Main photo: Bottles are unloaded from the machine at a rate of 11 bottles per second

In 2010, engineers at Southeastern Container (SEC), Orlando, Florida, a longtime producer of PET bottles for Coca-Cola, decided the time was right to make improvements to its Sidel blow molding machine.

While the machine performed satisfactorily mechanically, the control and automation system, installed in 1994, had run its course.

The existing S5 PLC used to automate the blow molding machine is no longer manufactured and replacements often require long lead times. The antiquated PLC made online troubleshooting very difficult for plant maintenance.

New standalone PLCs included onboard systems for air recovery, air pressure regulation, automatic lubrication, laser printing and vision inspection systems were not interlocked with the S5 PLC, making system-wide, integrated control impossible. Additionally, operators were challenged by the out-of-date operator station. The message display was failing and had burned-out LED sections. The display was controlled by digital outputs from the S5 PLC allowing only brief message texts. Reporting required a nine-pin dot matrix printer and the English text from the French machine builder was difficult to understand.

An obsolete loop controller, communicating serially to the S5 PLC, automated lamp heat control. Chances for operator error were increased during product changeovers because setup sheets were used for trimming the eight zones, and 336 on/off pushbuttons for 336 lamps.
Solvere solution

Knowing that similar blow molding machines today can cost up to $4 million, SEC looked to Solvere Systems, Belmont, N.C., to upgrade the control system and keep the existing mechanical components of the Sidel machine. The upgrade would replace the S5 PLC with a Siemens SIMATIC® S7 319 controller and other automation products. The end result would improve performance and efficiency. It would also simplify operation, improve diagnostics and data connectivity.

The challenge for Solvere was SEC couldn’t take the machine out of service for the upgrade. While Solvere provides a full-range of services from initial design consultation, to custom programming, system development, commissioning and ongoing support, upgrading a system without taking it out of service was new for the company.

Upgrading on the fly

Knowing that SEC depends on the blow molding machine to run a minimum of five days per week, Solvere devised a strategy that would allow the S5 and the new S7 controller to cohabitate without disrupting production.

The S7 controller was the logical replacement because it preserves the functionality of the original S5 PLC.

Many details of machine operation were easily converted from the S5 to the S7 platform. The new control system also includes a 15” MP 377 HMI color touch screen with recipe management and Profinet/Ethernet connectivity for the automation and data network.

The S7 controller is installed in three racks with 224 digital inputs including 32 high speed inputs requiring two interrupt input modules. The PLC also has 96 digital outputs, seven analog inputs and 10 analog outputs.

The high speed inputs are used to monitor safety I/O. If a problem occurs, the machine must stop immediately. The input modules generate a hardware interrupt in the controller that applies brakes and stops the machine in less than two mold stations, or 18 degrees of rotation.

Three-Stage Conversion

To maintain production requirements, Solvere completed the conversion in three steps:

Step 1: The plan was to install the S7 controller and debug the S7 program during planned downtime. The S5 PLC would be put back in control to accommodate production demands. Once the S7 controller upgrade was complete and tested, the S5 PLC would no longer be needed and serve only as a backup system during the conversion.

As part of the upgrade, Solvere provided a new control panel for the S7 controller that sat atop of the existing Sidel control panel. The panel was installed during weekends when the blow molding machine was scheduled for preventive maintenance.
Twenty conductor cables pre-installed on each S7 controller module were threaded down to the S5 control panel and landed on the Sidel terminal strip connecting the I/O points to both PLCs. Solvere shipped the S7 control panel to Orlando, and David Schoggins of SEC installed and wired the 224 inputs and 96 outputs to the Sidel main panel I/O terminal strip.

Switching back and forth between PLCs took only 15 minutes. The inputs stayed connected to both PLCs; only the output module terminals needed to be unplugged. It was a significant benefit to have the S7 controller connected to the inputs while the S5 was running the machine, allowing the S7 program to be debugged.

Regulated heat zone control was accomplished with a dedicated PID loop controller that communicated serially with the S5 PLC. Solvere eliminated the PID loop controller by taking the 0-20mA signal from the infrared camera into the S7 controller. Logic in the controller handled the PID loop and a temporary 10-inch MP277 touch screen was used in place of the dedicated loop controller.

The touch screen HMI displayed alarm messages and provided a way to control the oven temperature. When restored to the S5 controls, the original message display, 9-pin dot-matrix printer, and stand-alone PID loop controller were used.

There was only one difficult weekend spent debugging the program and the team very nearly completed the conversion before the scheduled maintenance time was up. The plant needed to go back into production during the week to meet Christmas demand and the team returned the following week. Step 1 of the conversion was then completed in three days.

Step 2: Four months passed before Step 2 began because once the original pilot devices (pushbuttons, panel meters and potentiometer controls) were removed, it would no longer be possible to go back to the S5 PLC. A plate was installed to cover the old pilot device mounting holes in the panel on the front of the machine.

Solvere permanently replaced all pilot devices with a 15-inch Siemens MP 377 touch screen HMI. The HMI provided detailed alarms as well as a graphical representation of the I/O devices. Each device is color-coded green or red to indicate a fault state. Trend screens display temperatures, motor amps and blow air pressures.

Step 3: Planned for late-year 2011, Step 3 will install heat controllers on Profibus under the lamps at the oven. This step will also install modern heat controls that provide individual on/off, 0-100% regulation, and lamp break detection for each of the 336 lamps in the infrared oven. Recipe screens will facilitate product changeovers.

Up and running
The controls upgrade has been operational for several months without any problems. Complementary systems for air recovery, air pressure regulation, automatic lubrication, laser printing and vision inspection can now be interlocked or even controlled entirely by the S7 PLC and HMI.

Additionally, if an adjustment is needed to improve operation, SEC now has the ability to make changes to the control system.

For example, the blow molding machine recently stopped because of a fault. The PET preforms were in danger of sticking to the stretching rods inside the molds. A simple program change was made to hold pre-blow and high-blow air pressure on for five seconds after the machine stopped fixing the issue. Problem averted.
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