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.
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
### Description of applied solutions

#### Axial fans

Before the installation of the new fans, the installation location and fluid dynamic load were subject to analytical analysis. The technical conditions of the basin were 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, Brownbooth GmbH KBA-1150 axial fans were used in the project. The fans are electric single-rotor axial fans. The housing and outer surface of the fan are made entirely of silumin. This selection of materials reduces noise emission to the environment. The fan shaft is mounted on a spline joint. The entire installation was adapted to the curvature of the fan station. The fans are fitted with a diagnostic system. Temperature sensors are installed in the front and rear sections of the housing and on one – on the fan housing. The signals from the transducers are provided to the ventilation station visualization system and displayed on the screen. Employees are informed about exceeding the warning threshold on the visualization 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 on frequency converters. The converter is supplied by a backup power source located in bay no. 2. Each of the drives is graphically represented on the operator station.

**Basic parameters of each of the fans:**
- Supply voltage: 400 V
- Rotational speed: 1500 rpm
- Unit efficiency: >80%
- Rated torque: 6 932 Nm
- Drive power: 1 500 W
- Drive revolutions: 63 rpm
- Unit weight: 177 kg
- Gear ratio: 218
- Drive phase: 3
- Supply voltage: 3 x 400 V AC
- Peak current: 20 kA
- Estimated manual damper shift time: ~5 min
- Damper shift angle (open-close): 60°
- Damper torque: 400 Nm
- Damper gear ratio: 9:1
- Driven power: 1 500 W
- Rated voltage: 400/230 V
- Drive revolution: 63 rpm
- Drive phase: 3
- Drive power: 1 500 W
- Damper shift angle (open-close): 60°
- Damper gear ratio: 9:1
- Driven power: 1 500 W
- Rated voltage: 400/230 V
- Drive revolution: 63 rpm
- Drive phase: 3
- Drive power: 1 500 W
- Damper shift angle (open-close): 60°
- Damper gear ratio: 9:1
- Driven power: 1 500 W
- Rated voltage: 400/230 V

#### Ventilation flap drives

Ventilation flap drives are supplied from the station’s auxiliary switchgear. Each drive is equipped with velocity and position sensors. The drives are controlled by position transducers, double path and torque switches as well as anti-condensation heaters with thermostats.

- Six of the drives installed on the frame and bolted to the foundation. The drive shaft connects to the emergency motor via a spline joint. The entire installation was adapted to the curvature of the fan station.
- The ventilation flap drives are supplied from the station’s auxiliary switchgear. Each drive is equipped with velocity and position sensors. The drives are controlled by position transducers, double path and torque switches as well as anti-condensation heaters with thermostats.

#### Auxiliary switchgear

The RW 400/230V switchgear is located at the fan station of the “Kościuszko” shaft. It is a two-section, single-system switchgear with incoming 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 2. Power supply to the fan station is connected to outgoing bays no. 1 and 2. The switchgear is equipped with automatic transfer switchgear (ATSE) which, in case of a break in one of the power supply sources, will supply both loads of the switchgear from the new power supply line and switch off the faulty line for safety reasons.

### Ventilation system

The complex ventilation system of the “Wieliczka” Salt Mine responds obeyed to the principles of ventilation control methods.
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.

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.

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.