Cardinal Glass Completes Cold Repair with Upgrade to Siemens PCS 7 Process Control System

A system failure at a float glass manufacturing plant can cause millions of dollars in ruined equipment, leading to lost production and sales. Approximately every 15 years these plants shut down to perform cold repairs. When Cardinal Glass Industries prepared for a 90-day planned shutdown to perform a cold repair on its Menomonie, Wisconsin, float glass plant, it wanted to make sure the control system would work dependably for the next 15 to 20 years. After considering several automation vendors, Cardinal Glass Industries chose an integrated and fully-redundant PCS 7 control system from Siemens Energy & Automation, Inc. Today, the control system reliably automates the entire "hot end" of the production process and provides the trending, diagnostics, and communications needed to keep the plant running reliably and efficiently.

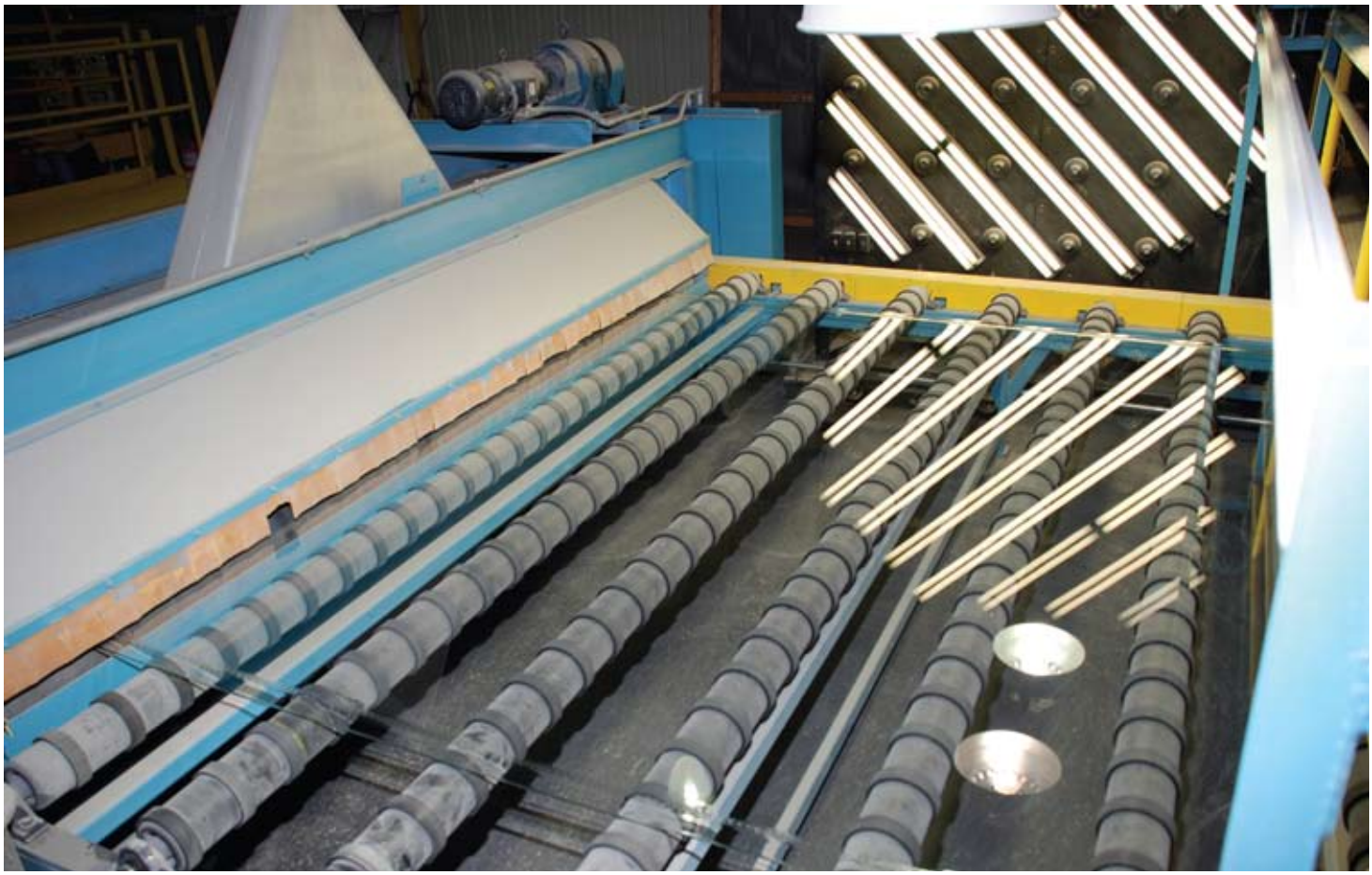
Approximately every 15 years, float glass manufacturing plants shut down. Massive furnaces operating close to 3,000 degrees Fahrenheit are allowed to cool. Cleaning, repairing, and upgrading the furnaces and production lines during this "cold repair" take on a feverish pace. Every minute spent on the planned outage affects the bottom line.

However, these costs pale when compared to the potential consequences of unplanned outages. A system failure can cause months of downtime and ruin a multi-million dollar furnace. Successful cold repairs allow the non-stop ribbon of glass to keep flowing.

When planning cold repairs, the engineers at Cardinal Glass Industries in Menomonie had much to consider. High on the priority list was the control system that is responsible for every aspect of the "hot end" of production process – from ensuring the right mixtures of raw materials in a batch to the quality of the finished product that always meets or exceeds customer specifications.

Recently, the Cardinal Glass float glass plant in Menomonie, Wisconsin, completed a cold repair within a 90-day timeframe. Mark Gehrke, Cardinal Glass electrical engineer, played a key role determining what control system modifications would be needed to take the plant through the next 15 years of supplying glass to residential window manufacturers.

While the existing system worked adequately at the Menomonie plant before the cold repair, Gehrke knew an



Glass is tested for proper thickness across its entire width. Any defects are discarded and recycled.

upgrade was in order. He needed a fully redundant control system with open communication interfaces and flexibility. He also wanted a system that would provide comprehensive and easy-to-use trending of process data for analysis. But, above all, reliability topped his selection criteria.

After evaluating options from a number of vendors, he chose an integrated automation and control system from Siemens Energy & Automation.

"The redundancy of the Siemens PCS 7 system was much better than the other systems we looked at," Gehrke says. "That was one of the main driving forces. We tested a rack of controllers from Siemens as well as the other vendors. There were fewer steps involved in implementing a Siemens redundant system. If we wanted to add I/O on the other systems we would have had to flip ones and zeros. The Siemens system was also very easy to implement."

The upgrade solution chosen for the Menomonie plant was a fully redundant Siemens SIMATIC® PCS 7 control system, operator station, engineering station, Masterdrive variable frequency drives, PROFIBUS I/O, and more than 30 SITRANS pressure and temperature transmitters. To take advantage of a digital fieldbus and to bring it all seamlessly together, Cardinal Glass replaced the electronics in its existing analog 4-20 type instruments with PROFIBUS PA communications capable modules.

"PROFIBUS helped us eliminate a lot of manual tweaking at the engineering station," Gehrke says. "Also, we chose to place a controller in each of our production areas even though we could have used just one controller for the entire operation. We chose to keep it broken up because of redundancy and the ability to isolate problems."

Gerhke says a big reason why the Menomonie plant met its 90-day schedule for the cold repair was he was able to retrofit the existing control cabinets with the new PCS 7 hardware.

"We basically gutted the cabinets and started over," Gehrke says "We saved the wire connections and put terminal blocks in the bottom. It was the only way we could have done it on time and on budget."

From Batch House to Cutting

The float glass manufacturing process begins when a precise formulation of eight raw materials are mixed in the plant's batch house. The PCS 7 system communicates to two S7 417 controllers (one each for manual operations and unloading) as well as to a S7 417 H controller for batching that ensures the correct amounts of raw materials are charged into the furnace. At the same time, cullet (recycled glass) is mixed with the other raw materials.

This batch is conveyed into the furnace by means of a batch charger. Here natural gas and air are combined in a stoichiometric mixture to create the temperatures necessary to reduce the raw materials to a liquid state. The PCS 7 system monitors and controls all furnace temperatures through the controllers and makes input changes as required. The waste gases generated during the melting process are monitored by another controller that automates an electrostatic precipitator system to reduce air emissions.

Gehrke says even small problems during this process can result in days of wasted product. Glass melting is a time-temperature process, so there can be up to three days worth of glass being melted and refined. If a slight error is made in batching, heating, or cooling, many tons of product are wasted.

"Think of the production process as a river," Gehrke says. "The flow has eddies that will bleed off into the ribbon for days or weeks or months. The control system minimizes the risk of these problems that can go on for days, weeks, or months."

As the glass enters the tin bath, or forming section, of the line, the glass temperature is approximately 2,200 degrees Fahrenheit. Once inside the tin bath, the glass floats atop molten tin where the top roll machines precisely adjust the width and thickness of the molten glass. The tweel, or refractory gate, controls the flow of the molten glass into the tin bath. Operators in the plant's control room can instantaneously adjust the flow of the glass through the tweel as needed. Resistive heating elements, hanging above the glass flowing on molten tin, heat different areas of the ribbon to ensure correct thickness and width.

The heat of the tin bath is maintained by a Thyro-P power controller that is integrated into the PCS 7 control system. Each top roll machine is controlled by a Siemens Masterdrive variable frequency drive and synchronous motors connected to the control system via PROFIBUS. The coordination between the drives, motors and control system delivers the precise adjustments to form the glass to within a 1,000th of an inch as well as maintains an internal atmosphere of nitrogen and hydrogen to prevent oxidation of the molten tin.

Cardinal Glass engineers say a big reason the Menomonie plant met its cold repair schedule was because they saved time by retrofitting the existing Bailey control cabinets with new PCS 7 hardware.

"We maintain the atmosphere in the tin bath with actuators and SITRANS pressure transmitters that are connected by PROFIBUS PA to the hazardous area controller," Gehrke says. "This patented process keeps defects out and provides a clear surface on top of the glass."

Now exiting the tin bath, lift-out rolls pull the ribbon of glass into the lehr where the glass is annealed. The lehr gradually cools the glass and is controlled by Siemens Masterdrive drives. This carefully controlled cooling process, also automated by the PCS 7 system and hazardous area controller, ensures the proper strength of the glass and the ability to cut the finished products, ranging from 1.6 to 7.0 mm thick residential windows.

Because the variable frequency drives are programmed using PROFIBUS and also communicate via PROFIBUS to the PCS 7 system, engineers can quickly replace drives and configurations as needed. Gerhke says this ability to quickly download the configuration parameters online changes reduces downtime at the plant and does not effect operation.

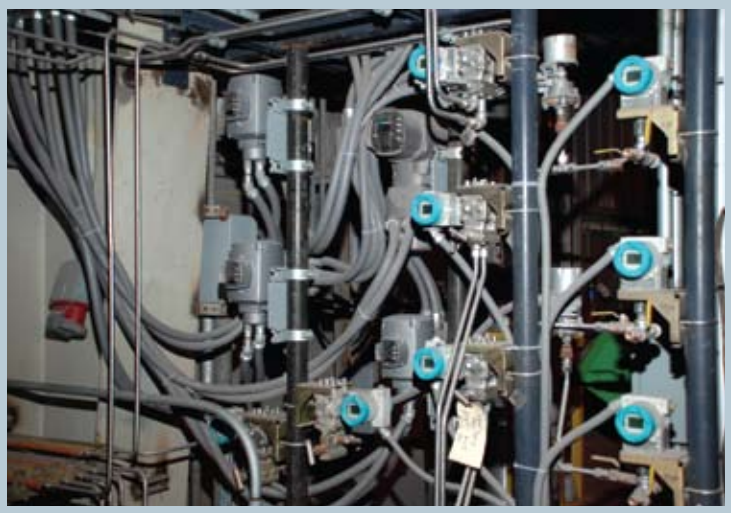
Additionally, because Cardinal Glass can now monitor the temperature and health of all its PROFIBUS PA instrumentation, downtime is further reduced.

"We get much better feedback over PROFIBUS," Gehrke says. "Operators know right away when a device is about to go bad or is overheating. Those diagnostics allows us to make adjustments before an instrument goes down."

As the glass exits the lehr it is tested for proper thickness across the entire width of glass. If any portion of the glass falls outside of specifications that portion is automatically marked and discarded to be recycled in the batch house. Additionally, a laser inspection booth positioned over the line permits an even closer analysis of 100 percent of the glass to detect defects and distortion.

Computer controlled cross cutters score the glass according to particular customer orders. The main line then snaps the glass at the scores and edges are trimmed to specifications. Trimmed glass and waste are fed back into the batch house to be used as cullet. The finished products are finally steered down individual lines where they are packed and shipped to residential window and door manufacturers.

Operators in the central control room use video to monitor a furnace that is maintained at target temperature by the PCS 7 system.



More than 30 SITRANS pressure and temperature transmitters are connected by PROFIBUS PA to the PCS 7 system.

"Throughout the entire process, operators can look at parameters that we never had access to before," Gehrke says. "Now they can reset faults themselves and analyze process data fast trends. Before, they had to call me to handle the problem."

Non-Stop Reliability

Chris Granley is engineering manager at the Menomonie plant whose primary job is to ensure everything in the plant runs non-stop until the next cold repair in 15 years. "I have been very impressed with the reliability of the Siemens PCS 7 control system. We have had no issues with the hot end control system since the switchover to the Siemens PCS 7".

The switchover over to the PCS 7 has provided him several useful tools.
He likes to use the trending, diagnostic, and alarm features of the PCS 7 to monitor system performance and diagnose any problems with the process equipment.

Conclusion

Mark Kehne, production manager at the plant, has also learned to rely on the PCS 7 system to help meet his production objectives. Referring to himself as an end user, Kehne works closely with Gehrke to improve quality and output.

"Our new process is much more streamlined than before the cold repair," Kehne says. "I use the system as a tool to help me problem solve and do root cause analyses. The PCS 7 system has removed much of the potential for error. If it sees something moving this way when it should be moving another way, it either automatically compensates for the problem or alerts the operator to the situation."

Kehne says he now achieves results faster and can fine tune the closed loops more easily. In the past, he says production adjustments were often too fast or too slow. Operators would also sometimes over compensate or under compensate parameter changes.

"Now I can give Mark Gehrke the feedback, and together we accomplish our goals with fewer iterations of revisiting the same thing as we typically experienced prior to cold repair," Kehne says. "The new control system is far superior to what we had before the cold repair."

"Reliability is the most important part of the control system," Gehrke says. "The PCS 7 system has met all of our expectations for reliability – not only by performing flawlessly, but helping the plant to quickly resolve operation problems. It is nice not getting the 1 a.m. wakeup calls about production events that our operators can now correct on their own."

Today, Gehrke says PCS 7 control system continues to reliably automate the entire hot end of the production process and provides the trending, diagnostics and communications needed to keep the plant running for the next 15 years.

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