SIEMENS

Case Study

How sweet it is:

Automation system upgrade boosts sugar production, profits, for Midwest farmers coop

Siemens state-of-the-art drives solution on a redundant regenerative common DC bus reduces process cycle time while improving reliability, efficiency, and performance.

From the moment it comes out of the ground, the sugar beet begins to deteriorate. Time is of the essence as it journeys from field to table, and its transformation from fleshy tuber to refined sugar is characterized by efficiency and speed. So when aging equipment caused a critical operation at one Midwest beet processor to falter, the facility faced the need to upgrade quickly ... and found the solution it sought in Siemens Drives and Automation Technology with Customer Support from Siemens and their local partner, Malloy Electric.

Sugar beets have been grown in the upper Midwest for more than a century, with tons of the sweet conical roots processed each year. In the early 1970s, to ensure optimum handling of this valuable crop, which typically contains 14-20% sugar, farmers in the area formed the Minn-Dak (Minnesota-Dakota) Farmers Cooperative. Today, shareholders deliver their harvest to a centrally located plant in Wahpeton, ND in the heart of the Red River Valley, where from August to May, beets are turned into sugar in a continuous batch process.

The facility relies on six gigantic centrifuges to spin juice from processed beets and separate usable sugar crystals from the remaining material. The instrumental procedure depends on a drives control system configured on a common DC bus, but existing equipment was becoming a maintenance headache with an escalating total cost of ownership. As a result, Minn-Dak chose to invest in a new, more reliable solution: productized drives from Siemens SINAMICS S120-CM (cabinet module) family, pre-engineered to system requirements and developed into modules for easy insertion into the operation. In addition, Malloy Electric incorporated automation components, HMIs and PLCs also from Siemens, to better control and measure the process and make it easier for operators to monitor.

The impact of reliability

The 300-hp centrifuges operate in a common DC bus arrangement in three-minute-long cycles. During each cycle, about 2,000 lbs. of massecuite (juice and sugar crystals) produces approximately 800 lbs of sugar. Each drive motor controls a centrifuge as it moves through its paces, accelerating, processing, and then decelerating.

"Significant amounts of energy moves between each motor during the 3-minute cycle," observed Dave Kirkpatrick, Drives Engineer, who coordinated Siemens role in the undertaking. "By configuring the system on a common bus, energy from one motor can shift to another more efficiently, minimizing the internal losses that result from pushing power back to the grid one minute and demanding power the next. The acceleration process creates a large but temporary horsepower requirement. When the cycle is complete and the centrifuge is emptied, the sugar drops from the unit at a relatively low speed. Then the cycle begins again."

Reliability was key to the project. "If the centrifuges don't run, we don't produce," said Merlyn Mindeman, I & E Supervisor at Minn-Dak. "First, we considered a single drive per centrifuge solution from another vendor, thinking it would be more reliable. But then we talked to Siemens and they proposed a common bus solution—the same kind of approach we had been using with the older equipment and the one I prefer—with full front-end redundancy, two back-ups actually. If one system fails, the operation switches to the other and we keep operating. And the common bus is more energy efficient, allowing us to put back on the line any power that needs to be dissipated. Our distributor, Malloy Electric, had worked with Siemens in the past and suggested this system, which seemed to do what we needed for less money."

"I knew the previous system had used a common DC bus and that Minn-Dak liked that approach," added Bob Jacobson, General Manager at Malloy, a leading system integrator in the electrical and power transmission industry. "So I suggested they use the SINAMICS solution, knowing the equipment would provide the redundancy the facility needed on the front end and give a level of reliability that would make everyone comfortable."

The SINAMICS, high-performance product line was familiar, and one Malloy had used before. "It seemed like just the right thing for this process," added Greg Parham, VP of Technologies and Services at Malloy Electric and Jacobson's associate. "From our perspective the entire integration went well. We learned some things initially, and then further refined the system down the line to make it ready for Minn-Dak's 2012-2013 campaign."

Incorporating redundancy, efficiency

Because redundancy was so essential, a robust front end was developed. A failure costs Minn-Dak in the neighborhood of $5,000 for every hour the process is down. "They can't afford to have the system shut down," said Kirkpatrick. "If it does, the centrifuges must be cleaned out—a very messy situation—and the entire system restarted. So we selected a redundant active line module that connects to the grid and provides a DC voltage to supply to the rest of the system. If the grid changes, if the power supply sags or droops, the active line module compensates and keeps the system operating. It also operates at unity power factor, improving the overall effectiveness of the equipment."

The active line module was sized so a single front end would be large enough to supply all the power requirements to run all six centrifuges. "Because some units were accelerating and some decelerating, the power system needed only to supply the difference in consumption," explained Kirkpatrick. "Six times 300 hp was not necessary because of the circulating current on the common bus. Supplying one item on the front end reduced the number of components in parallel and the likelihood of failure, thereby increasing reliability. Because the front end is fully redundant, if it were to fail, the system would automatically transfer to a second system and keep the centrifuges operating."

The redundant front end carried the added benefit of increased efficiency. "If you use one drive per centrifuge, extra energy is potentially discarded," noted Parham. "With a common DC bus such as this one, Minn-Dak is essentially running six centrifuges for the cost of running two."

In this case, Minn-Dak's local provider is able to offer them an attractive electricity rate so that power efficiency concerns are not an overriding concern. However, in areas not fortunate enough to have low energy rates, being able to reduce the power bill in this relatively simple way can offer an important advantage.

Creating a window to the process

Incorporating Siemens' PLCs and HMIs into the system gave Minn-Dak personnel the added advantage of a clearer window into the process. With the programming support of Steve Ericksen, president and CEO of Neskcire, a Nebraska-based systems design and development company, Siemens and Malloy were able to interface the HMIs and PLCs with the drives.

"We wanted to give the operators the ability to monitor the drives from within the centrifuge processing area, or from any of several other locations elsewhere in the plant," said Ericksen. "The HMIs and PLCs gave personnel a way to ensure the centrifuges were filling correctly and operating properly. If a problem occurs, an alarm sounds and a signal alerts the right people. Although the plant control system manages the cycling of the centrifuges themselves, the HMIs and PLCs add a reliability/troubleshooting interface that allows any developing problems to be uncovered and resolved quickly."

The automation equipment included modular Siemens SIMATIC S7-1200 controllers, and expandable 1212C CPU starter kit with 14 integrated inputs/outputs, suited for the simple but highly precise automation tasks the Minn-Dak operation performs. The compact devices feature a scalable and flexible design, a communication interface to meet the highest industrial communication standards, and a full range of powerful integrated technology functions for unprecedented efficiency. The controllers interface with Siemens SIMATIC TP1200 HMI comfort panels to provide high-end performance in applications where high resolution is needed. The starter kit used includes the device, configuration software, Ethernet cable, and memory card to perform sophisticated HMI tasks in the system's PROFIBUS/PROFINET environment.

A performance that 'beets' all

The new system went on line in late spring 2012 prior to the onset of Minn-Dak's heaviest production period. "When we first commissioned the system, it really wasn't under true load conditions," said Kirkpatrick. "We did a lot of pre-testing in late spring and early summer to make sure we were ready when the harvest came in."

The upgraded solution unquestionably performs better than the previous installation. The more tightly controlled speed regulators on the drives achieve faster rates of acceleration and deceleration, cutting cycle time and allowing each batch to be processed faster, thereby boosting production and efficiency.

"We've set 11 production records this year," observed Mindeman. "If we're lucky, we typically hit one a year. So apparently the new system is doing well. We measure performance by daily sugar production. At one point, we went over the 34,000 hundred weight per day mark and then broke the record ten more times after that. So it seems like this is a reliable system. We've had no major issues and we're satisfied with it. That's why on some of the smaller projects we have coming up, we're looking at using Siemens equipment again. It's doing its job."

For more information on Siemens products and systems, including the drives, PLCs, and HMI panels discussed in this article, visit the Siemens Industry website at *www.usa.siemens.com*.

For more information on SINAMICS visit the website at www.usa.siemens.com/sinamics

For more on the Minn-Dak Farmers Cooperative, visit the website at *www.mdf.coop*.

For more about Malloy Electric, visit the company website at *www.malloyelectric.com*.

For more about Neskcire Systems LLC, visit the company website at *www.neskcire.com*.

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