NICE^3

Project Fact Sheet

Dyebath Reuse in Carpet Manufacturing

A new system enables textile manufacturers to reuse dyebath chemicals and processing water reducing energy, water, and operating expenses

Benefits

- Reduction in energy use, industry wide, of 3.6 trillion Btu/year; 7 trillion Btu by the year 2010
- 70% reduction of auxiliary chemicals required, 36 million pounds, nationwide
- 42% reduction of water required, 400 billion gallons nationwide
- Savings of $1.6 million per year for each average-sized carpet manufacturing plant

Applications

Though this project was developed for nylon carpet dyeing, the technology holds promise for widespread implementation in carpet manufacturing. In addition, it offers several opportunities involving other textile products, fiber types, dye classes, and dyeing equipment.

The Georgia Institute of Technology (G.I.T.) has developed an effective automated dyebath analysis and reuse system that improves the energy, environmental, and economic performance of dyehouse batch operations. The new system enables dyeing solutions to be accurately monitored and adjusted for reuse.

According to industry estimates, 160 pounds of water are used to produce each pound of textile product. The current wasteful batch dyeing process requires all water and residual chemicals, as well as the energy required to heat the mixture for dyeing, to be dumped after one application. Spent dyebaths can only be reused after they are sampled, analyzed, and reconstituted, a process requiring labor and expertise that are unavailable in the dyehouses. Therefore, successful commercial reuse depends on an automated analysis system that precisely analyzes dyebath samples in real-time and provides for reconstitution and reuse. If fully implemented throughout the carpet industry, this innovation is expected to reduce energy consumption by 3.6 trillion Btu/year. Waste and cost savings will also be substantial.

Automated Dyebath System

This automated dyebath system includes (from left to right): a carpet dyeing chamber, a holding tank, and a dye analyzer that adjusts dyeing solutions for reuse. This system dramatically reduces energy use, discharged wastes, and overall costs.

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Project Description

Goal: The project goal is to develop, demonstrate, and evaluate a commercial scale, automated dyebath reuse system for nylon carpets. This will establish the ability to improve the energy, economic, and environmental performance of batch dyeing through automated dyebath reuse.

A series of tests examined necessary changes in the batch dyeing process. Effective reuse of the baths requires that the conventional dilution cooldown at the end of the cycle be eliminated and that the subsequent cycle be started hot. Both hot-termination and hot-startup present risks of product quality defects, and appropriate adjustments were devised. Development of the sampling and analysis system included investigation of low cost alternatives in dual-beam spectrophotometry and the means to integrate computer control of the analysis system components with both the programmable logic controller (PLC) controlling the manufacturing equipment and the mini-computer for production scheduling. The resulting system permits sampling and accurate analysis of the spent dyebaths without human intervention — no requirement for additional labor or the expertise of an on-site chemist. The same computer calculates necessary makeup chemicals and dyes to reconstitute the spent bath for reuse with the next batch. The innovation is applicable to a variety of batch dyeing systems.

Georgia Institute of Technology is demonstrating this new technology with assistance from the Georgia Pollution Prevention Assistance Division, Shaw Industries, and the NICE^3 Program through the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Techniques were developed to permit hot-start and hot-termination of the batch dye cycles, with two different dye chemistry systems.
- Developed an automated, low-cost, dual-beam spectrophotometry system with calibration for a three-component acid dye recipe.
- Plant equipment was installed and modified to recover spent dyebaths for reuse.
- Software was created to control the analysis system and to interface with the PLC and mini-computer, which provides equipment and schedule control respectively.
- The performance of the automated analysis system and the dyebath reuse process has been demonstrated for several series of nylon 6 and nylon 6.6 broadloom carpets.

NICE^3—National Industrial Competitiveness through Energy, Environment, and Economics: An innovative, cost-sharing program to promote energy efficiency, clean production, and economic competitiveness in industry. This grant program provides funding to state and industry partners for the first commercial demonstration of energy efficient and clean production manufacturing and industrial technologies. Total project cost for a single award must be cost-shared at a minimum of 50% by a combination of state and industrial partner dollars. The DOE share for each award shall not exceed $500,000 to the industrial partner and up to $25,000 to the sponsoring state agency for a maximum of $525,000.

Project Partners

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Georgia Pollution Prevention Assistance Division
Atlanta, GA

NICE^3 Program
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