Better Drinking Water

Turnkey solution of a modern waterworks through successful cross-border cooperation

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The town of Jimbolia, with a population of just under 13,000, lies in the western part of Romania. The town's water supply consists of a functioning distribution network into which untreated well water is pumped via a temporary storage tank according to need.

The deep waters typical for the region are low-oxygen (reduced) waters having an increased content of primarily ammonia, iron and manganese and in some cases arsenic and with increased clouding. The existing wells are poorly sealed and in need of renovation. The regular occurrence of coliform germs is more the rule than the exception. In addition, loading with TOC/DOC and hydrogen sulphide also proved to be unexpectedly high. This had not been indicated by the analysis values used as the basis for the design.

An oxidation stage with ozone for oxidation and disinfection with a subsequent biological filtration stage was defined for the treatment process based on these water parameters. This process had also proven itself in a comparable smaller waterworks in the village of Bobda, which also belongs to the district of Timisoara. Disinfection at the end of the plant is carried out with chlorine – in accordance with the legal requirements in Romania.

Basic conditions for project development

With deadline specifications for financing, the project had to be completed and the plant had to be in operation by the end of July 2010 at the latest in order to secure the EU grant of an amount of Euro 1,000,000. Due to these specifications the operator (Aquatim) responsible for the region and the municipality decided in favour of the plans of the Romanian engineering office Aqua Plan West, which designated the building of an industrial building with an office complex for the administration and an attached plant building for the hydrotechnics system (**fig. 1**).

Fig. 1. Office complex with attached building for hydrotechnics system. © Hydro-Elektrik GmbH

The hydrotechnics system was in turn mainly divided into two stainless-steel raw water tanks with a capacity of 100 m^3 each, a three-line filter system with a treatment capacity of up to 65 m^3/h each and two stainless-steel pure water tanks with a capacity of 570 m^3 each.

This design made it possible to achieve rapid completion of the construction phase with top quality at comparatively low costs. With conventional concrete tank systems it would not have been possible to realise this project in this quality ▶▶

Fig. 2. Compact drinking water plants. © Hydro-Elektrik GmbH

Fig. 3. Tank system with pressure booster system for pure water supply. © Hydro-Elektrik GmbH

and especially not with such a short building period.

The order in the amount of approximately € 2,100,000 for the turn-key production of the entire plant went to the Romanian company HES from Timisoara together with the company Hydro-Elektrik GmbH in Ravensburg, Germany, as a sub-contractor. Here Hydro-Elektrik GmbH together with HES was responsible for the project planning of the plant and for the delivery of all hydraulic and electrical components.

The tight time schedule required excellent coordination and scheduling reliability of all partners and parallel production of the technical components at the manufacturing plant in Germany.

The start of planning and construction was in October 2009. Due to the frost to be expected, the concrete floor plate had to be poured and brought in a loadable condition for the installation of the tanks and the building shell had to be built before Christmas of 2009. Despite the occasionally inclement weather, these goals were achieved. At the same time, the filter tanks and the raw water tanks were produced at the manufacturing plant in Germany. Despite the fact that winter had meanwhile come with snow, it was possible to transport and install the two raw water tanks and the three filter tanks in the production building on schedule in the week before Christmas of 2009. The conclusion of this work was the preassembly of the supporting floor structure for the pure water tanks. It was therefore still possible to close off and dry the production building inside in time before Christmas. The lean-mixed concrete for the supporting structure of the pure-water tank bases were installed in mid-January. This enabled the pure water tanks with a capacity of 570 m^3 and a diameter of 10 m each to be welded in on site with a special process from the end of February.

Raw water system

The raw water from the various wells is routed to the new waterworks via a collecting pipe. Following measurement with MID, the water is routed in the raw water tanks with a special Venturi nozzle system for two stage aeration. The outgassing of hydrogen sulphide occurs also in these tanks. The tanks also enable additional ventilation for oxygen enrichment and for outgassing of hydrogen sulphide.

Ozone bio-filtration stage

Under the influence of ozone as a strong oxidation agent the organic carbon compounds with a high molecular weight are split and the concentrations of the compounds with a low molecular weight are increased. This conversion of the DOC into assimilable substances also explains why an ozoning stage always has to be followed by a biologically optimised reactor or filter. This is normally a filter stage with downstream flow, specifically constructed as a bioreactor in which the mineralisation or reduction of the amount of nutrients takes place in a completely natural way. The zone with the highest level of biological activity is in the upper filter bed. End products include water and carbon dioxide.

Ozonation

Generally, both the DOC and the colour have to be taken into account when determining the required ozone dose. Depending on the DOC/colour ratio, ozone doses between 0.8 and 2.5 mg O_3/mg DOC are required. It is obvious that at such high doses excellent and fine-bubbled mixing-in of the ozone followed by blending is extremely important. Venturi/injector combinations have proven especially successful, through which the entire water flow is treated with a highly-concentrated ozone/air mixture. The reaction with slow-reacting water constituents takes place in the downstream reaction tank. The substances providing colouration have already mostly been destroyed with ozone shortly after the initial reaction. Iron, manganese and arsenic are oxidised, as well as any hydrogen sulphide still present. The disinfection, in which viruses, parasites and germs are reliably killed due to the high concentration time (CT) values, occurs parallel to the oxidation. Due to the long holding time in the reaction tanks and the high ozone doses a generously dimensioned ozone biofiltration system – despite its high ozone consumption – is also always a reliable barrier in accordance with the multi-barrier principle.

Oxygen production

Technically produced oxygen is used for ozone production. So-called PSA (Pressure Swing Adsorption) systems are suitable for decentralised oxygen production. They increase the oxygen content up to a purity value of up to 95 % by filtering out nitrogen. In the first step, the air has to be compressed, dried and filtered. The air compressed to 7.5 bars is fine-filtered and fed to the oxygen generators. The oxygen generators consist of two tanks filled with so-called molecular sieves. When pressurised, these molecular sieves absorb atmospheric nitrogen. This results in an increase in the oxygen concentration outside the sieve. During the first pressure relief oxygen escapes which is specifically routed into the oxygen tank. With a complete drop in pressure, the nitrogen also escapes from the molecular sieve again.

Filter design

The filter in the ozone biofiltration system must fulfil several tasks. Besides breaking down residual ozone in water – a prerequisite for biological activity – and holding back turbidities, particles and viruses the filter also has to be a good bio-reactor. In principle, biological colonisation occurs on almost all filter materials. Materials based on active porous carbons or filter carbons are far superior here to other porous materials. The colonisation of a filter with activated carbon also occurs more quickly than is the case with other materials. Depending on the filter design backwash-water quantities to be used vary between 35 and 45 m/h. The amount of backwash-water need is around 5 to 6 m^3 per m^2 of filter area. Air flushing has to be checked in individual cases. After flushing the filter the first filtrate (approximate quantity of a filter volume) has to be carried off. The filter run times must be adapted to the respective raw water conditions. Less than 1.5 per cent of the treated water quantity has to be used for the filter flushing. Ozone biofiltration systems can be operated round the clock without any problem [2]. It is preferable to use chlorine or ozone for the final disinfection.

Pure water supply

Pure water is pumped by means of a fully automated pressure booster system with 4 pumps. The system supplies up to 240 m^3/h at constant pressure and approximately 30 m WS.

Summary

Cross-border cooperation requires particular care when managing the project. A certain incalculable residual risk always has to be taken into account. Residual risks are in particular the type of financing and the reliability and the informative value of water analyses.

Literature

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