36957 PDF

Project Title: Pilot Scale Implementation: Real-Time Monitoring of Batch Dyeing Processes

Project Number: S-94TT-1
Principal Investigators: Keith R. Beck, Warren Jasper, Ralph McGregor, and Brent Smith.
Industrial Collaborator: W. Hunter (Cotton Inc.)

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Abstract:

The purpose of this project is to transfer some of our research successes of the past six years to industry. This is being accomplished through laboratory modifications of a dyebath monitoring system to make it portable, by rewriting dyebath monitoring and control software to make it more useful and user-friendly, and by sharing research results at a technology transfer short course for interested parties in the textile industry.

Goals:

To develop a demonstration program package from dyeing programs that have been written for data acquisition, modeling, and control and provide those to industry;

To develop a portable data acquisition system, validate its use on pilot scale equipment at NCSU, and, finally, to use it to study production dyeings in manufacturing facilities;

To imbed laboratory and industrial dyeing information in a knowledge base that can be continuously updated and used to improve and trouble shoot dyeing processes.

To develop an industrial support group to share in technology transfer activities, feed back information for ongoing research, and eventually fund transfer activities.

Introduction:

As a result of strong encouragement from the textile industry to transfer results from the Dye Applications Research Group (DARG) to the manufacturing environment, a technology transfer project was proposed. This report details the objectives and mid-year progress of that work.

Progress:

Portable data acquisition system

The flow injection analysis (FIA) system[1] that was developed in the DARG labs was suitable for monitoring laboratory bench dyeings, but was too cumbersome to be practical in a pilot or production environment. The largest component of the system was the diode array spectrophotometer. With the assistance of Dr. Bill Hunter, Cotton, Inc., five different miniature visible diode array or charge couple device spectrophotometers were investigated. After dozens of calls, a Zeiss spectrophotometer, roughly the size of a two-inch cube, was selected. Only a

deuterium source that provides ultraviolet radiation was available from the distributor of the Zeiss instrument. A tungsten/halogen visible source lamp was found from one of the other manufacturers of small spectrophotometers. This source, coupled by fiber optics to a flow cell holder from a third supplier and then to the Zeiss spectrophotometer forms the system that will measure full visible spectra (380-780 nm) from the FIA apparatus (Figure 1).

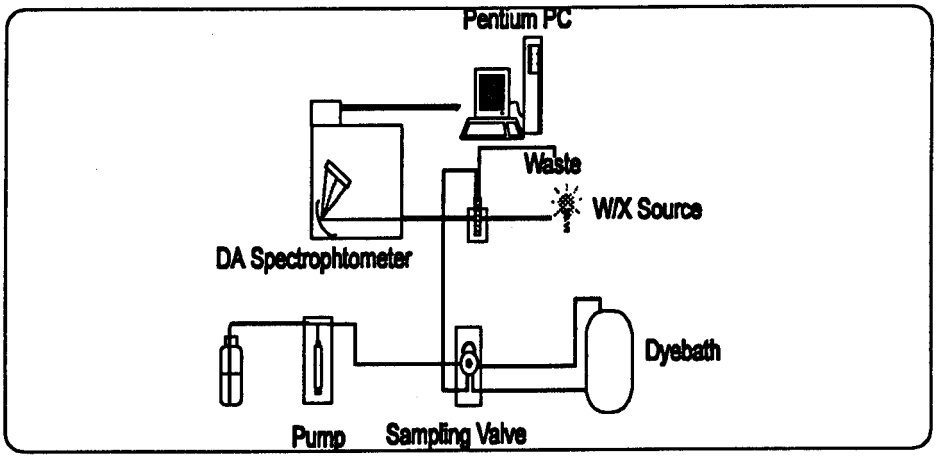

Figure 1. FIA Apparatus

Data acquisition from the spectrophotometer and actuation of the FIA pump and valve will be controlled by a Pentium PC. Data acquired from the spectrophotometer will be automatically written into a spread sheet, and graphs of exhaustion and dye concentrations will be updated in real-time.[2] Software for these measurements is being developed by the programmer hired for this project. The components have been ordered and should arrive in time to meet the October goal for assembling the system . Because this is a technology transfer project, most of the underlying hardware and software will be available "off-the-shelf" from multiple vendors and conform to industry standards. For example, the controlling computer is a 90 MHz Pentium running Linux, a public domain UNIX operating system.

Personnel:

The research technician position has been created and candidate interviews will be held during the next two weeks. The technician will assemble the components of the FIA system and develop a standard interface for connecting to pilot- and production-scale dyeing machines. The computer programmer has been hired and is actively working.

Short Course and Lab Visits:

The Dye Application Research Group arranged for and presented a technology transfer short course during June. Papers on all aspects of the research project as well as talks on process automation by ABB personnel were presented to the 35 industry attendees. One afternoon of the course was devoted to demonstrations of FIA, real-time monitoring and adaptive control of batch

dyeing, use of theoretical models for prediction of dyeing behavior, and a fuzzy logic controller. Representatives from three different corporations expressed a strong interest in the FIA monitoring system as soon as it is ready for industrial use.

During 1994, more than sixty visitors from 31 companies, three universities, and six countries visited the DARG labs and were given demonstrations of the results of our research.

Publications:

1. Lefeber, M. R., Beck, K. R., Hunter, W. D., Smith, C. B., and McGregor, R, " Flow Injection Analysis of Dyebaths", Textile Chemist and Colorist, 26 (5), 30-34 (1994).

2. Jasper, W. and Reddy, M., ``Real-Time System for Data Acquisition and Control of Batch Dyeing", IEEE Annual Textile, Fiber, and Film Industry Technical Conference, Greenville, SC, May 1994.