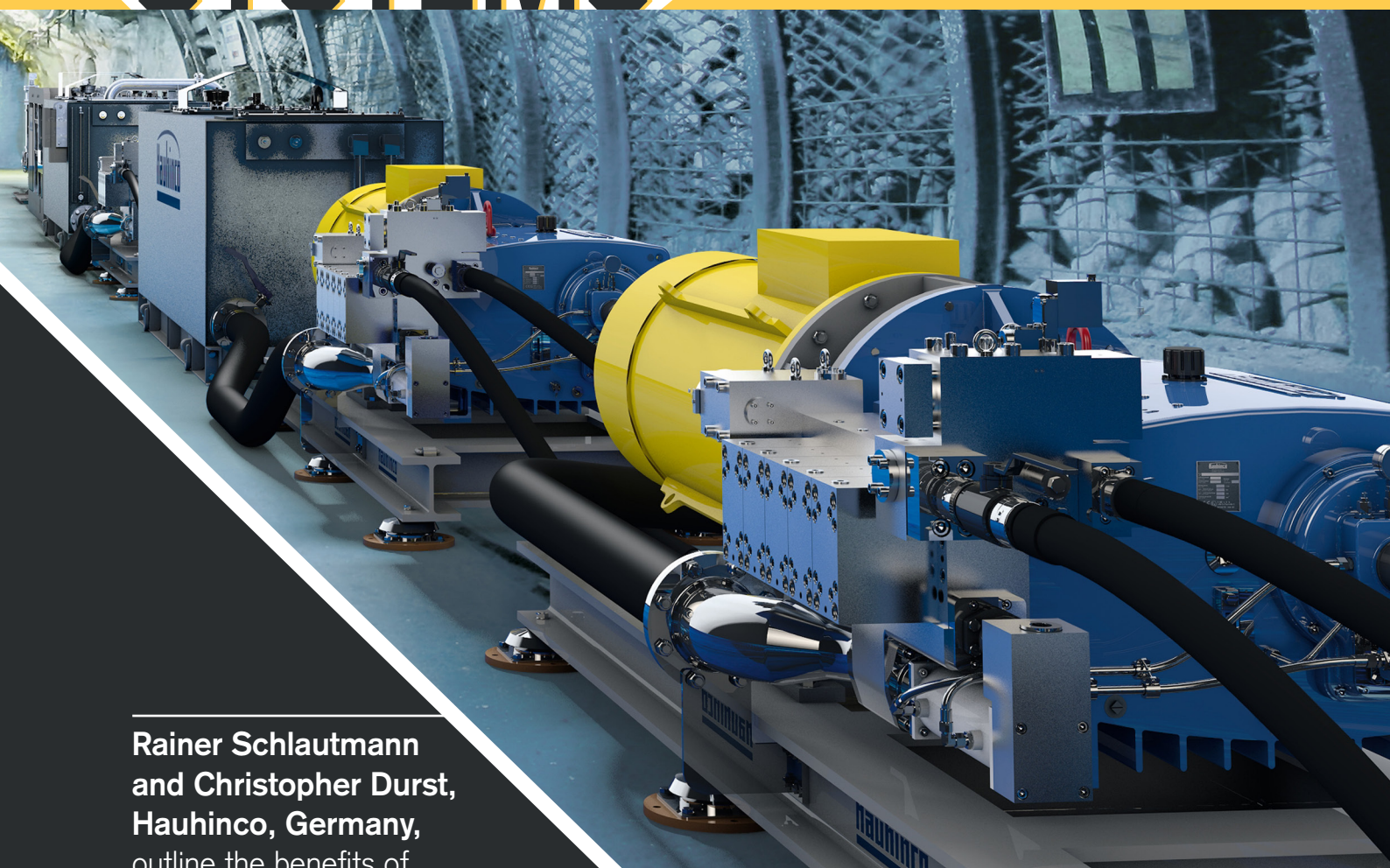


# WATER TREATMENT SOLUTIONS FOR LONGWALL MINING SYSTEMS



**Rainer Schlautmann and Christopher Durst, Hauhincó, Germany,** outline the benefits of integrating water treatment systems into longwall mining operations.

**E**very mine has its own geological condition. As such, requirements for individual mines vary and pump system designs must be adapted as necessary to meet country-specific regulations.

Pump stations are at the heart of longwall operations in underground mining. High-pressure pumps generate the necessary pressure for the roof supports in the longwall. Furthermore, the pump stations enable the roof supports to move along the face of the coal seam. The necessary performance in terms of litres and pressure is fundamentally dependent on the rate of excavation and the supporting power required by the roof supports. Currently, in high-capacity longwall applications, flow rates of up to 1270 l/min. at an average of 340 bar are required.

Water-spray pump stations are used to minimise dust formation in the longwall. The station's plunger pumps supply the shearer water-spray, or the

coal plough water-spray and the cooling systems for the drive motors, with the necessary pressure and volumetric flow rates. The pumps in the water-spray stations typically deliver 600 l/min. at 90 bar.

Hauhinco offers more than just high-pressure pumps and pump stations for the mining industry. Since the late 1980s, the company has expanded into the field of water hydraulics.

A close collaboration has also taken place with Caterpillar Global Mining Europe GmbH in Lünen, Germany (then, operating under the name Bucyrus), jointly looking for a solution to significantly improve the water quality in an underground longwall in a Polish mine. At the time, Caterpillar was in the process of implementing a complete longwall in the mine, but was concerned about the durability of the hydraulics props, because of the extremely high concentrations of salt in the water. As a result, an extensive water analysis of the mixing water was prepared. It is well known that salt, or salty water, accelerates corrosion. In technical facilities, the term corrosion refers to the reaction of a metallic material with its environment, which causes a measurable change in the material and can result in the impairment of the function of a metallic component or of an entire system.<sup>1</sup>

Experience has shown that this is not the only mine with such contaminated water and that it has already led to problems in longwall operations.

## A solution to corrosion

In collaboration with Caterpillar, Hauhinco developed a solution for this problem and

tested it on its own test-bench. By means of a reverse osmosis unit, it was possible to successfully filter out the salt content and other substances identified within the mixing water; a quick and simple solution for the problem had thus been found.

However, for the next stage, it was necessary to develop this into a system approved for underground mining. Alongside the standard mining requirements, the system needed to be suitable for the hard conditions in underground mining and it also needed to be able to supply the required flow rate of cleaned water for the longwall.

After less than five months, the result was a high-performance water treatment unit with all the necessary approvals for underground mining.

The system is installed in a compact base frame with the dimensions 3300 mm x 1519 mm x 1100 mm and can be simply integrated into an overall system, irrespective of the manufacturer. Therefore, a subsequent upgrade of an existing high-pressure station is possible and an immediate improvement in water quality can be achieved. Particularly in completely new systems, a water treatment system is a logical and reasonable investment. Cavitation problems in the props of the roof supports can be prevented from the very start, lifecycle costs are reduced and the investments of the mine are protected.

## Design and functions of the water treatment system

The integral components of the water treatment system are the filtration unit, the

reverse osmosis unit, the tank and the control system.

In the first stage of the water treatment process, the raw water (i.e. the untreated water from the mine) enters a multi-stage filter. During the filtration process, first the solids contained in the raw water are filtered out using a double filter at 50 µm and 25 µm, and then by a 5 µm fine filter.

In the next step, the water enters the key element of the system: the reverse osmosis unit. In the standard system design, this unit consists of one pressure pipe with a membrane, a metering pump, a dispersant tank, two flow monitors and a needle valve. For pressure monitoring purposes, there are also two pressure gauges installed in the raw water feed pipe and in the concentrate drain of this assembly.

A metering pump mixes the raw water with a dispersant mixture and pumps it through the pressure pipe. The membrane separates the raw water into permeate (purified process water) and concentrate (waste water). Optimally, the ratio of permeate to concentrate should be 1:1. This ratio is set by means of the two flow monitors and the needle valve.

The standard system design includes an integrated 1000 l tank for storing the process water. The tank size can be adapted to the requirements of the mine. To monitor the filling level, the tank is equipped with an electrical level monitoring system and a visual filling level display. The dispersant tank has a volume of 400 l and is also equipped with an electrical level monitoring system and a visual filling level display.

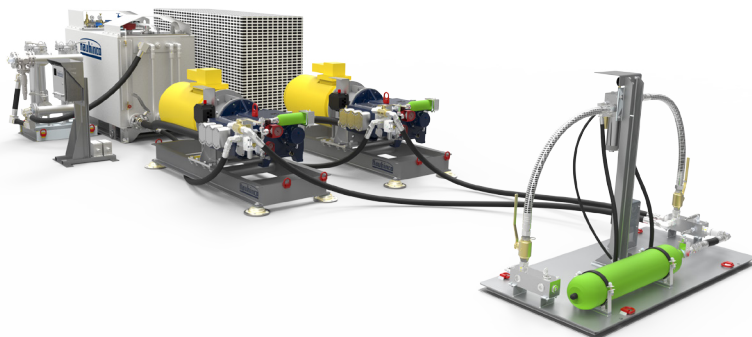
The operating modes 'automatic operation' and 'test operation' are pre-programmed in the control system.

'Automatic operation' allows the fully-automatic treatment of the raw water and the delivery of the process water from the tank to the pump station.

In 'test operation', the various components of the water treatment system can be individually activated and deactivated.

## Results of the first system

The first water treatment system was put into operation in 2010. From 2000 l/hr of salty raw water, it was possible to prepare



A pump station adapted to geological conditions for a mine in Turkey.



Pump station with integrated water treatment system and three EHP-5K400 high-pressure pumps for a mine in Russia.



Image shows the compact water treatment system with its main components: filtration unit, reverse osmosis unit, tank and control system.

1000 l/hr of clean water. The raw water had a conductivity of 1990  $\mu\text{S}$ . After the treatment process, the value for the clean process water was just 19.5  $\mu\text{S}$ . These values show the effectiveness of the system. The system itself runs fully automatically in the treatment process, i.e. no manual operation is required. The degree of contamination of the filters is displayed. The maintenance-friendly structure allows fast, cost-effective and simple replacement of the filter elements.

Even after five years of underground operation, the system still runs flawlessly and supplies the roof supports with clean medium.

Franz-Heinrich Suilmann, Head of Engineering for Roof Support Hydraulics at Caterpillar Global Mining Europe GmbH, sees the preparation of the emulsion for the longwall hydraulics by a water treatment system based on reverse osmosis as a practical alternative. Thus corrosion damages in the hydraulic systems can be avoided ensuring sustained compliance with Caterpillar's quality requirements for the hydraulic fluid.

## Adaptation to water quality and required flow rates

Mines, where the water quality already led to problems in the hydraulic props in the longwall, quickly showed interest in the ability to treat the water directly underground.

Since the launch, Hauhinco has already commissioned a number of water treatment systems in coal mines. The water treatment system has been continually developed since its launch and adapted to the increasing requirements and respective circumstances. In addition to high salt content, the water samples from the mines also contained high levels of chalk, iron and many other solids. These substances can also be filtered out, in some cases with adaptations within a system.

Because of the increasing requirements in terms of the volumes of water required in the longwall, several variants of the treatment system have been developed over recent years. The tank sizes and the treatment volumes can now be flexibly adapted to the requirements. The largest system designed so far has eight membranes and can supply up to 8000 l/hr of water.

## Conclusion

In underground mining, a water treatment system is a logical and reasonable addition to a longwall hydraulics system. The aim of every mine is to achieve the most effective operation, while keeping lifecycle costs as low as possible. The compact design of the water treatment system and the manufacturer-independent and problem-free integration into a pressure supply station can be a fundamental component in achieving this objective. Compared with the overall costs of a longwall, the additional investment is small and, considering the lifecycle costs and the service life of roof supports, it pays off. <sup>W</sup>C