

Continuous Control of Coordinated Batch Processes

Dyeing and bleaching operations in textile manufacture have inherently been batch processes. Select Controls, Charlotte, North Carolina has taken these batch processes and combined them into an efficient continuous integrated manufacturing control system.

Requirements

- Machine level logic, sequence and timing control
- PID temperature loop control
- Chemical additive flow control
- Recipe setup and dye order handling
- Production data management, reporting
- Operator inputs, prompting, alarms and acknowledgement

Solution

- Select Controls, Inc., "LINEMAX" real time, computer and PLC based control system
- B&R PLCs for machine control
- B&R industrial computer for supervisory control and complete operator interface

Benefits

- Improved bleaching quality
- Higher production rates
- Reduced chemical and energy costs
- Well-managed production data

Select Controls has developed a unique approach to dyeing and bleaching that continuously automates the individual batch processing of the dyeing

and bleaching machines. The resulting operation is a continuous process control system made up of individual but coordinated and supervised batch control processes. The key benefits - more production, better quality at lower costs and well-managed production data.

The continuous hosiery bleach line consists of up to five dyeing machines arranged in-line. The first machine is loaded with unfinished goods and the Select system automatically controls the goods through the line. When the first machine has finished its operation, the goods are transferred by raising the basket of goods out of the dye bath and unloading to the following machine in line for the next operation. The sequence continues on down the line until the goods have finished the final operation in the last machine. As one "dye order" passes down the line, new control parameters and setpoints are updated on each machine so that different styles of goods can be run continuously back-to-back.

The system is designed to completely automate the individual machine sequence of operation including the addition of water and chemicals, temperature control of the bath, cycle timing and the transfer goods from one machine to another. The only operator actions required are, on signal from the system, to load greige goods into the first machine and receive finished goods from the last machine as it automatically unloads.

The control system

The Select Controls "LINEMAX" solution is a real time, computer and PLC based control system designed for automatic, hands-off operation of textile bleaching and dyeing machines.

A complete bleaching line can consist of up to 5 machines. Each of these lines is controlled locally by one B&R PLC. Up of five lines are supervised by a MAESTRO industrial computer workstation. The total system size for a complete bleaching and dyeing operation can be a maximum of 25 machines, 5 PLCs, and 1 industrial computer. Communication from the industrial computer to the PLCs is via the B&R MININET local area network.



Continuous Hosiery Bleach Line



Machine Control Panel

Machine control panel

Each line of dyeing machines has one machine interface control panel to house all of the PLC (programmable logic controller) equipment and pneumatic components for automatic operation of all paddle machines in the line. The B&R MULTICONTROL PLC rack houses the PLC power supply, CPU modules and I/O modules. The I/O modules included digital inputs and outputs for sequencing, a high speed 15 channel counter input module to read signals from the chemical flow meters, an 8 channel RTD input module for temperature sensing and an 8 channel analog output module for temperature control.

Temperature Control

Most goods are sensitive to temperature changes which can cause fiber damage, thus control of the machine water/chemical solution temperature is critical. Each of the dye machines has a tank temperature control loop that is implemented in the PLC. A RTD sensor located in the dye machine tank provides the temperature input and a steam heat exchanger is used as the control output element.

The PID algorithms are performed in dedicated co-processors which function in the same rack as the main PLC CPU. This feature proved of great benefit in the Select Control system by allowing a co-processor to handle all of the PID temperature control loops and the network interfacing without affecting the fast response of the main CPU.

Chemical Metering

Chemicals such as whiteners, softeners, peroxide and bleach are added to the individual machines in amounts and times as scheduled by the supervisory computer. The scheduling is determined by the set-up recipes that have been entered by the user and the supervisory computer downloads this information to the control PLC.

Computer Master Station

The industrial computer workstation serves as both the supervisory controller and user interface to the system. This station is used for setup of the process, monitoring of all production data, alarming, recipe storage and report generation.

The workstation is made up of the panel mounted MAESTRO multitasking industrial computer, high resolution color monitor, computer keyboard and dot matrix printer. The multi-tasking operating system, OS-9, allows the MAESTRO to handling monitoring, control and interface tasks concurrently for faster system response.

Supervisory Control

The workstation computer application software allows the user to create dyeing and bleaching formulas, store them and transfer them to the separate line controllers. The software allows direct access to control individual machines in the line. The software also

provides information on machine conditions and reports of completed batches.

Menu Selections

The supervisory control menu consists of several functions that allow operators to monitor and control the complete bleaching process from the master station. Operator options include:

- line and machine overviews
- sequence schedules that are running on each machine
- sequence programming to create, edit and download recipes to a line or an individual machine
- maintenance functions to change the operating parameters of each machine
- temperature monitoring displays
- management reports

Any type of system change such as entering sequences or maintenance functions requires a user access code.

"Set-up" recipes

The supervisory control station enables the user to program a "set-up" or recipe of parameters for automatic production of dye orders through the line. Each of several lines can run different set-ups simultaneously. When a set-up is changed, new control setpoints are updated on each machine as the last dye order passes through the line, so different styles of goods may run "back-to-back".

When in operation, each machine in a line carries out its own sequence independently of the other machines in the line, except it can only transfer the goods to the next machine when the next machine is ready and its receiving door is open.

Well-managed data

The manual system used in the past provided very limited production data to supervisors. The Linemax system includes a database format for storage of chemical usages and production

efficiencies and delays. The Linemax report generator allows the user to create customized reports that give instant access to such data as line number, machine number, chemical cost, delay times, style name, set-up, date and time are included in the database.

Product quality, repeatability and efficiencies are much improved by giving this information to production control in a timely manner. Additionally, the flexible report generator allows the user to choose the specific data he needs to examine.

Line Alarms

Color coded alarms are displayed at the top of every screen for each machine in each line. All alarms are continuously updated.

USER BENEFITS

Direct benefits of the Select Controls continuous bleach line control and data management system are; operator safety, improved product quality, reduced reworks, higher production rates, reduced chemical costs and lower water consumption.

Improved quality - By precisely controlling each dyeing machine (from chemical additions to cycle times and temperature levels) the quality of the product is much improved. This precise control virtually eliminates costly reworks that are common with the manual control system.

Higher production- Because individual machine batches are coordinated to run continuously, not only are reworks greatly reduced but higher production rates are also attained. An end user of the Select Controls system has reported the ability to now process 18 runs per shift compared to 13 per shift previously - a production rate improvement of 38%.

Reduced chemical costs - Accurate metering of each chemical means the proper amounts are used with no waste and no spills occur from manual handling. Individual chemical costs are entered in the system database and can be updated whenever cost changes occur. The Linemax report generator continuously monitors the exact amounts of each chemical used and calculates the resulting costs which are then available at any time.

Lower water consumption - By controlling the amount of chemical additives to the bath, the chemical concentration can be tracked and the same water safely used for several batches. After each batch, just enough chemicals are added to return the bath to the proper concentration. This operation can be repeated up to 10 times before the machine has to be rinsed (automatically) and refilled with fresh water. This not only decreases water usage but also conserves the amount of chemicals used while still maintaining product quality.

Operator safety - An important feature of the Select Controls system is the automatic, controlled addition of chemicals to each of the machines that make up a line. In addition to providing chemical cost savings, this system function also benefits the operator by eliminating his continuous exposure to the toxic chemicals. Operators do not have to come in direct contact with the chemicals each time a new batch is started in a machine. The only interventions required of the line operators with the Linemax system are loading of new goods in the first machine and receiving the finished goods from the last machine as it automatically unloads.



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