Optimization of an Inline Oxygen Barrier Coating Process for Polyethylene Pipe

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Category
Discrete Manufacturing/Process Control

Products Used
LabVIEW 7.0
FieldPoint Thermocouple, Analog Input, and Relay Modules

The challenge
The challenge was to develop a flexible process monitoring and control system that would provide researchers the ability to understand and optimize the process of coating polyethylene pipe with an oxygen barrier coating. Data Science Automation was selected to automate the manual process that had been initially used to move the process through a proof of concept stage. The multistage process of applying and curing the coating is shown schematically in Figure 1. The process contained nineteen independent parameters that affected the quality characteristics of the coating. The ability to tailor the process and reliably reproduce the product with tight constraints would require an application that provided extensive flexibility.

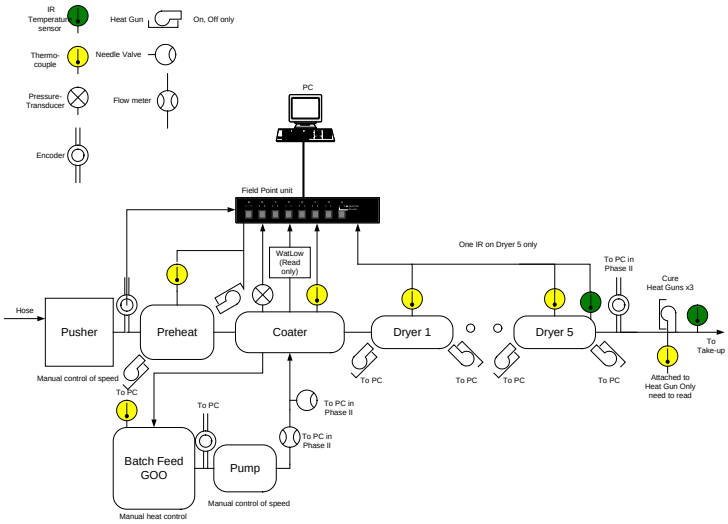

Figure 1. Coating System Schematic

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The Solution

Through months of manual operation of the coating system, a basic understanding of the dominant process variables was obtained. However it quickly became apparent to researchers that in order to optimize a process with so many independent variables, a very flexible automation system would be required. Data Science Automation was chosen to develop the application. Data Science Automation chose National Instruments FieldPoint hardware because of its modularity and the distributed nature of the process which extended over a length of nearly more than one hundred feet.

In order to provide the versatility required that would allow the researches to have an application that could be used initially to understand the details of the process then later be used to optimize and control the process under steady state operation, the application architecture needed to be uniquely designed.

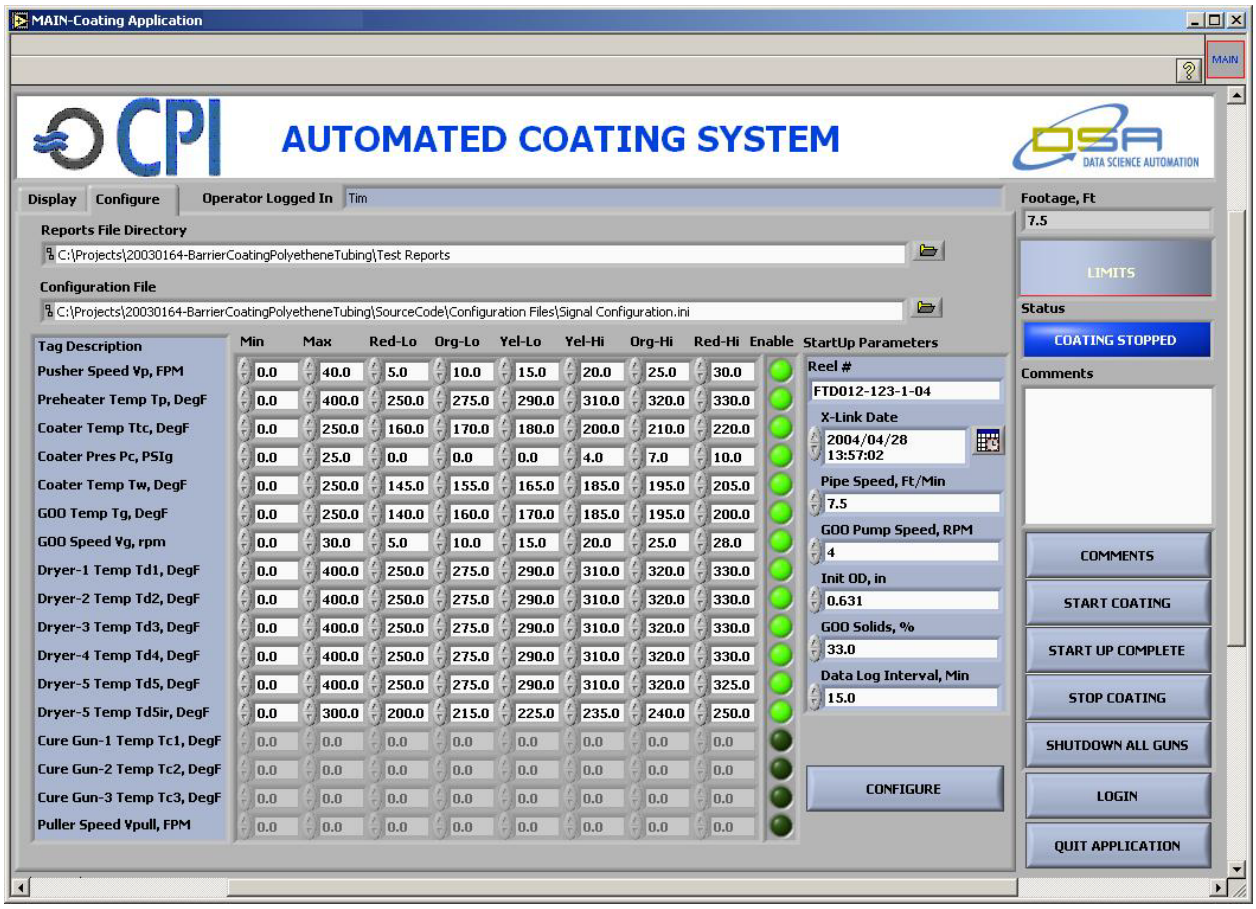

Figure 2. The Configuration Tab Allowed Setup of Process Variables and Limits

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The thirteen independently controllable process parameters were associated with four bands of color coded values. These bands and other process parameters were configured on the configuration tab shown in Figure 2. Prior to the coating station, the pipe was preheated in order to improve the coating adhesion. The researchers affectionately referred to the coating material as “Goo” because of its molasses-like consistency. Once the Goo coated the piping, an extremely sensitive five stage curing and drying process began. This was controlled by the LabVIEW application using the FieldPoint modules.

Once the process achieved steady state operation, the main display tab shown in Figure 3 was used to provide easy visual feedback of the current operating state through the color coded indicators. The process was then run for several hours while logging data in order to obtain a statistically significant sample of pipe. Later, samples taken at various intervals along the length of the pipe were analyzed to determine the properties of the coating. Based upon the results of the analyses, adjustments to the process were made and the process was repeated until the optimal conditions were achieved.

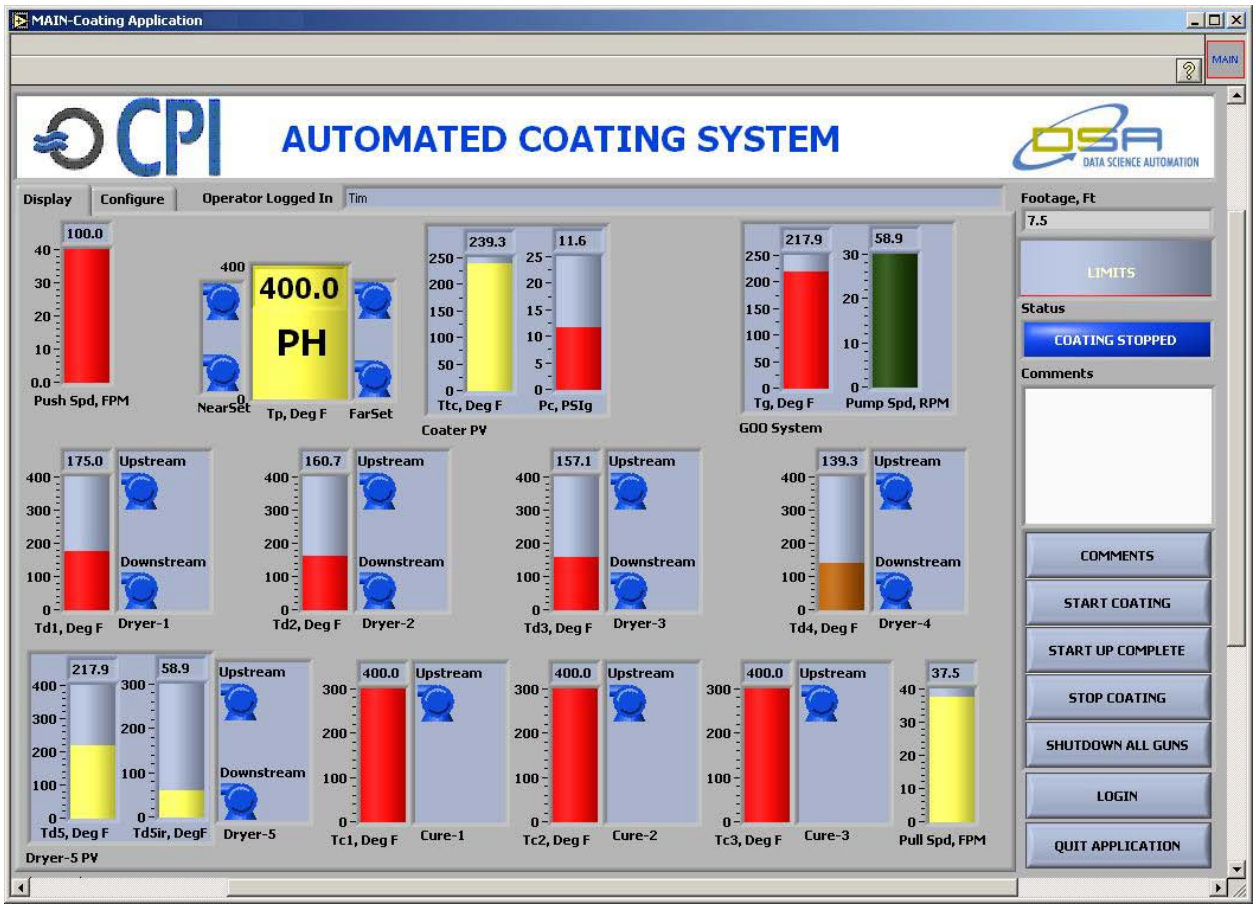

Figure 3. The Display Tab Allowed an Intuitive Overview of the System Status with Green, Yellow, Orange and Red Coding of Value Ranges

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The system will be modified to add control to its functionality in order to prevent the drifting of process parameters in order to reliably obtain the best quality product achievable. Since the application was designed with the anticipation of adding automatic control the additional development effort will not be significant.

Summary

When the leading manufacturer of coated polyethylene pipe for commercial and residential plumbing and heating applications wanted to extend its product line to include a new line of oxygen impermeable coated piping, only with LabVIEW was the team of automation engineers at Data Science Automation able to provide researchers an automated solution with the flexibility required to allow the optimization of the unique multi-stage coating process. This allowed an incredible reduction in the time to market that allowed the company to maintain their competitive edge within this fast growing industry sector.

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