Application story
Water supply

Markets served
Machine building

Energy savings of 15 %

Aquatech helps its customers reduce their energy consumption by intelligently combining motors and frequency converters.

When the pump system of a waterworks had to be replaced, Aquatech, an Eaton Solution Partner, developed a new drive concept in cooperation with the operator. The new concept has reduced the operating and maintenance costs, so that the investment in the upgrade will quickly pay for itself.

Location:
Mittelneufnach near Augsburg, Germany

Challenge:
Reducing the high energy and maintenance costs for the pumping station of a local water utility (Zweckverband Stauden-Wasserversorgung)

Solution:
Eaton Controlling IE4 motors with PowerXL DG variable frequency drives

Results:
Lowering the energy costs of the water utility by about 15 %

"All in all, the combination of IE4 motors with DG1 drives enabled us to reduce the water utility's energy costs by about 15 percent. At an average of 5,000 operating hours per year for each drive, this translates into major savings."

Markus Huber,
Aquatech Project Manager

The clean-water pumps in the waterworks of the local utility previously consumed up to 2.5 million kilowatt hours of energy per year. By replacing the conventional drive technology with IE4 motors, which are controlled using DG1 variable frequency drives, it was possible to significantly increase the energy efficiency of the application, reduce wear on the non-return valves, and avoid the need for gate valves during start-up and shutdown.

Challenge:

High energy and maintenance costs

Previously, the pumping station of the water utility consumed between 2 million and 2.5 million kilowatt hours of energy in order to supply 37,000 people with around 2.4 million cubic meters of clean drinking water each year. This represented an enormous cost factor for the water utility. Most of the electricity was required to drive the three clean-water pumps, which pump the treated water into the mains while also filling up three water towers.

Using gate valves wastes a lot of energy

By today's standards, the energy consumption was very high, as a result of the outdated drive technology, which was of a type that is still used in many waterworks today. Conventional electric motors with a capacity of 55 kilowatts each were used to drive the pumps, while the motors were switched using motor starters. The delivery rate of the system was then gradually increased by switching on the three pumps one after the other. In order to avoid pressure surges during the start-up phase, a gate valve was used to regulate the flow rate: During start-up, the gate valve, which controlled the flow to the water supply system, initially remained closed. It only opened slowly once the pump had reached its full capacity, so that the pressure in the water supply system increased only gradually. However, this meant that the pump worked "against" the closed gate valve during start-up, so that the energy supplied

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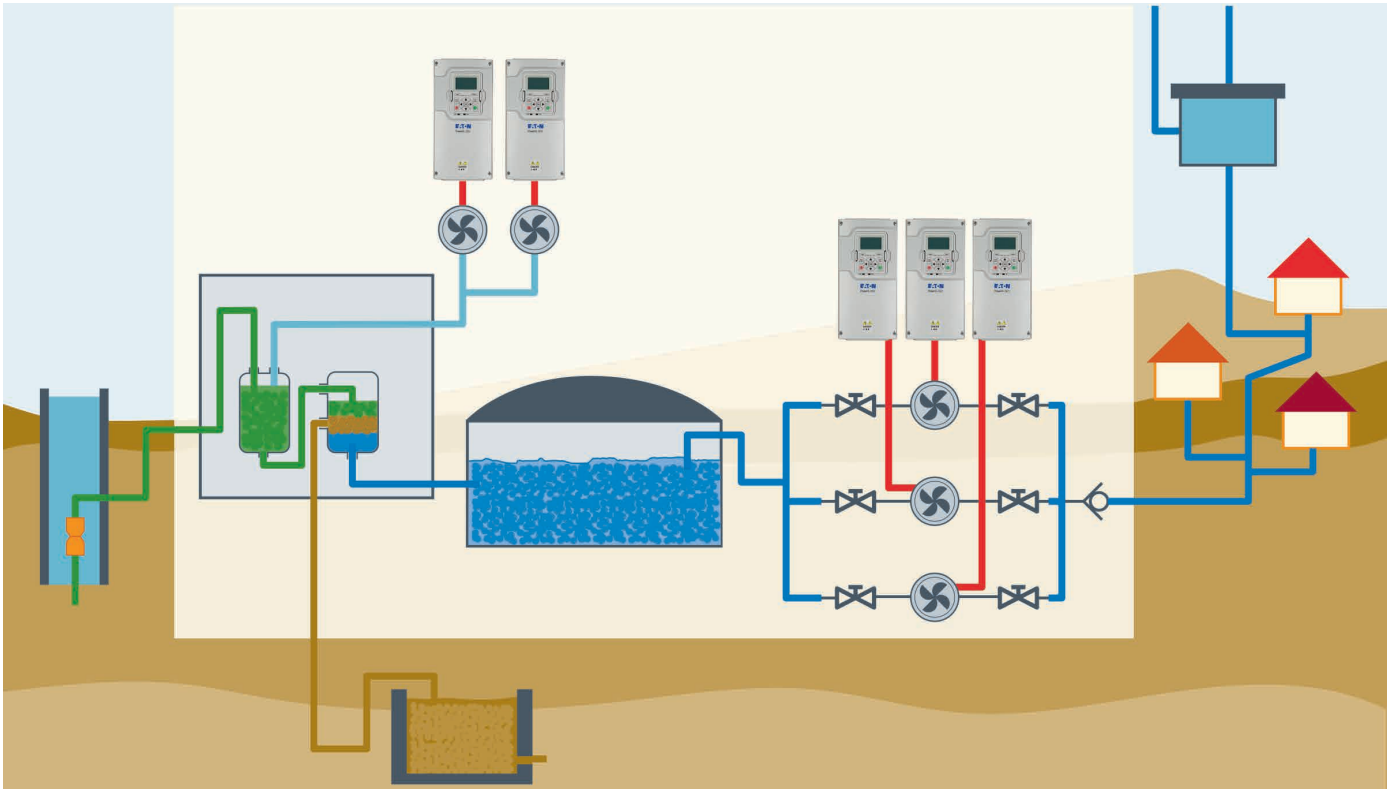

Fig. 1: The diagram illustrates the process of providing potable water, starting with the extraction from a deep well, through the treatment of the water and its supply to consumers via water towers in the catchment area.

by the motor could not actually be used to pump water. From a performance point of view, this drive technology was particularly inefficient because the pumps could not operate at their optimum operating point, i.e. in the most energy-efficient manner, because the speed of the pumps could not be changed – the pumps either did not run at all or ran at full power. If no water was needed, a non-return valve prevented the water from being pushed back from the supply system. During shutdown of the pumps, the gate valves were used to reduce the backflow. Nevertheless, each shutdown resulted in increased wear on the non-return-valve.

In 2018, the water utility therefore decided to carry out a comprehensive upgrade of the pumping station, with the aim of reducing the overall life-cycle costs. Improving the energy efficiency of the system was the main priority. The contract was awarded to Aquatech AG, based in Regen, Germany. The company specializes in electrical, drive and automation technology, with a focus on water supply systems, wastewater disposal and renewable energies. It is also Eaton's Solution Partner for drive technology in Southeast Germany.

Solution:

IE4 motors in combination with variable frequency drives

As a first step, the Aquatech experts replaced the conventional electric motors with IE4 motors, which are particularly energy-efficient. Aquatech also implemented a motor-speed control system that ensures smooth start-up and shutdown and prevents the pumps from working against the valves, which wastes a lot of energy. The motor starters were thus replaced with PowerXL DG1 variable frequency drives from Eaton. Since Aquatech has been working with Eaton for approximately 30 years, it was familiar with all the advantages of the DG1.

The PowerXL drives have been designed for motor control up to the highest efficiency class IE4. Thanks to a unique energy optimization process, driving motors with the DG1 also consumes between 2 percent and 10 percent less energy compared to conventional frequency inverters. Aquatech chose the DG1 because it offered an all-inclusive package: The rugged and easy-to-operate drives come with internal EMC filters (category C2) for connection to the public grid, and while the standard version is suitable for virtually all applications, a version with IP54 protection is also available. This enabled Aquatech to place the drives directly in the pump room – without the need for any control cabinet. As such, the drives do not require any separate cooling system, which saves additional energy.

Built-in communication interfaces

"In addition, commissioning the devices was very simple," as Aquatech's Markus Huber emphasizes. For many applications, installers can commission the DG1 right out of the box, without the need for any time-consuming configuration on site. The user-friendly navigation menu on the five-line LCD display, as well as the self-explanatory type codes and the limited number of standard parameters (18) considerably simplify the commissioning process. In addition, the DG1 drives include a number of communication protocols as standard, meaning they can be directly networked without any additional hardware. "Thanks to the integrated Ethernet IP interface, we have direct access to the individual drives that we installed at Staudenwasser," says Huber. "This makes it easy to implement remote maintenance and thus to increase the availability of the system." The pumping station is controlled and monitored using a PLC and a process control system to which the drives connect via Modbus TCP. All drive parameters can thus also be monitored via the control system.

Result:

Smooth start-up without gate valves

The combination of DG1 drives with IE4 motors allows for speed-controlled operation: During start-up, the pumping capacity increases only gradually, thereby avoiding the voltage peaks and pressure surges that often plagued the old system. In fact, this has enabled the waterworks to eliminate the gate valves entirely. With the new system, sudden pressure changes in the water mains are also a thing of the past – thanks to the variable frequency drives, which gradually reduce the power output of the pumps. As a result, the non-return valves now close in a much more "gentle" manner, which translates into less wear on the equipment.

Working at the optimum operating point

What contributed most to reducing the overall operating costs, however, is the fact that the new system allows the pumps to run at their optimum operating point of 42 Hertz to 53 Hertz. The process control system calculates the quantity of water required

for filling the water towers and uses this information to determine the required number of pumps, taking into account the flow rate at their optimum operating point – which translates into significant energy savings compared to the old system.

What's more, the water treatment process is now also more energy-efficient: The well water is aerated using two rotary vane compressors – the added oxygen then binds the iron and manganese particles dissolved in the water, causing them to form flakes that can be filtered out. Aquatech replaced the conventional 5.5 kilowatt compressor drives that were previously used for this purpose with IE4 motors, which are controlled using DG1 drives. With this solution, Aquatech has implemented a system that optimally coordinates the entire delivery process, from the well through treatment all the way to the water towers.

The customer's verdict:

"All in all, the combination of IE4 motors with DG1 drives enabled us to reduce the water utility's energy costs by about 15 percent. At an average of 5,000 operating hours per year for each drive, this translates into major savings," says Markus Huber.

Fig. 3: The application is now speed-controlled, thanks to the combination of IE4 motors and DG1 drives. The power losses associated with the old gate-valve system have thus been eliminated.

Fig. 2: The new IE4 motors are significantly more energy-efficient than standard I2 motors. The use of DG1 variable frequency drives further improves the energy balance of the system.

Fig. 4: The DG1 drives are also used to aerate the well water.

Background: Zweckverband Stauden-Wasserversorgung

The Zweckverband Stauden-Wasserversorgung supplies around 2.4 million cubic meters of naturally pure drinking water each year. The utility's waterworks are located in Mittelneufnach, in the "Naturpark Augsburg – Westliche Wälder" (Augsburg Western Woods Nature Park), an area of outstanding natural beauty that's also known as the "Stauden". The utility supplies water to approximately 37,000 people across 21 municipalities. Three water towers with a total capacity of 6,500 m³ are required to cover the fluctuating demand, with consumption peaks that are at times extremely high. The water is supplied to households via an extensive system of pipes, with a total length of around 570 kilometers.

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