INTELLIGENT PUMP CONTROL

REDUCES ENERGY CONSUMPTION BY 80%

CHALLENGE

Significantly reduce energy costs, convert the entire cooling system within one week, flexible pump speed with constant discharge pressure to all consumers, elimination of valves, no change to cooling reliability at full load even if one pump fails.

SOLUTION

Use frequency converters to control the pumps for precise adaptation of capacities to current need for coolant, optimization of impellers in the centrifugal pumps.

RESULTS

Energy savings of more than 80%, several thousand euros saved after just one month. Savings in operation of the cooling tower, efficiency of all pumps increased to 85.3%.

German company ICL-IP Bitterfeld GmbH has been producing phosphorus-based flame retardant since 1997. Their plant in Bitterfeld-Wolfen currently employs about 80 people. Many of the steps in the production process, from the phosphorus and chlorine starting materials to the final products (phosphate ester), involve exothermic reactions Much of the released heat is led away in water-cooled heat exchangers. A centralized cooling tower runs almost continuously, or about 8250 hours per year, in order to provide the required cooling water. Water temperature varies seasonally from 19 to 25°C and has a flow rate of up to 1100 m^3/h, resulting in a cooling capacity of up to 6 MW. In 2011, plant managers analyzed the processes in the cooling tower. They discovered that the three cooling water pumps, running in parallel, ran continuously against throttle flaps, even under partial-load conditions and reduced thermal loads in the plant, resulting in an unfavorable hydraulic operating point and poor efficiency. Thermal utilization of the cooling tower normally fluctuates between 50 and 100 percent, due to seasonal factors and varying usage by individual consumers during normal operations. Average utilization is about 70 percent.

The three Allweiler® cooling water pumps of the NT series. Capacity of 360 m^3/h, max. delivery head 52 m.

The main cooling tower. The fourth pump at the far right is a reserve pump and is not automatically included in control.

COLFAX Fluid Handling

Automatic control ensures constant pressure, regardless of the current need for cooling.

ENERGY EFFICIENCY A CORE CONCERN

A 2014 company-wide program to improve energy efficiency systematically sought out additional weak points in how energy is used. When it came to the cooling water pumps, new motors and speed control with frequency converters produced significant savings. With this as a foundation, Production Manager Dr. Jürgen K. Seifert developed a technical concept for controlling the three pumps in a way that adapts to the various processes' continually changing needs for cooling water and eliminates the energy-inefficient method of using throttle flaps. Before implementation, multiple simulations indicated a high potential for savings with a projected ROI of two years. The pump control, designed and supplied by Allweiler GmbH (a Colfax Fluid Handling Group company), is central to the new concept. The system utilizes three frequency converters and includes cascade functionality. The 75 kW IE 4 + synchronous reluctance motors achieve efficiency of 96%, a major improvement over previous motors (built in 1996) with about 90% to 92% efficiency. They even run very efficiently under partial load. As a result, procurement costs are amortized in two to three years. Past experience in a previous round of optimizations showed that significant savings could be achieved by converting control over the cooling tower fans to frequency converters, providing yet another reason to be confident in using them with pumps.

FREQUENCY CONVERTERS REPLACE MANUAL INTERVENTION

In the past, the pumps were run at a constant 1450 l/min. The pumps were "regulated" with throttle flaps located directly at the pump outlet on the discharge side. This was necessary in order to bring the pumps into the performance curve range where the drive motors were not overloaded (counter-pressure at the consumer side is only about 3.5 bar at full hydraulic load). In general, this type of control destroys energy, but it is usually unavoidable in situations like this, where there is a fixed-speed pump and a system with low counterpressure.

Using the throttle flaps, pressure was held at a constant 4.8 bar at the pump outlet, regardless of the actual need for coolant. This achieved a constant power consumption at the motors of 68 to 75 kW, at which time each pump was expected to stabilize near its rated capacity of 360 m^3/h.

As an initial energy-saving measure after the analysis, one or two pumps were switched off during partial-load operations, e.g. when consumers (heat exchangers) are turned off. But this approach is difficult because the remaining pumps must be monitored continuously to make sure they do not become overloaded. If loads suddenly change, engineers must be prepared to undertake rapid manual interventions.

Frequency converters solve this problem by replacing manual, inconsistent "on/off control" with a continuous, intelligent adaptation of pump speeds to the actual need for cooling water. As a result, manual interventions are no longer needed. The pumps are synchronized and run continuously in their optimal range, and pump discharge pressure remains constant. The cascade feature automatically switches pumps on and off as requirements change on the consumer side.


One frequency converter controls the speed of each of the three cooling water pumps.

Dr. Jürgen K. Seifert: "The power consumption of the motors indicates that the pumps are saving a great deal of energy."

Even without frequency converters, the greater efficiency of the new motors alone would pay for themselves within three years.

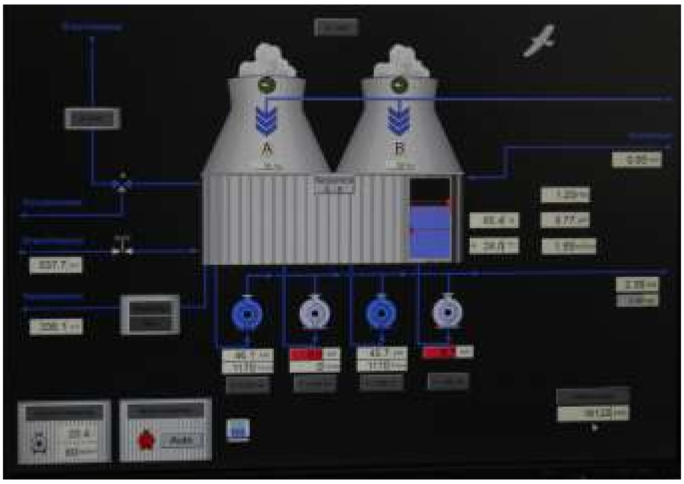
SMOOTH SWITCH

Practical execution of the upgrade was completed in close contact with the supplier of the pumps. Allweiler GmbH has long developed intelligent controllers for cooling water pumps in systems where the need for cooling water frequently changes, whether due to fluctuating temperature of the cooling water (e.g. the difference between summer and winter) or because of varying loads imposed by the process. Due to its experience, the manufacturer was able to very quickly provide a suitable solution for the plant. According to Dr. Seifert: "Only rarely have I experienced such a smooth project execution. They immediately understood our concept and executed it with precision." It was essential to stay within the one-week production downtime for upgrade and restarting, because most customers are on just-in-time delivery schedules. Not only the upgrade was completed within this brief time window, but also general reconditioning of the three Allweiler® NT series water pumps. The manufacturer even recalculated the impellers and replaced them with the maximum size impellers. Thanks to the optimized impellers, which are driven at the optimal speed, the pumps now achieve an excellent efficiency of 85.3%.

Start-up also went smoothly. "The start-up process also proceeded to our full satisfaction. Allweiler® kept all of its promises, both from time and financial perspectives," says Dr. Seifert. After just one month, power costs for the cooling tower were several thousand euros lower. Because of this success, the customer has short-term plans to convert other pumps with dynamic requirements to this control concept.

POTENTIAL FOR SAVINGS UNDERESTIMATED

In many cases, energy consumption in such systems plays only a secondary role and is often neglected. Even at the Bitterfeld plant, energy costs make up a comparatively small proportion of overall production costs. But the new controller actually reduced power requirements for cooling by 50 to 60%, or about 1000 MWh yearly. In other words, the investment paid for itself within one year, faster than predicted by the simulations. Even when all three pumps are running under full load, energy requirements drop from 75 kW to 37 kW per pump. In consideration of the lower energy consumption of the entire plant, the energy required to run the cooling tower now accounts for a much smaller proportion of the total. All of the money that is saved flows directly into operating results.



The output and speed of all pumps is displayed on the control panel. In this case, only pumps 1 and 3 are in operation.

The Bitterfeld plant shows just how much potential for savings can be found in industrial systems utilizing oversized pumps that were dimensioned and installed years ago with excess reserves. As prices for frequency converters drop and become more accessible, the use of intelligent controllers makes more sense even for higher output systems. The question "How reliable are the electronics and what happens if a frequency converter fails?" is less of an issue. First of all, the technology is mature. Secondly, thanks to optimized control, two of the three pumps at the Bitterfeld plant can cover a large portion of the needs if one of the frequency converters would actually fail.

EXPECTATIONS EXCEEDED

Successful deployment of such a solution requires knowledge of fluid technology, of the pumps themselves, and of intelligent controllers. For its customer Bitterfeld, Colfax Fluid Handling was able to build on proven solutions and deliver the optimal solution. This was possible only because the manufacturer provides all of the components, which are optimized for installation together. According to Dr. Seifert: "For us, Colfax's impressive consulting services and documented expertise with everything related to the pumps, motors, and frequency converter technology were decisive for awarding them the contract. After several trouble-free months of operation, we can say that our expectations for efficiency improvements have actually been exceeded."

One of the large consumers. The numerous heat exchangers are at various locations in the plant and are connected to the main cooling tower with lines of different lengths. This places elevated demands on the intelligence of the pump controller. A specific minimum preliminary pressure must be ensured even at the most distant cooler, and in every operating state.