

Control system modernization at Constance Water Works

Pioneering open control architecture ensures water supply security

The building is venerable, the technology is new. At Constance Water Works located in Constance, Germany, outdated automation technology was recently replaced with Beckhoff control components. The new, fully automatic control offers a wealth of added value beyond the system's core functionality. One of them is operator comfort, with energy efficiency thrown in as a considerable bonus.



Constance Water Works was upgraded with PC-based Control technology from Beckhoff. This results in higher operator comfort and improved security of supply.

The AEG control system from Stadtwerke Konstanz had been operating since 1989 and was showing its age. For some time it had become apparent that the spare parts supply for the system could no longer be guaranteed in the long run. A project to implement a new system was initiated, with the aim of controlling and monitoring all the equipment at the water works. Fully automatic operation was a must, and security of supply had to be maintained at the present level as a minimum, if not improved. Business unit manager Wolfgang Fettke and his technology team headed by Wolfgang Treib from Constance Water Works sought a state-of-the-art solution. "Our decision in favor of the Beckhoff system clearly gave us added value," said Wolfgang Treib. The user-friendly monitoring and documentation of the production data, which the new control delivered, wasn't one of our main objectives initially. What was important to those responsible for the project was openness of the system. Cegelec, the contractor, was given the following instructions: no manufacturer-specific dependencies for the selection of hardware and for the communication protocols.

Meticulous water treatment

The water works supplies a population of 87,000 in Constance and the surrounding area. It could deliver up to 50,000 m³ of drinking water per day. The current delivery volume is 14,000 m³ per day on average. The trend is falling because, like the rest of the population, the inhabitants of Constance use drinking water with increasing efficiency. The water is extracted from a depth of 40 m, below the thermocline or metalimnion. At this depth the water is very

clean and protected from surface contamination. The Constance Water Works supplies three zones with different elevations, which are operated at different pressure levels.

Raw water is extracted from Lake Constance via a 700 m long pipeline and initially, in the first step of the water treatment, fed through micro-strainers with a mesh width of 23 µm. In a second step the water is disinfected with ozone, which is generated from ambient air directly at the water works. The third and last step is a sand filter, which in 2005 was upgraded to a multi-layer filter. Small quantities of iron (III) chloride are added to improve the filtration results, although the water from Lake Constance is of such high quality that the dosage can be 200 times lower than usual.

Modular Bus Terminals replace expensive I/O cards

It would have been relatively simple and cost-effective to replace only the plant "intelligence." This was indeed the initial intention. A conversion would have been non-critical, and reusing the old CPUs would have been simple. "However, since we wanted a trend setting solution, everything pointed to an open system architecture, which we found in the open and modular Bus Terminal technology," said Wolfgang Treib, commenting on the specification requirements. "We regarded and still regard this as the most economical solution." Wolfgang Treib can substantiate this based on practical experience: "The cost of an I/O card 20 years ago today buys us several Industrial PCs, including Bus Terminals today." Keeping a few Bus Terminals in stock for MRO doesn't tie up too much capital.



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One of the key requirements for the new automation system was to avoid proprietary components and serial bus protocols. "The primary goal for the type and structure of the new control system was to improve plant availability. The decision to use the Industrial PC (IPC) system gave us much more freedom in the design of the applications, and the current structure has also made interfacing to subsystems much simpler," said Wolfgang Fettke. "The decision to use the Beckhoff system has led to significant benefits because sensitive, demand-based control comes with detailed information from many different points within the plant. These data are provided by a wide range of sensors. In addition, measuring systems that provide an IP-capable protocol, such as Modbus TCP, can be integrated easily."

Control retrofit completed during operation

The new control system based on Beckhoff components was configured and linked to the two IPCs in parallel with the existing process. One of these IIPCs operates as a master, the other is available as "cold standby." Both are equipped with a dedicated switch for process connections.

"Critical system functions run on Embedded PCs," said Wolfgang Treib. If necessary, these system components can be operated autonomously, in order to ensure system availability. Modbus TCP is used for integrating the operating panels with the control system.

The conversion took place while the plant was in operation. The task was facilitated by the system architecture: Constance Water Works has three distinct

sections, referred to as "supply channels." Each section from one step can operate with a section from the next step, for example, microfilter 1 with ozonation 2. This variability must be mapped in the control system. One of the three "channels" at a time was converted to Beckhoff technology, while the other two "channels" ensured the supply.

A total of six Panel PCs are used for functions that require local control. The operators of Constance Water Works wanted the operation to be "as simple as possible." Via the touch screen Panel PCs the process can be controlled, and actual and set values can be checked. Wolfgang Treib is sure that the operating personnel will quickly get used to the new technology: "We have an HMI that enables world-class local control that is convenient for the user."

Signal communication with the master control system of the municipal services takes place via the IEC 60870-5-104 telecontrol protocol. Information from around 1,600 data points is transmitted in this way. During the change-over the respective station addresses were changed one by one, and the corresponding parameters set. According to Wolfgang Treib, adapting these data to the Beckhoff system wasn't a problem. "It was a diligent but routine piece of work."

Integrated system maximizes flexibility

Conversion of a sensor structure that has evolved over decades, such as in a water works, could turn out to be "interesting" to say the least. "The sensors have essentially remained unchanged," said Wolfgang Treib. The different signals, whether they are 0...10 V, 4...20 mA or digital outputs, are now all "wired" in a consistent manner. Bus Couplers were installed wherever critical process data are generated for the water works operation. Because of the flexibility of Beckhoff Bus Terminal technology, the system has become truly integrated. Since the type of input signals is essentially irrelevant from the perspective of the Bus Terminals, most signals required no modification. "Only in a few instances was it necessary to install buffer amplifiers or duplicate measuring signals," said Dieter Völkle, sales representative at the Beckhoff office in Balingen, Germany. "This was more for redundancy reasons rather than the actual function." Extensions could be easily implemented, if necessary. The open system could accommodate additional bus devices at virtually any point.

According to Wolfgang Treib, the PC-based Control system has a further benefit: "On-call staff no longer have to be on-site, e.g. during weekends, but can conveniently log into the control system via a PC and check the status of the plant. If, for example, a microfilter fails, the system would issue a signal. The duty officer can check remotely whether one of the two other microfilters has taken over. If this is the case, attendance at the water works is not required. The current system reduced the number of on-call deployments – a side effect which we didn't plan for, but it is very welcome."

The operators of Constance Water Works also expect the new control system to result in improved energy efficiency. "With a consumption of more than 2 million kWh per year, a reduction of just one percent would be a nice, additional benefit," said Wolfgang Fettke.

Further Information:

Stadtwerke Konstanz www.stadtwerke.konstanz.de

Cegelec Deutschland GmbH www.cegelec.com