

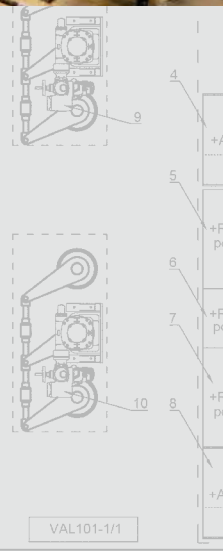


MWM ELEKTRO

COMPLETED PROJECTS



**Modernisation of the main fan station
for the Kościuszko shaft
of the "Wieliczka" S.A. Salt Mine**



The "Wieliczka" Salt Mine is one of the most valuable historic monuments of the material and spiritual culture in Poland, visited by over a million tourists from all over the world every year. It is also a world class heritage site, it was one of the first to be placed on the original UNESCO list of the World Heritage Sites.

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The Wieliczka Salt Mine has very particular conditions. It is related to the untypical obligation to not only guarantee the safety of the employees and tourists, but also to prevent the degradation of the mine by maintaining stable atmospheric parameters.

Advantages of the modernisation

Increased safety of mine employees, persons on underground tourist routes and the entire plant – implemented by the installation of equipment guaranteeing long, trouble-free operation due to the application of a modern control system.

Decreased power consumption – the installed fans had a higher energy efficiency rating and are coupled with a power supply and control system designed to optimise their performance.

Decreased station maintenance costs – the operator station in the station building was reduced by moving the control system to the plant's control room located approx. 1 km from the station.

Noise emission to the environment decreased by 15% – the installed equipment generates less noise, the new fans' envelope provided better acoustic insulation.

Purpose and scope of the modernisation

The modernised main fan station for the Kościuszko shaft is located at the border of the center of Wieliczka. The main fan station is used by the "Wieliczka" S.A. Salt Mine for ventilation purposes – it works on the exhaust shaft.

The primary purpose of the modernisation of the main fan station for the "Kościuszko" shaft is to improve the safety of mine employees and the persons in the underground tourist routes of the "Wieliczka" S.M. The equipment used to date showed significant wear (e.g. flaking of the fan rotor blades). In the case of the station responsible for the main ventilation system, the situation required immediate modernisation.

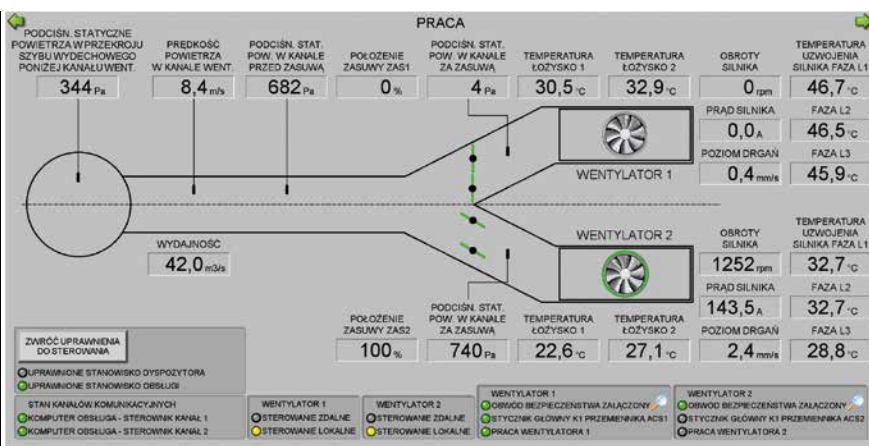
The secondary purpose of the modernisation of the main fan station for the "Kościuszko" shaft was the reduction of the station operation costs. This was implemented by removing the continuous service station and reducing the power consumption costs.

The comprehensive modernisation of the main fan station involved:

- replacement of two axial fans,
- modernisation of ventilation damper drives,
- modernisation of the station's auxiliary switchgear,
- installation of a second, redundant control and measurement system for the station,
- providing local (from the fan station room) and remote (from the plant's control station) power supply and control,
- preparation of a full technical and technological documentation as well as all formal approvals required to start the operation of the modernised station in mining operation plant.

MWM Elektro presented the investor with solutions capable of delivering on the assumed goals.

The complex ventilation system of the "Wieliczka" Salt Mine requires advanced air parameters control methods.





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Description of applied solutions

Axial fans

Before the installation of the new fans, the installation location and foundation were subject to thorough analysis. The technical condition of the foundation was found to be sufficient for the adaptation. For this purpose, an intermediate frame was made – the fans were installed on the frame using vibration absorbers.

In order to meet the technical requirements of the Investor, Korfmann GmbH dAL16-1100 axial fans were used in the project. They are electric single-rotor axial fans. The housing and rotor of the fan are acid-resistant while the motor is explosion-proof.

Due to the aggressive operation environment, the blade rotor of the fan is made entirely of silumin. This selection of materials guarantees a long-term and trouble-free operation of the blades.

On the suction side of the fan, there are silencers, reducing the noise emission to the environment. The fan shaft is mounted on maintenance-free rolling bearings, guaranteeing to provide at least 30,000 hours of trouble-free operation.

The fans are fitted with a diagnostic system. Temperature sensors are installed in the pre-made sockets in the fan's bearing mounts. Vibration sensors are installed on each of the bearing housing and one – on the fan housing. The signals from the transducers are provided to the ventilation station visualisation system and displayed on the screen. Employees are informed about exceeding the warning threshold on the visualisation screen. In case of exceeding the emergency threshold, the fan will be automatically stopped.

The power to each of the fans is supplied from the auxiliary switchgear via frequency converters. In the fans used until modernisation, controlling efficiency was implemented by changing the tilt angle of the blades. This technical solution was not effective in the aggressive work environment due to the fact that the

salt aerosol depositions resulted in blocking the mechanism. The selection of a correct fan rotor construction and changing the power supply method enabled the adaptation of station efficiency (by changing the rotational speed of the rotor) to current requirements.

The fans are capable of reversed operation by changing the direction of the motor revolutions.

- phot. 1 View of the fans station after modernisation
- phot. 2 Fans before installation
- phot. 3 Commissioning at the manufacturer's plant
- phot. 4 Unloading the fans
- phot. 5 Fans with the envelope structure

Basic parameters of each of the fans:

Rated capacity	60 m ³ /s
Supply voltage	400 V
Electric motor power	110 kW
Rotational speed	1 500 rpm
Unit efficiency	>80%
Fan weight:	approx. 4 500 kg



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2400 w świetle kanatu



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Ventilation flap drives

Ventilation flaps are installed in the duct in front of each of the fans. They are used to shut off idle fans from the system. The drives of the flaps were modernised according to the requirements of the customer. The current drives were replaced by more compact and maintenance-free models. The drives are equipped with position transducers, double path and torque switches as well as anti-condensation heaters with thermostats.

Each of the drives is installed on the frame and bolted to the foundation. The drive shaft is connected to the reaction arm via a spline joint. The entire construction was adapted to the current force transfer system.

The ventilation flaps drives are supplied from the station's auxiliary switchgear. In case of failure, there is a possibility of manual flap adjustment. Each of the drives is graphically represented on the visualisation screen, all the operation parameters are also provided.

phot. 6 Ventilation damper drives

Basic parameters of each of the drives:

Rated torque	6932 Nm
Drive power	1500 W
Supply voltage	3 x 400 V AC
Drive revolutions	63 rpm
Gear ratio	218
Damper shift angle (open-close)	60°
Electric drive damper opening/closing time	35 s
Estimated manual damper opening/closing time	~5 min
Total unit weight	177 kg

Auxiliary switchgear

The RW 400/230 V switchgear is located in the fan station of the Kościuszko shaft and is used to supply power to the main fans and the auxiliary equipment of the fan station. It is a two-section, single-system switchgear with incoming and coupling bays, equipped with compact breakers with electric drives and outgoing bays equipped with fuse switches, contactors, installation breakers, residual-current breakers and overload relays. Power supply is connected with cables to incoming bays no. 1 and no. 3. Bay no. 2 is a section coupling.

The switchgear is equipped with automatic transfer switching equipment (ATSE) which, in case of a break in one of the power supply sources, will supply both bays of the switchboard from one power inflow and will disconnect the faulty inflow for safety reasons.

Switchgear parameters:

Designation	RW 400/230 V
Rated voltage	400/230 V
Insulation rated voltage	690 V
Busbars rated current	320 A
Number of circuits	
– incoming	2
– section coupling	1
– 400 V outgoing	8
– 230 V outgoing	6
Incoming rated current	320 A
Peak current	20 kA

The 400/230 V separating transformers for the power supply of the control and operation parameters monitoring system of the fan station are located in bay no. 2.

phot. 7 RW 400/230 V auxiliary switchgear



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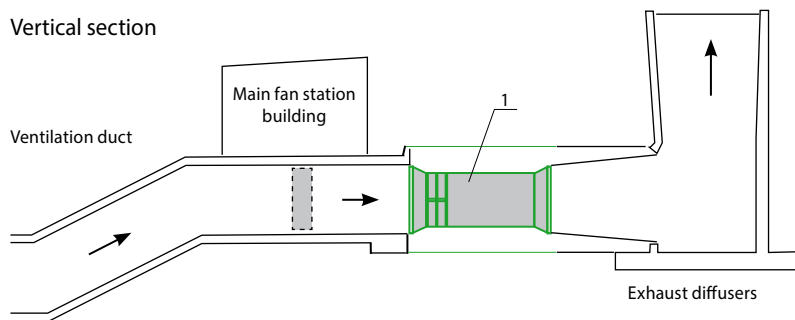


Main fan station

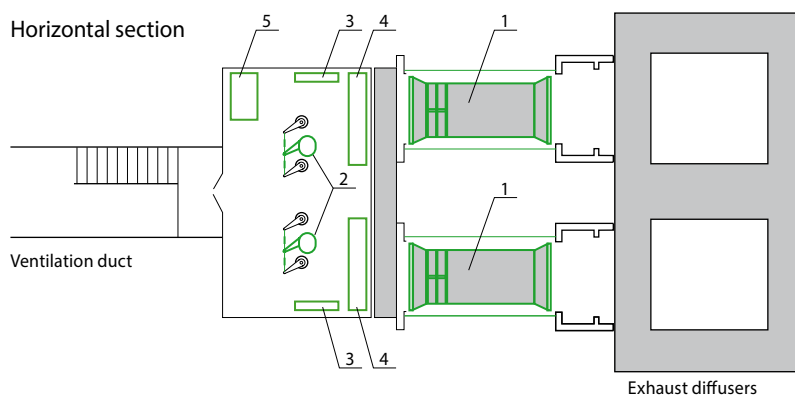
Ventilation duct sections with a list of modernised elements:

- 1 - dAL16-1100 axial fan
- 2 - ventilation damper drives
- 3 - control and measurement instruments
- 4 - fan control and power supply cabinets
- 5 - operator's station

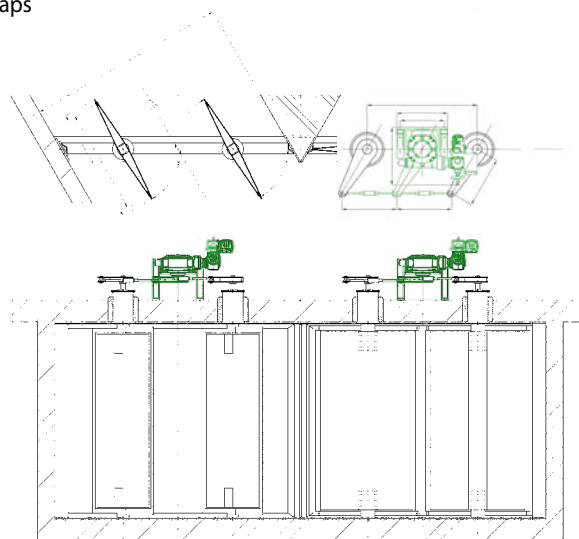
Vertical section



Horizontal section



Ventilation flaps



Control and measurement instruments

A new control and measurement system was installed to display the operating parameters of the main fan station. A mimic panel was made to present the pressure in the ventilation duct and in the shaft below. The panel houses 4 pressure difference transducers used to display the static pressure:

- in the shaft, below the ventilation duct,
- in the ventilation duct, behind the dampers,
- in the ventilation duct, behind each of the flaps.

An anemometer was installed in the ventilation duct to display the velocity of air sucked into the shaft.

phot. 8 Control and measurement instruments

Analog signals from measurement instruments are transmitted from the controller to the visualisation system, enabling the dispatcher to continuously analyse the main operating parameters of the station on the screen.



Fan station control and operation parameters monitoring system

The fan station control and operation parameters monitoring system is based on an AC500-type PLC installed in the transmission and measurement cabinet (TPS) as well as two PC computers with implemented control and visualisation system software.

Control station no. 1 (local) located in the Kościuszko shaft main fan station service room consists of the TPS cabinet with a PLC and a PC computer with a touchscreen. The control and visualisation application enables controlling the fans and dampers as well as the visualisation of the fan station operation parameters. The local control station enables individual control of fan drives and damper drives as well as the display of the basic system operation parameters. The local control system is independent of the TPS cabinet and the PLC.

Control station no. 2 (remote) located in the mine's main control station consists of PC computer with a touchscreen. The application implemented in the computer enables remote control of the system as well as the visualisation of the fan station operation parameters.

The fan station control and operation visualisation system is based on the ASIX package, capable of providing computer visualisation, monitoring and control of industrial processes.

phot. 9 Control station no. 2

The package is compatible with the MS Windows NT/2000/XP/7/8 operating systems. The system enables remote control of the operation of fans and dampers.

The system displays the operation and parameters of the fan station as well as basic parameters of the RW400/230 V switchboard. Additional visualisation screens enable the display of the operation of system elements, diagnosing faults and disturbances. Data transmission from the TPS cabinet to the control station is based on the Ethernet network with TCP/IP protocol. Each of the computer stations enables independent data recording and archiving, based on the information retrieved from the TPS station. The fan operation parameters, pressure, airflow velocity, start and stop times as well as emergency statuses are logged.



Conclusion

The modernisation fully satisfied the Investor. The most important improvement is related to the safety of the underground employees, tourists (over a million of whom visit Wieliczka every year) and of the heritage monuments in the mine.

The modernisation brought significant savings – the use of modern, more efficient equipment contributed to lower power consumption, while moving the control system to the main mine control station (approx. 1 km away) enabled the reduction of a continuous service position.

Advanced material, power supply, control and operation technologies will extend the life of the equipment and guarantee trouble-free operation.

Among the beneficiaries of the modernisation are also the residents of the mine's surrounding area – the reduction in the noise level emitted to the environment will, without doubt, improve their life comfort and the entire Wieliczka neighbourhood.



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