Every day it flows out of our taps – drinking water. It is the No.1 foodstuff and more vital to us and our survival than anything else. Therefore the reliable supply of large cities and areas with high population densities presents a special challenge to the surrounding waterworks.

In Düsseldorf, the wells of the three waterworks of the Düsseldorf municipal works process the filtrate of the river Rhine as the first step of the ‘Multi-barrier-principle’. The water is treated according to the ‘Düsseldorf Method’, a process developed by the Düsseldorf waterworks.

Secondly, the water is treated with ozone while flowing through a contact container, which has a strong oxidizing effect. At the same time, flavors and odors that might impair the quality of the drinking water are decomposed.

In a third step, the ozonized water is stored for about 30 minutes in an intermediate storage container to allow for any remaining substances to be degraded.

Next and last comes the filtering. The water is pumped into a steel container that is filled with two different filter layers. The top layer removes oxidation products from the water and organic substances are microbiologically decomposed.

The second filter layer consists of activated carbon granules which absorb flavors and odors and any other unwanted substances. Finally, small quantities of a phosphate silicate mixture is added to the water to prevent the pipes from corroding.

Minimal quantities of chlorine dioxide are also added to protect the water from contamination with germs as it is transported through the water supply system.

The extraction, processing and distribution of drinking water is constantly monitored by the employees of the quality control department according to the current drinking water ordinance.

The water is supplied to private households and industrial enterprises via a pipe-system extending over more than 1,700 km.

Two elevated tank systems with a volume of approx. 125,000 m³ and a number of pressure increase and reduction units guarantee optimal supply of customers with drinking water.
Automation Requirements

Up until the 1970s, the daily business of supplying water was defined by extending water procurement, treatment and distribution systems, as forecasts indicated steadily increasing demand. However, in the 1980s, the water consumption first remained constant, before decreasing in the 1990s to less than 100 m³ per inhabitant, per year. The strategy of the Stadtwerke Düsseldorf to fight increasing costs was the early introduction of automation in the areas of water extraction and treatment. Therefore the equipment and process stages were automated by means of programmable logic controllers (PLC) back in the 1990s already. However, there was neither synchronization and coordination between the different systems, nor an upper level data collection or archive.

A suitable Control-/SCADA System had to meet the following requirements:
• Open and hardware-independent system;
• Separate levels and functions of control systems and control technology;
• Central data archiving and backup, plus simple administration of the database;
• Flexible visualization of the systems;
• Import and export of data for SQL database via MS Excel;
• Networking of control rooms in order to monitor and operate other waterworks from a central location;
• Connection with telephone system for messaging.

Since the water supply of the Stadtwerke Düsseldorf depends on its local facilities, availability is always the prime concern when it comes to renewing or modernizing systems. In that respect, well-trained operating personnel and state-of-the-art control technology are the decisive influencing factors governing the availability of the systems. Monitoring, controlling and continuous optimization of the systems are the main tasks of automation technology at these facilities, including pumping stations for the extraction of water, filter systems and water chemistry for water treatment in addition to pumping stations and storage facilities for water distribution.

Implementation

The planning, design, supervision and administration of control system was carried out by the works’ own personnel. There is a clear process defined for the integration of new systems, which begins with the compilation of all messages and commands of the system in the form of an Excel assignment table. This provides a complete overview beginning with the entry-point address, data item assignment, chemical/physical quantities up to the item name, and constitutes the basis for generating CSV files.

Prior to the introduction of the SCADA system, a standardized control hierarchy and thus a joint operation concept was developed to control and monitor the entire water supply of the Stadtwerke Düsseldorf. During the implementation phase, all the control systems were tested at field level, replaced if necessary, and subsequently networked.

In setting up the SCADA system, the control rooms of the waterworks were adjusted to the changed requirements of both the personnel and the new technology to permit

![Overview of the supply area](image1)

![Filter room at the ‘Am Staad’ waterworks](image2)

![Control room at the ‘Am Staad’ waterworks](image3)
fully automatic operation with as little effort as possible. This was done gradually, beginning with the ‘Flehe’ waterworks, followed by ‘Am Staaß’ waterworks and finally the largest waterworks in Düsseldorf, ‘Holthausen’. This process was carried out without interrupting operation.

The elevated tank systems and pumping stations located in the city’s area were connected to the new control system via state-of-the-art redundantly designed technology. In addition to the operation and monitoring level, the central process data acquisition and evaluation is a fundamental component of the new control system, as is the documentation of operation and data evaluation.

The first implementation step for the new control system was completed in 2000. Further expansion, particularly the conversion of the ‘Am Staaß’ and ‘Holthausen’ waterworks, followed at the end of 2003 and 2006, respectively. As an experienced Wonderware system partner, the company wpe - wolfgang h. paul elektrotechnik GmbH in Lünen was assigned with the supply and initial configuration of the control system, the connection of the field bus level and the monitoring of the communication between field and control level. One of the objectives was that modifications to the control system could be made by employees of the Stadtwerke Düsseldorf themselves. Along with the automation, standardized systems were installed at all waterworks as well as at remote stations.

Control Systems

To control the systems of the individual upstream and downstream process steps, systems of the type Simatic S5 (95U; 115U) and S7 (300; 400) in addition to Matic control systems from Auma are used. The coordination of the control systems and contact to the higher-level control system is effected in a separate PLC (‘Central Services’). At field level, the control systems are connected via profibuses on a point-to-point basis. The upper-level control systems of the process stages and the connection to the SCADA system were realized via Industrial Ethernet (H1) in a ring topology. The remote stations are connected via permanent modem connections and, for added security, parallel via dial-up modems, directly to the SCADA system of the Flehe waterworks.

SCADA Systems

The goal was to separate the functional units and to establish redundancy to minimize the effects on the overall system in the event of system malfunction. Therefore the control systems at the three waterworks are set up similar to each other and interconnected. One workstation is used for operating and monitoring the systems. There InTouch is used as a visual display system in a multi-monitor environment as well as monitor connection.

The collection of process data runs on a separate database server with Wonderware’s Historian (previously known as IndustrialSQL Server) being used as a database. The evaluation of the data is carried out on a separate workstation, where ActiveFactory software with FactoryWorkbook is used for direct data evaluation in Excel, while the ActiveFactory Trend and ActiveFactory Query clients are used for data analysis.

The reporting system provided in this setup, includes an operation-log for data analysis and optimization (trend evaluation), hourly and daily evaluation of the production data (water quantities, electrical power, water quality) and reports on the internal cost allocation to Düsseldorf municipal works. Furthermore, documentation is available on the adherence to water rules and regulations, as well as documentation pertaining to the compliance with drinking water limit values.

Also, the preparation and editing of reports, analyses and documentation is performed exclusively by employees of the waterworks. For transmitting process messages
generated by the control system to the handsets of the telephone system, the RPM kit from Wonderware is used, which is installed on a separate computer. It forwards process messages to the telephone systems and makes them readable handheld devices.

Since the three waterworks are connected with each other, it is also possible for process data to be transmitted to each of the other works if necessary. Using Wonderware FactoryFocus, the management of the Operations department as well as laboratory staff are able to gain an overview over the current operating status and to run analyses and evaluations with FactoryWorkbook.

**Summary**

The central archiving and backing up of the data, plus the rapid evaluation of the historical data made it possible to fully meet all set targets associated with the introduction of the new control system:

- Fully automatic operation;
- Flexible reporting;
- Reduction of the operating costs;
- Increasing plant safety;
- Increasing plant availability;
- Optimization of maintenance;
- Quick and easy analysis and optimization of the processes;
- Simple administration.

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