time effective, especially when considering the relatively small investment of UNIDO funds and the time needed for procuring equipment from overseas. Plant site consultations of UNIDO experts have been productive and apparently useful for the Korean textile and dye manufacturers.

Research and development activity in dyeing and finishing requires a thorough understanding and frequent consultation of technical literature which is mainly in English, German, and Japanese. A limited proficiency of the Staff in these languages is a considerable disadvantage. A critical review of the technical literature with the emphasis on practical aspects, translated into Korean, is therefore very helpful for the Staff of the Center. A lecture program combined with discussion periods chaired by an English and Korean speaking scientist (Dr. Oh) is an effective format for bringing the Staff up to date in dyeing and finishing technology.

The Dyeing and Finishing Research Center is now functioning and growing further. However, the future of the Center hinges on infusion of technical knowledge and methodology from the outside experts, until the Center can become selfsufficient in solving technical problems and developing new technology needed to increase the quality of Korean textiles.

## RECOMMENDATIONS

The UNIDO project completed can be viewed as a first phase in establishing a viable and effective Dyeing and Finishing Research Center at KRICT.

The Center is now entering second phase during which the Center has to become an effective research and development organization and serve the Korean textile industry. The thrust of the industry to improved quality places a greater technical demand on the Center and requires a highly competent and prompt response of the Center to the problems of the industry.

The continued input of outside experts will be essential in raising the technical standards of the Center. The outside experts should provide information in the form of lectures and seminars, and get involved in the actual work in the laboratory to demonstrate techniques and methods of dyeing and finishing on a laboratory scale.

## 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 Taejeon 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 RO-82-027.5) and the author of this report (DP/82/027/11-52), Gert Bremhorst (see the reference of his report above).

The purpose of the project DP/ROK/82/027/11-52/31.7.B. subject of 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.

In 1987 the worth of textile and clothing exports exceeded the US \$ 10 billion mark. Although this was probably the last year in which textiles dominated Korean exports, the textile industry will remain one of the most important exporters in Korea. The industry also has done much to create jobs. According to the statistics of the Economic Planning Board the textile industry provided 19.7% of total employment in 1986, while textiles represented 12.7% of total manufacturing production.

However, Korean textile industry faces now more protectionism in the importing countries and stiffer competition from developing countries. Higher quality is therefore the only way for the Korean textile industry to prosper.

Kim Woo-choong, chairman of the Korean Federation of Textile Industries, says that the industry is entering a maturing period. "Quality enhancement should direct the industry's efforts to prosper through technological and managerial innovation. We should increase our competitiveness in such sophisticated fields as dyeing and fashion." (Textile Asia, December 1987).

Both government and industrialists are thinking of remodeling the industry and focus on higher-quality goods. "The only direction for it now is toward high quality", said Mr. Ju Dong-Silk, executive vice-chairman of the Korean Federation of Textile Industries. (Textile Asia, November 1987).

The Dyeing and Finishing Research Center of KRICT has a practical and useful purpose to raise the quality of the Korean textiles by conducting research and development work which most textile mills are not equipped or capable of doing. However, the Center needs intensive technical input from technical experts 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) and DP/ID/SER.A/840 20 May 1987)

- 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.
- 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 consultants 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.
- 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 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 construction work to provide laboratory space for the new equipment has been completed and the equipment has been installed. 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. The personnel of the Center has been trained by manufacturers of the instruments to operate the equipment by UNIDO consultants. However, a continued training program, to assure effective and troublefree operation of the equipment and high quality results, is essential.

### 3. Laboratory Facilities at KRICT

The Center needed suitable facilities for housing the equipment purchased. In accord with the recommendations of the UNIDO consultant 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 used for dye application. The other room, with a constant humidity control, houses 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. KRICT is now constructing a new building which will provide ample space for the Dyeing and Finishing Research Center.

### 4. Training Program

Training of the Dyeing and Finishing Research Center personnel was envisaged to include UNIDO consultants, fellowships for studying abroad, and study tours for the research staff.

Dr. Ahmed Hassan lectured in Nov. 1987 on new ideas and advancement in textile machinery, trouble shooting, and quality control of plant operation and energy saving processes.

Mr. Brian Eastwood gave a lecture in Nov. 1987 on printing techniques of silk, polyester and cotton.

During his third visit the author of this report presented lectures on

- . Color measurement, quality control and color matching by a computer.
- . Theory of dyeing.
- . Reactive dyeing processes, and their theoretical and practical aspects,
- . Hydrophilic finishing of polyester fibers.
- . Liquid dyes.



The technical program, consisting of lectures and discussion periods, was designed to serve current interests of the Dyeing and Finishing Center.

The emphasis on higher quality of Korean textiles increases the need for sophisticated tests and color measurement techniques. Color measurement methods and color coordinate systems are used for color matching, quality control and optimization of dyeing processes. The Center is now equipped with a computer aided color matching system. However, the training provided by the manufacturer was mainly an instruction to operate the instrument. It was therefore appropriate to devote several lectures to principles and techniques of color measurement. The lectures described the most important coloristic systems used today: the CIE x,y,Y, the CIELAB, and the CMC systems. The lectures were illustrated with color slides prepared by the lecturer for this purpose, and with examples of actual computer printouts.

Most dyes used in Korea are manufactured in powder form. In Europe and in the United States powder dyes are being replaced by liquid dyes. The liquid dyes have several advantages over powder form dyes. The liquid dyes are dustfree, contain less dispersant, produce more uniform dyeings of higher tinctorial efficiency, and most important - permit automated dosage in automated dye houses. Since liquid dyes make it easier to achieve a better color control and higher quality, the market share of liquid dyes will probably increase in Korea. Therefore two lecturers of the program described processes for making liquid dyes. Fundamental principles and detailed process conditions were given for colloid milling disperse dyes to form stable liquid dyes.

The color yield and fastness properties of dyed textiles depend on dye diffusion and the physical state of the dye in fibers. In order to improve dyeing processes the mechanisms of dye diffusion in fibers have to be understood. Several lectures of the program explained the processes for dyeing cellulosic and synthetic fibers. A solvent assisted process for dyeing cotton and polyester fibers was described to elucidate dyeing mechanisms with unpublished data.

Reactive dyeing, which attaches a dye to cellulosic fibers by a chemical bond, is probably one of the most important processes for dyeing cotton in Korea. The Center has contracts for improving the synthesis of vinylsulfone and dichloroquinoxaline dyes. Two lectures with discussion periods were therefore devoted to reactive dyes, principles of reactive dyeing and optimum conditions for exhaust, semi-continuous and continuous reactive dyeing processes.

Several lectures with discussion periods were devoted to wettability of fibers, detergency, and hydrophilic finishing of polyester fibers. Polyester fibers are strong and impart wash and wear characteristics to the garment. However, a limited moisture sorption and transport are undesirable from a comfort point of view. Hydrophobicity of polyester fibers impedes detergency of fatty and oily soils. The Center has a contract to develop hydrophilic finishes for polyester fibers. Hydrophilic ethylene oxide based finishes increase wettability and moisture sorption. Principles of hydrophilic finishing, selection of chemicals for hydrophilic finishes and test methods were described.

Visits of Korean textile mills and discussions with Dr. Oh of the Center have convinced the author of this report that finishing problems are at least as important as dyeing problems in the Korean textile industry. Future technical lecture programs at the Center will have to place greater emphasis on finishing technology and test methods for the quality control of finishes.

The lectures were translated by Dr. Oh into Korean and will be used for further training of the Staff. A question and answer discussion period followed each lecture and revealed the interest of the staff in the subject matter.

The author of this report visited during the third period two Korean textile mills (Tongkook Dyeing and Finishing Co. Ltd and Han Kook Yeum Kong Co. Ltd, both in Taegu).

Although the UNIDO training program has been effective, more teaching and training is needed. Start up instruction for operating new equipment has been provided by the manufacturers, but the staff of the Center has to increase their technical skills 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 planning and conducting research and development work needed to increase the quality up Korean textiles.

TABLE I. 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

Laundry-o-meter, L-PI 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 AHIBA Turbocolor dyeing apparatus was purchased with Korea Government funds, in view of shortage of UNIDO funds.