



thermowave  
PHE for process and industry



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## Constant temperatures at a depth of around 1,100 m

Everything must be right underground. Durable and robust technology from thermowave allows the temperature in the tunnels below ground to be maintained reliably and permanently at below 28 °C. The thermowave products have already withstood a two-year test phase underground in a mine in a corrosive working environment with high humidity and have done so trouble-free and without being damaged.

The air underground in the mine at a depth of up to 1,200 meters is above 40 °C and very humid owing to the high salt content (80 % rel. humidity). Under such corrosive conditions, it is not only the technology installed deep below ground that is affected, rather also the health of the people working there. To make working conditions more tolerable, the air is cooled conventionally by means of water circulation, which extends from above ground to a depth of around 1,200 metres.

Simply in terms of the height to be overcome, enormous pressure is created in the system, since 10 m water columns correspond to a pressure of 1 bar. It is also difficult to ensure a uniformly high level of water quality in a water cycle of this size. Contamination in the system in turn however damages the cooling technology both above and below ground.

### Overview

Business line:	Energy & Process
Application:	Mining
Country/Region:	Europe
Fluid:	Water
Product:	thermowave thermolineVario



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▲ The greatest adversary to technology installed underground is the highly corrosive atmosphere and high humidity and corresponding formation of condensation.



▲ The thermowave thermoline-Vario plate heat exchangers are designed to be especially corrosion resistant and can even withstand very unfavourable installation in the condensate without any restrictions.

## Water column with 100 bar

The high pressure in the system is reduced below ground conventionally over two stages before the cold water reaches the air coolers in the tunnels. A central pressure regulator in the shaft in the first stage reduces the pressure of the water column from around 100 to 20 to 25 bar, while local pressure regulators in the tunnels reduce the pressure again to approx. 6 – 10 bar.

The local pressure regulators are generally located a number of kilometres away from the shaft in the individual tunnels. The former have mechanical parts and are highly susceptible to faults owing to the pressure fluctuations in the large circulation system. If the local pressure regulators fail, however, the air coolers are also affected directly and the geothermal energy can no longer be removed from the tunnels.

Apart from the high attrition and repair costs that arise in this regard, regular failure of the air-conditioning technology means that no eight-hour shifts are allowed underground on the grounds of health or labour regulations. The failure of cooling technology is therefore a very costly affair for the mine operator in a twofold respect.

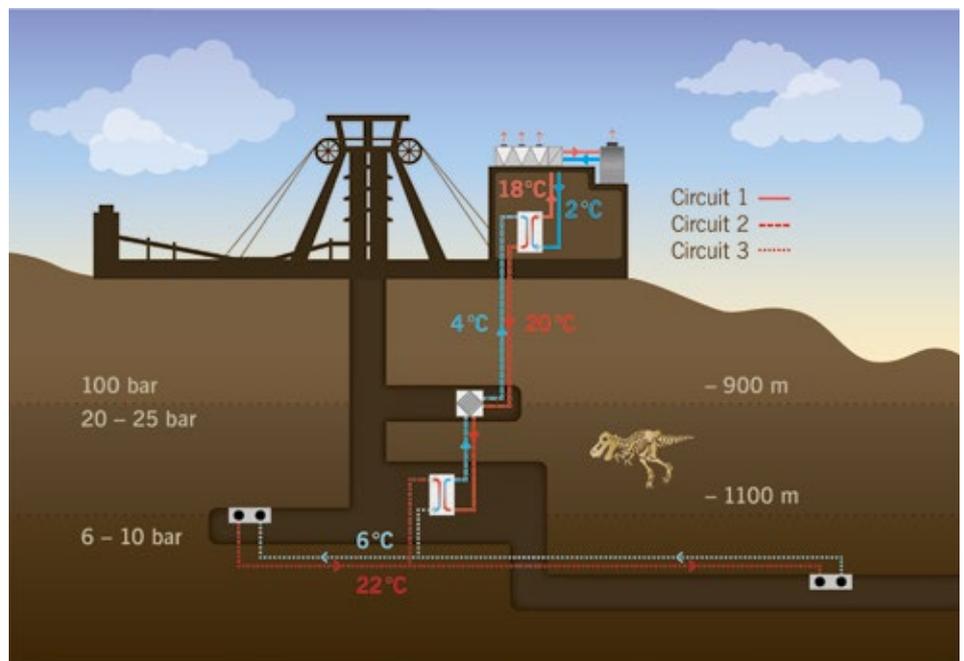
## thermowave thermolineVario plate heat exchangers split the water cycle and act as pressure regulators

This special technical challenge was reason enough for the engineers and technicians at thermowave to find an economical alternative. The result is a solution that has convinced the operator in every respect after a two-year pilot phase.

Instead of the local pressure regulators, custom-made models of thermowave plate heat exchangers of the type thermolineVario were integrated in the water cycle. As two-way units, they split the water cycle from the central pressure regulator to the terminal equipment into two cycles separated from one another by the partition plates and therefore act reliably like secondary pressure regulators.

## Two instead of just one water cycle

The primary circuit extends from the ground surface down to the central pressure regulator at a depth of approx. 900 metres. The water then continues flowing to the plate heat exchangers, which are installed at a depth of around 1,100 metres. The



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second circuit is separated in the thermowave thermolineVario from the first circuit and connects the plate heat exchangers with the air coolers in the individual tunnels. There is a pressure of between 20 and 25 bar just upstream of the PHE and around 6 – 10 bar in the second water circuit.

The separation of the pressure stages by three water cycles creates uniform operating conditions for the water-cooled air coolers in the tunnels, enabling them to operate smoothly. The water quality remains constant in turn in the primary circuit and protects the sensitive parts of the refrigeration engineering above ground from contamination and attrition.

### As good as new after two years in operation

The thermowave thermolineVario plate heat exchangers still look as good as new even after a two-year pilot phase, even though they are installed in very dirty condensate and operate day and night at high pressure. This remarkable durability is enabled by the use of especially corrosion-resistant materials and very stable construction: the frame components are specially coated, for example, and the solid bars as well as the plates are made of molybdenum steel (SMO 254) according to DIN 1.4547. The tightening bolts also have a special corrosion-resistant coating.

The dimensions of the thermowave thermolineVario plate heat exchangers are adapted to the special spatial conditions in mining and were therefore measured fully in advance. For the installed technology, this primarily means a compact design which is achieved for the plate heat exchangers for example by installing an intermediate plate for stability as well as solid supports. Thanks to the low design and special constructions of the special enhanced transportation points, the fully assembled unit supplied can be transported to its installation location on a special-purpose vehicle even in low tunnels. The required output therefore has to be split between several units in case of insufficient space.

### 125 m<sup>3</sup> of water by two per hour

In an area of approximately 3,500 x 1,000 mm and a clearance of 2,500 mm, the unit has a heat exchanger surface of 380 m<sup>2</sup>, which in turn has a thermal capacity of 2,500 kW. The water coming from the air coolers at a temperature of 21.6 °C is cooled to 5.2 °C, since the average circuit transmits 3.4 °C from the primary circuit and heats up in the thermowave thermolineVario to 19.5 °C. Around 125 m<sup>3</sup> of water flows through the plate heat exchanger every hour on both sides. The two-way construction also allows cleaning runs to be performed by means of a circuit in counterflow operation.

### thermowave plate heat exchangers for the mining industry

Above ground, planners and customers have long since been familiar with the use of thermowave products in the mining industry. For example, the company's plate heat exchangers are integrated in free cooling systems or used for sulphuric acid coolers in copper purification processes and also supplied for ammonia evaporators and condensers. Special materials, such as molybdenum steel (SMO 254) or titanium steel (Group 1), are used in heavy-duty conditions. thermowave plate heat exchangers with a capacity of more than 50 MW have already been installed in this industry sector.