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Honeywell Process Solutions

Automation Technology Helps Precast Producer Reduce Energy Consumption and Lower Costs

Gregg Jacobson, Gary Jacobs, Tom Holmes and Tony Bryant, Wells Concrete
Don Pankowski, Wally Metzen, Gretchen Hughes and Dave Tillges, Honeywell Process Solutions

In 1951, Guaranteed Gravel & Sand Company of Mankato, MN, purchased a small concrete drain tile and ready-mix concrete plant in Wells, a farming community in south central Minnesota. They named the company Wells Concrete Products Co. After the acquisition of a plant in Grand Forks, ND, and an expansion in Albany, MN, the unified company was rebranded as Wells Concrete.

Today, Wells Concrete provides building owners, developers and contractors with architectural and structural precast products for commercial and industrial buildings, stadiums and parking ramps. Much of its business is focused on developing customized, precast concrete panels that become the walls, roofs, and supporting structure of new buildings.

Wells Concrete currently operates precast concrete production plants at its Grand Forks, Wells and Albany sites. It has upgraded the process automation technology at these facilities in an effort to reduce energy consumption, lower operating costs, and ensure the highest quality for its precast products.

Figure 1. Wells Concrete’s precast plant in Albany, Minnesota.

Background

By producing concrete in a controlled environment (i.e., a precast plant), concrete products can be properly cured and closely monitored by operations personnel. Precast producers incorporate a combination of preparation, inspection, reinforcement, temperature gauging, and a fine balance of mixing, testing and curing to assure a quality product.

The precast production process involves pouring concrete into molds, or beds, and curing it for a certain period of time before removing the newly formed concrete structure from the bed and shipping it to the customer for installation. The size, shape and complexity of the product will determine the type of process and mold form that is required.

Figure 2. The precast concrete production process involves pouring concrete into molds, or beds, and curing it for a certain period of time.

Large precast operations have well-equipped labs and develop intricate quality procedures, testing all aspects of the concrete both before and after casting and developing extensive quality control (QC) tools. For quality assurance purposes, prior to the concrete in the bed being cured, a sample of the concrete is taken to be monitored and later stress-tested. It is critical this sample is cured at the same temperature and rate as the concrete bed for accurate results.

Today's Operational Challenges

Concrete is the most widely used material on earth after water, and similar to other global resource-intensive industries, the concrete industry is getting smarter. Producers and their business partners alike are looking to develop a more intelligent manufacturing footprint, as well as better capabilities for satisfying customer demands.

In a precast concrete plant, curing is one of the most important steps in the production operation, since it has a significant impact on concrete strength and durability. Concrete hardens as a result of hydration: the chemical reaction between cement and water. However, hydration occurs only if the concrete's temperature stays within a suitable range. Traditionally, manufacturers have used oil- or gas-fired steam boiler systems to cure precast concrete. With these systems, about a third of the energy goes up the flue. Also, energy is lost in the pipes, which run from the boiler to the bed. The hot pipes must transfer their energy to the air around the pipe. The air then transfers its energy to the steel form, which, in turn, provides energy to the concrete.

Since the curing process for concrete consumes a lot of energy, precast producers have been challenged to maintain their profitability while facing issues such as increasing utility rates, more expensive and scarce skilled labor, and rising material and equipment costs.

Process Control Requirements

At its Wells, Minnesota, manufacturing site, Wells Concrete previously utilized analog chart recorders to monitor the curing process of both precast concrete beds and sample boxes in the facility's West Plant (Architectural Building). The sample box temperature was controlled by using the actual temperature of the concrete bed as a set point. The set point was fed to a digital controller, which regulated the heat source (300-watt light bulbs) in the sample box. The concrete beds were heated by gas-fired radiant heaters, which were turned on after a pour and turned off the next day—usually a 12-14 hour run.

Figure 3. Radiant gas heaters above concrete beds.

Wells Concrete's East Plant relied upon manual valve actuation for its gas-fired steam boiler system. It employed the same basic production procedure as the Architectural Building, except steam coils were used as a heating source under the concrete beds. During the night shift, a steam boiler operator was responsible for checking the analog chart recorder to see if a bed had achieved the proper cure temperature. Based on experience and knowledge of the process, the operator also ensured the bed was not being overheated. If the temperature level was satisfactory, the operator would manually close the steam valve feeding the bed. This approach was imprecise and wasted a significant amount of energy.

Wells Concrete recognized the high natural gas consumption and costs associated with its concrete curing process. In 2007, the company turned to Honeywell Process Solutions to find a better way to control the operation of its heating systems, and thus reduce production-related energy costs. The answer was simple and the results better than expected.

Improved Automation Solution

Wells Concrete first contracted Honeywell to implement a new, automated process control solution in the Architectural Building at its Wells facility. This project included installation of Honeywell's XYR 5000 wireless temperature transmitters and a HC900 controller to monitor and control the temperature of eight concrete beds in the building, as well as the sample boxes associated with each of the forms. Specview software provided the necessary supervisory control and data acquisition (SCADA) capability.

Figure 4. Sample box temperature is controlled based on associated bed temperature.

The Honeywell XYR 5000 temperature transmitters eliminated the need for long thermocouple wiring runs around the concrete beds, cut down on the number of I/O modules required with wired transmitters, and simplified the overall control system design. The wireless transmitters reliably and securely transmit up to 2,000 feet on a 3-5 year battery life with an accuracy of ±0.1 percent.

Honeywell's HC900 controller is a cost-effective automation platform for equipment and small to medium processes. It is a hybrid controller combining loop and logic control for unit process applications requiring analog measurements with discrete actions. The controller's redundancy capability is ideal for applications where maximum process uptime is needed. The redundant platform provides redundant CPUs, power supplies and network communications for additional process security.

Figure 5. Honeywell's HC900 is a hybrid controller combining loop and logic control for unit process applications requiring analog measurements with discrete actions.

With the new control system, the bed temperature is monitored and sent from the wireless transmitter to a base unit, which is hardwired to the HC900 controller. This temperature reading is used to control the sample box as it was before. However, the current temperature also controls the operation of the radiant heater. When the concrete has reached the desired curing temperature, the heater shuts off automatically and the concrete will hold enough heat to continue the curing process. When the concrete temperature goes below the desired curing temperature, the heater is once again turned on.

Wells Concrete subsequently partnered with Honeywell to apply the same process automation solution in the East Plant of the Wells facility. In phase two of the project, the company wanted to expand its control capabilities for 13 radiant steam beds. Wireless transmitters would still monitor bed temperatures with sample boxes controlled by applying a heat source, but now steam valves in the field would also be controlled using wireless technology. A wireless gateway takes an on/off signal from the HC900 controller and sends it out to the various I/O units. The output request activates a relay, which is hardwired to each steam valve's motor actuator. Operators also have the convenience of being able to preset when they want the curing system activated and deactivated days ahead, within a seven-day period.

Additionally, project engineers implemented new programming allowing beds in the East Plant to be interchanged, as needed, with different sample boxes.

Figure 6. Wireless 4-20 mA control signal sent to steam valve.

The control system in the East Plant went on-line in August 2009. HC900 controllers replaced analog chart recorders and controllers and were commissioned on all beds and sample boxes. The beds were brought on-line gradually as production needs increased. Features built in to the control system for special circumstances eventually became part of the normal production process.

Most recently, Wells Concrete installed a Honeywell control system at its Albany precast concrete production facility. This project once again required wireless transmitters for automatic steam valve actuation and indirect radiant heat control, as well as the radiant heaters hung from the ceiling of the plant for architectural casting applications.

A Kraft steam generator is used in the curing process, which had the potential to create too much heat and destroy the product. Plant operators needed a reliable safety shutdown capability that would automatically turn off the steam generator should the steam temperature exceed acceptable levels. For this reason, the steam generator was direct wired to the HC900 hybrid controller. The steam generator's safety interlocks are monitored from the Experion system; if the steam generator trips off line, a process alarm is generated, notifying plant operations of the cause.

In phase three, Wells Concrete chose to employ Honeywell's Experion Vista software platform for SCADA purposes. Aligned with the HC900 controller, this software delivers a comprehensive system infrastructure that includes alarm and event management, built-in system displays, system trends, configurable reports, and history collection.

Wells Concrete will utilize Honeywell's Experion HS system for all future control system upgrades at its precast plants. Experion HS is a state-of-the-art software platform incorporating applications for both human-machine interface (HMI) and SCADA. It is specifically designed to provide an integrated and affordable solution for smaller unit operations such as those found in the concrete industry.

Impressive Project Results

At the Wells, Minnesota facility, the operational benefits of enhanced process automation technology were seen in only a few weeks. The control system in the Architectural Building went on-line in January 2007, and by March of that year, the local natural gas provider wanted to check the accuracy of its gas meters as the facility's gas usage had dropped dramatically. Where plant operators previously ran gas heaters for up to 15 hours per concrete bed, they now apply heat to the beds for an average of only 3 hours. The new control solution quickly paid for itself by enabling 60-70 percent savings in energy costs.

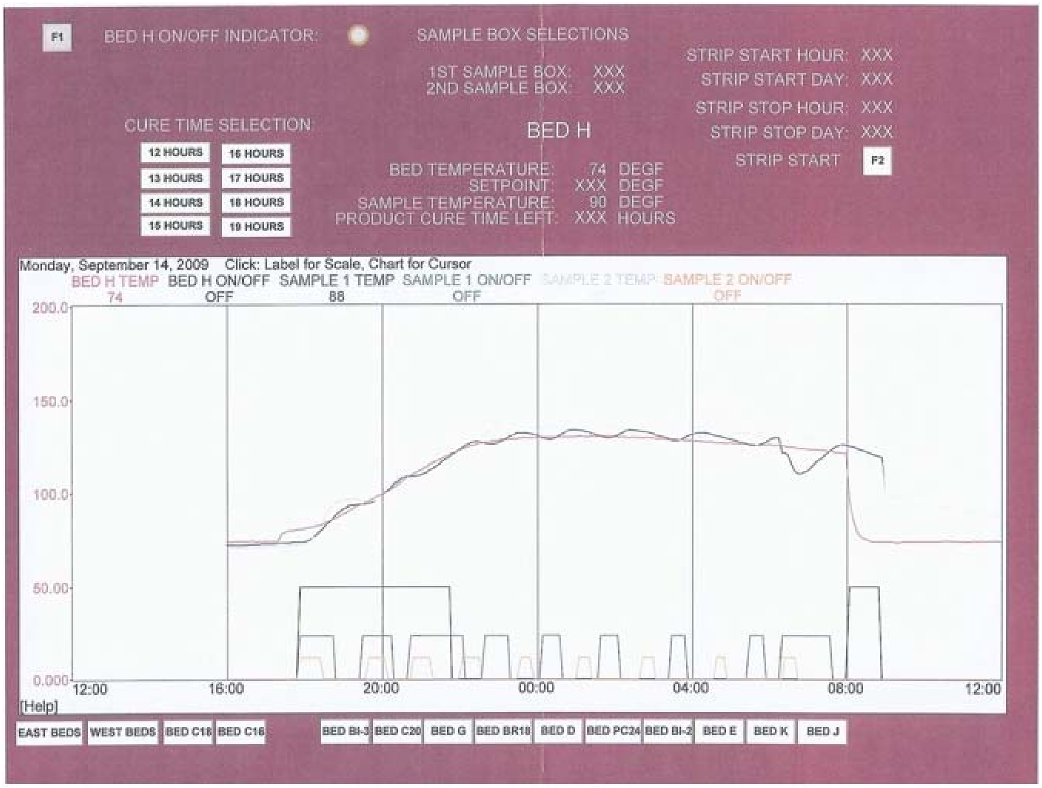

Figure 7. Wells Concrete has benefited from significant reductions in energy usage at its production plants.

After only a month of service with the upgraded control system in the East Plant, Wells Concrete saw a 75 percent reduction in steam usage and a decrease in labor hours required for production personnel to monitor the bed operation at night.

In addition to efficient energy usage, operators at the Albany facility have the necessary automation technology to maintain consistent quality of architectural concrete products—regardless of ambient temperature, humidity and other environmental conditions within the plant.

Going forward, the implementation of advanced process control technology creates opportunities for additional automation such as environmental controls, which can be used to generate reports demonstrating compliance with U.S. Environmental Protection Agency (EPA) guidelines. Detailed process history information can also be used to document temperatures of cured concrete as required by state regulations.

Conclusion

Wells Concrete is looking to the future with a secure migration path for the Honeywell process control technology at its precast production facilities. Implementation of the advanced Experion control system platform across all plant operations will help unify people with process variables, business requirements and asset management. Experion integrates advanced applications that work together across an entire facility to increase productivity and decrease operational costs.