A Secure Supply of Clean Water for the City of Gothenburg

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Above: The water treatment plant at Alelyckan, Gothenburg has together with the Lackarebäck plant a combined production capacity of 280,000 m^3/day.

Below: Operators in the control room at Alelyckan can monitor the water cleaning and distribution processes with the help of Advant Station 500 Operator Stations.

Gothenburg, situated on Sweden's west coast, is the country's second largest city with a population of about 450,000. Göteborgs VA-verk (Gothenburg Water and Sewage Works), a public-service water management company, is responsible for the city's water supply and the transport of sewage. It also supplies water to neighbouring local authorities. The annual consumption of water amounts (1993) to 44 million m^3, with households accounting for 31 million m^3.

Two water treatment plants, one at Alelyckan and the other at Lackarebäck, cater for Gothenburg's main water supply. With a combined production capacity of 280,000 m^3/day they annually feed 62 million m^3 of clean water into the water supply network.

Water supply system

The first public water supply in Gothenburg was established as far back as 1787, with the water being obtained from a local spring and distributed through wooden logs to a number of hydrants. Towards the end of the 19th century the water supply system was expanded with raw water being taken from the River Göta. An infiltration water treatment plant was built at Alelyckan in 1894. Today's Alelyckan plant with chemical treatment was inaugurated in 1949 and its capacity was further increased in 1958. To meet the continued growth in demand, Göteborgs GA-verk built a new water treatment plant at Lackarebäck (completed in 1968) and new reservoirs.

Gothenburg's water supply system today consequently comprises two water treatment

plants, which receive raw water from River Göta and the Delsjö Lakes through a system of tunnels. The Delsjö Lakes serve as raw-water reservoirs for the Lackarebäck plant. If it is necessary to shut down for any reason the supply of raw water from the Lärjeholm intake on the River Göta to the Alelyckan plant, raw water can instead be pumped to this plant from the Delsjö Lakes.

Clean water is distributed through 1,661 km of pipes with 52 pumping stations. There are also 18 reservoirs with a total volume of 62,000 m^3 in different parts of the city. The water supply system is supervised round the clock from the main control room in the Alelyckan plant. The Lackarebäck plant as well as a number of pumping stations are operated and supervised locally from control rooms manned during the daytime.

Water treatment process

Basically the same process is used for treating the water at both Alelyckan and Lackarebäck: chemical precipitation, sedimentation, filtration and adsorption using activated carbon. In the water treatment plant the raw water is first chlorinated when necessary, and metered before passing to a deposition basin, where lime is added. Aluminium sulphate is then added to bring about precipitation of particles. These form flocs, which entrap the substances causing turbidity and colour in the water. Because the flocs are heavier than water, they settle on the bottom of the following sedimentation basin. However, all the flocs are not sufficiently heavy to settle in this way. They are separated in rapid filters, where the water passes through a 1-metre-thick layer of activated carbon.

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The carbon used in the filters is reactivated after about four years in a special plant, which is also controlled by Advant OCS.

Before being pumped to the reservoirs, the purified water is treated with lime to achieve a pH-value of about 8 and disinfected with chlorine/chlorine dioxide to lessen the risk of microbiological regrowth in the water supply network.

New open control system

Göteborgs VA-verk installed its first computerized control system, based on the ABB Master concept, in 1985 at Alelyckan. In 1986 the control system was expanded with new computer memory capacity and the addition of further subsidiary control points.

In 1993 Göteborgs VA-verk decided to invest in a new control system to provide better expansion possibilities and, above all, to meet future integration needs. ABB received an order in January 1994 for the supply of the control system based on the Advant OCS. ABB's deliveries included 25 Advant Controllers 55, seven Advant Controllers 110, two Advant Controllers 450, two Advant Station 520i Operator Stations, three Advant Station 515 Operator Stations, one Advant Station 515 Information Management Station (IMS), one Advant Station 100 Engineering Station (ES) and a MasterBus 300 control network. All this equipment entered into operation at the end of 1995.

All the I/O cards from the old control system were retained along with the programs for the plant equipment in the central system at Alelyckan and the MasterPiece units in use. The programs were transferred to the Advant Controllers 55, 110 and 450.

System configuration

The two Advant Controllers 450 constitute the heart of the OCS. One is installed at Alelyckan and the other at Lackarebäck. Their task is to perform the logic and supervision using central I/O in the two plants. Further, they initiate the backwashing of the active filters and the batching of chemicals, and are responsible for the automatic pump

control. In addition, they communicate with the Operator Station and distributed controller units in each plant and in the city.

The Advant Controllers 55 replace existing MasterPiece 100 units and serve ten new distributed controller units in the city's water network. They perform all the necessary logic, regulatory control and measurements. Communications between these controllers and the central Advant Controller 450 take place using the RCOM protocol with dial-up modems (ten controller units) and with a multi-drop mode on public telephone lines for the remaining units. Should any interruption occur in the communications, the Advant Controller 55 itself carries out the control on its own and collects the appropriate data.

The Advant Controllers 110 are used for the slightly larger distributed controller units like those for the Lärjeholm raw-water intake on the River Göta, the raw-water pumping station, the underground pumping station, the pumping station at Härlandatjärn, the underground wastewater treatment plant and the carbon reactivation plant. The same communication system is used here as for the Advant Controller 55.

There are altogether five Operator Stations (OS), with two Advant Station 520i OS in the Alelyckan control room and three Advant Station 515 OS serving Lackarebäck, the Ringön maintenance department and the carbon reactivation plant.

The OS act as the window for the operators out to the processes in the various plants. All operations and supervision take place here. They also generate trend curves and reports.

The Advant Station 515 IMS stores historical data from trend curves, alarms and reports. It also serves as an open platform, allowing other systems to exchange information with the complete supervisory system using the SQL protocol. Furthermore, the IMS includes communication links to the special systems connected to the TCP/IP LAN:

- River monitoring system
- GS Alfa alarm system (based on local radio)

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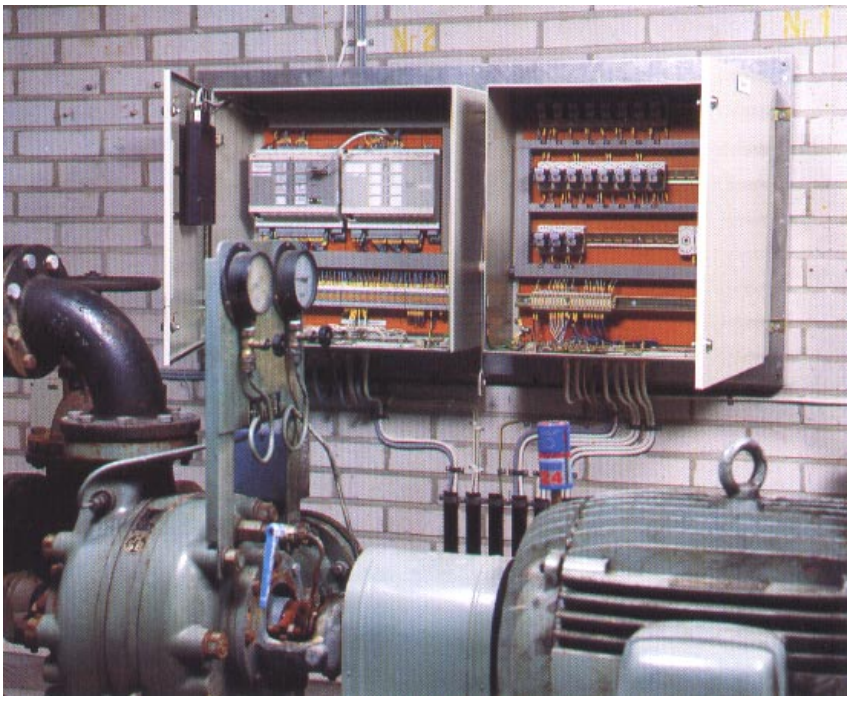

Advant Controller 55 performs all the necessary logic, regulatory control and measurements in the city's water network.

- PC system for speech emulation, Ringön maintenance department

The Advant Station 100 ES, a portable PC-compatible unit, can be connected up at a station to gain access to all units connected to the MasterBus 300. It is used as an on-line tool for program editing. The spare parts forming complete systems are used for system testing and in-house training.

Communications

The ABB MasterBus 300 is used for high-speed communications between the Advant Controller 450, the Advant Station 500 OS and the Advant Station 500 IMS. A variant of this bus permitting transmission over a public telephone line (64 kbit) is used for communications with the Advant Station 500 OS in Lackarebäck and Ringön. The RCOM protocol is used for the communications to/from the AC 55, AC 110 and AC 450 in the distributed controller units. Finally, the TCP/IP protocol is used for communications with other computers on Ethernet.

Special functions

Automatic backwashing of active filters. After 48 hours of operation, the filters require backwashing to remove the flocs. On the basis of the water's turbidity and bacteria content as well as of the filter resistance, backwashing is initiated by the AC with time limits for the backwashing intervals.

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The quality of the water in the River Göta is monitored both at the Lärjeholm intake and at seven measuring stations upstream.

Comprehensive monitoring and optimization of the backwashing intervals for the different filters according to the queue principle are included.

Carbon reactivation. The backwashing does not remove all the organic substances from the carbon. After about four years of use, the carbon has to be removed from the filters for reactivation in a special furnace. The carbon can then be used again. An Advant Controller 110 controls the carbon reactivation plant. It is unusual to find such a plant in a water treatment process, but it nevertheless makes an important contribution to the ecological handling of carbon, because it reactivates carbon utilized in both the two water treatment plants and other external plants for drinking water.

Water leakage. Göteborgs VA-verk introduced at an early date a system for detecting water leaks and eliminating them. A calculation model for leakage measurements has been incorporated in the Advant OCS. This is used to help minimize such leakages and to secure the supply of water to consumers.

Operating plans for high-level zones. Pressure control of the pumps is employed to ensure the efficient distribution of water and has replaced elevated storage tanks. However, for safety reasons it is not possible to replace all such tanks and reservoirs. The water distribution can nevertheless be made more efficient by pumping water up to levels corresponding to a probable consumption curve per day. These operating plans and curves are incorporated in the Advant OCS.

Monitoring of river water. The quality of the water in the River Göta is monitored at both the Lärjeholm intake and at seven measuring stations spread out upstream over a distance of about 80 km, with the values being transmitted by radio. The IMS in the control room of the Alelyckan plant receives the data. Here, the values are displayed and recorded, constituting a basis for the closing of the Lärjeholm intake in the event of an excessive pollution level and for tracing the source of the pollution.

pH control and batching of chemicals. The acidity of the water is controlled by adding chemicals, which imposes special demands on the control system. The Advant Controllers with self-tuning adaptive PID controllers are ideally suited for this application.

Alarm system. The Advant OCS has a special alarm system for transmitting alarms in the control rooms. Alarms can also be received and acknowledged on pagers.

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