Conceptual considerations of the modernization of the main fan stations of mine Y and their economic aspect

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Abstract. In connection with the liquidation of the hard coal mine Y and the change its functionality, it is necessary to modernize the main fan station installed at the "Northern" shaft of mine Y. The article presents concepts of changing the efficiency of WPK 5.0 fans installed in the "Northern" shaft and the methods of air flow regulation for target model of a mine with a reduced network of mining excavations. It discusses four alternative variants of technical solutions. The most effective of them are illustrated with a preliminary economic analysis, the results of which enable the right investment decision to be made.

1. Introduction
Pursuant to Decision 787 of the Council of the European Union of December 10, 2010. [1], which allowed member states to grant financial support to facilitate the process of closing uncompetitive coal mines in 2016. The Polish government obtained approval from the European Commission for the presented plan to close some coal mines in Poland [2]. Based on the approved plan, Poland could allocate PLN 7.95 billion (EUR 1.8 billion) from public funds to guarantee the organized closure of uncompetitive coal mines by 2018 and mitigate the social and environmental effects of their closure. The recovery program for the Polish mining industry was based, inter alia, on the transfer in 2015-2017 of thirteen unprofitable hard coal mines by 2018 and mitigate the social and environmental effects of their closure. On February 8, 2018, at the request of the Polish government, the European Commission issued a decision [3] extending until the end of 2023 the possibility for the state to grant state aid for the restructuring of the hard coal mining sector, as well as increasing the amount of aid to PLN 12.99 billion (EUR 3.12 billion). This amount includes both aids granted under Art. 3 (closure aid) and under Art. 4 (aid to cover exceptional costs) of the Council Decision. The closure aid was granted until the end of 2016. The aid to cover extraordinary costs - the mine closure process, post-closure activities, including the financing of tasks related to securing neighboring mines against water, gas and fire hazards during and after the closure of mines, repair mining damages caused by the operation of the closed and under liquidation mining plant, as well as financing the restructuring of employment in mines put into liquidation before January 1, 2019, has been increased. The total amount of aid for exceptional...
costs, which were granted for the period 2015-2023, amounts to PLN 12.67 billion (EUR 3.04 billion). Some of these funds were also allocated to the process of decommissioning the Y mine and transforming its infrastructure into a stationary underground water pumping station, protecting the neighboring mines against water hazards. The rational use of social funds is the main aspect of the activities of Spółka Restrukturyzacji Kopalń S.A. therefore, it seems reasonable to ask the following question: **What are the costs of modernization of mine Y’s main fan station and which of the modernization options is technically and economically justified?**

2. **Technical description of the current state**

The existing fan station at the North shaft (Figure 1) is equipped with two modernized radial fans of the WPK 5.0 type with a rotor diameter of \(D_z = 4460\text{mm}\) and a steel structure built inside the spiral that reduces the body of Zabrzeńska Fabryka Maszyn Górniczych POWEN Sp. Z o.o. Its modernization is related to the need to adjust the parameters of the main ventilation fans of mine Y to its target model. Due to the ongoing from 2017 the liquidation process of mine Y, the number of active mine workings in the mine decreased by 75%, and thus the operating parameters of both fans are too large for the prevailing conditions. This situation generates not only financial losses related to the excessive consumption of electricity by operating fans, but also creates real fire hazards due to the carbon oxidation process in the remaining mine workings as a result of too much air flowing through the mine's ventilation network.

![Figure 1. Main fans station at the North Shaft - satellite image.](image)

2.1. Operation parameters of the fan station

Currently, WPK 5.0 fans operate on closed steering apparatuses and closed main flaps due to excess air in the Northern Shaft subnetwork. Their basic parameters are presented in Table 1.
The fan station is equipped with concrete underground ducts with a rectangular cross-section, concrete diffusers, a system of reverse channels and cut-off dampers. A steel structure is built into the concrete and steel parts of the body, reducing the fan spiral.

Table 1. Technical parameters of fans at the North shaft

| Fan Parameters | Fan No.1 and No.2 |
|----------------|-------------------|
| Type           | WPK-5.0 radial, single-stream |
| Producer       | Zabrzańska Fabryka Maszyn Górniczych POWEN |
| Place of installation | North shaft |
| Number of turns | 375 rpm |
| Nominal capacity | 20 500 m³/min. |
| Nominal depression | 3330 Pa = 340 mm H₂O |
| Power           | 1600 kW |
| Tension         | 6 kV |
| Engine          | GYe 1616t/01 synchronous |
| The method of capacity regulation and damming | steering camera |
| Flap control    | electric |

Own source.

The northern main shaft fan station is supplied with 2 6kV cable lines:
- Basic (power supply from 6 kV switchboard, shaft IV),
- Backup (power supply from 6 kV switchgear, shaft IV).

The main circuits of synchronous motors are supplied from rotary switchgears equipped with low-oil circuit breakers with SCI4 drive.

Each of the fans also has an individual 500V switchboard for supplying auxiliary devices, i.e. exciter motors, bearing lubrication unit, flap drives, steering apparatus, etc. powered by 6 / 0.5kV 1000kVA transformers.

Both fans are also equipped with an individual Ro switchboard which supplies power to the lighting circuits, plug-in sockets and oil heaters in the tank.

The station also has a common auxiliary switchboard 220VDC for both fans, which supplies power to the control, protection and signaling circuits of the synchronous motor, as well as the signal board.

Both fans have their own independent control system consisting of:
- control cabinet,
- boot cabinet,
- cabinets for measuring instruments,
- signal board.

The efficiency of the fans is controlled by a steering apparatus.

2.2. Technical condition of the fan station buildings
The technical condition of the building structures of the main fan station located at the northern shaft of mine Y was assessed based on an on-site inspection on September 16, 2020. During the inspection, the walls of the fan station building were considered good. No major gaps or cracks in the plaster were
found. The ventilation ducts are made of a reinforced concrete structure and are attached to a reinforced concrete ventilation telescope connected to the shaft. Currently, there is a negative pressure in the ventilation ducts up to 3900 Pa. After modernization, depending on the variant, the negative pressure in the duct will be between 2,500 and 3,500 Pa. The general condition of the ducts is satisfactory, only local re-profiling of the walls, ceiling and floor is required.

The ventilation ducts are equipped with dampers with a vertical axis of rotation, which are driven by electric actuators. Due to their poor condition, when modernizing, it is necessary to replace the dampers with their bearing and electric drives. The air from each fan is discharged to the atmosphere through a concrete diffuser about 14m high. Visually, the diffuser objects are properly maintained, no excessive leaks or cracks have been found. The general and technical condition of the diffusers was assessed by experts from Carboautomatyka S.A. as satisfactory. A similar opinion was obtained for the head-shaft building objects, which do not require any additional investments in the assumed target model of the mine.

3. Design analysis
The subject of the design analysis undertaken by the Energy and Ventilation Department of mine Y in cooperation with Carboautomatyka S.A. [4] was to develop a concept of changing the efficiency of MDF 5.0 No. 1 and No. 2 fans installed on the North Shaft. The analysis should consider the use of equipment from the decommissioned ventilation South shaft of Y mine, the physical decommissioning of which is planned for the third quarter of 2021. The modernization was considered according to the following variants:

- Installation of smooth speed control systems for the existing engines, considering the preparation of engines for an inverter.
- Installation of smooth speed control systems along with the transfer and installation of devices obtained from the southern ventilation shaft of the Y mine.
- Installation of a mechanical air flow regulation system along with the transfer and installation of devices obtained from the southern ventilation shaft of the Y mine.
- Construction of a new station.

Modernization of the station is related to the need to limit the parameters of the main ventilation fans due to the smaller ventilation network of the mine. The operating parameters of the fans were determined for the following variants of target mine models:

Variant I maintain the current network of workings and ventilation connection with the S mine belonging to Polska Grupa Górnicza S.A. to "refresh" its ventilation areas with air supplied from the mining area of the closed mine Y.

Variant II of liquidation of all redundant workings of mine Y and maintaining the ventilation connection with mine S belonging to Polska Grupa Górnicza S.A. to "refresh" its ventilation areas with air supplied from the mining area of the closed mine Y.

Variant III - maintaining the minimum number of pit excavations at the level of 850m. Providing only ventilation of the main drainage pump hall of mine Y.

Regardless of the adopted solution variant, the main fan station must meet the requirements of the currently applicable regulations, including those relating to fans and devices installed in used air ducts, treated as an extension of the underground excavation.
Table 2. Fan operation points for selected variants of ventilation of mine Y

| Variant | Flow in the shaft (m³/min) | Suction (m³/min) | Fan efficiency | Vacuum at the shaft cutting area (Pa) | Vacuum at the fan inlet (Pa) | Stamping resistance (Pa) | Total static stack (Pa) |
|---------|---------------------------|-----------------|----------------|-------------------------------------|-----------------------------|-------------------------|------------------------|
| I       | 6140                      | 1286            | 7426           | 123,77                              | -2986                       | -3386                   | 200                    | 3586                  |
| II      | 2252                      | 725             | 2977           | 49,62                               | -2850                       | -2914                   | 32                     | 2946                  |
| III     | 1731                      | 675             | 2406           | 40,10                               | -2465                       | -2507                   | 21                     | 2528                  |

For the purpose of designing the modernization of the fan station, on the basis of calculations and analysis of the ventilation network, the operating points and parameters of the fans were determined for individual variants of ventilation of mine workings in mine Y (Table 2). Bearing in mind the above-mentioned points of work, the following variants of the modernization of the fan stations installed at the North shaft of mine Y were analyzed.

3.1. Analysis of the planned modernization of the fan station for variant A

This variant assumes the use of the existing infrastructure for both fans and the development of smooth speed control systems for the existing motors, considering the preparation of the motors for the inverter. The WPK 5.0 fans installed at the station have an outer rotor of $D_e = 4460$ mm. Based on periodic measurements of the fans from 2017 [5] and 2018 [6], the fan characteristics were drawn (Figure 2a). The required operating points were marked on the characteristics and the possibility of achieving them by changing the speed was checked computationally. Figure 2 shows that the fan with the current impeller and smooth speed control cannot work with any of the required operating points. Work point no. 1 is on the left side of the characteristic, while point no. 2 is at the top of the characteristic. Operating points 3 and 4 are not achievable for this fan in any way.

![Figure 2. Characteristics of WPK 5.0: a) with the rotor $D_e = 60$mm, b) with various 4280mm, for different rotational speeds in the technology of controlling the parameters of the converter.](image)
In the next Figure 2b shows the characteristics of the WPK 5.0 fan with an impeller with an outer diameter $D_z = 4280$ mm. Reducing the outer diameter of the impeller meant that the operating point no. 2 is on the right side of the characteristic, but still does not meet the dissipation condition of stable fan operation. Work point 1 is at the top of the flow curve, while work points 3 and 4 are still unattainable.

The above simulations show that the modernization of the existing fans by adding devices for smooth speed control does not make sense because the required operating points will not be achieved [7], [8].

3.2. Analysis of the planned modernization of the fan station for variant B

Variant B of the modernization of the fan station at the northern shaft assumes the use of the existing infrastructure for both fans and the use of devices installed on the southern ventilation shaft.

The following three main ventilation fans are installed in the southern ventilation shaft of Mine Y:
- fan type WPK - 5.0, version "P", with parameter adjustment by means of a stepless change of the rotational speed of the drive motor with a rated rotational speed of 370 rpm, one piece,
- fans type PRJ - 280 / 1.4 in options "L" (No. 2) and "P" (No. 1). Driven by motors with a constant rotational speed of 375 rpm, one (no. 1) and 370 rpm, the other (no. 2), with adjustment of parameters by means of manually operated axial steering apparatus installed at the inlet to the rotor; two pieces.

The analysis shows that the effect of modernization works in Variant B would be like the effect obtained in Variant A. If this variant was used, the main fans station at the North Shaft would still not achieve any of the 4 required operating points. Which means that also in this variant, the use of motors to drive the modernized fans is not possible.

3.3. Analysis of the planned modernization of the fan station for variant C

As part of variant C of the modernization of the fan station at the North shaft, the possibility of operation of the fans with smooth speed control and the steering apparatus was analyzed for the selected stations operating points.

![Figure 3. Characteristics of the WPK 2.6 fan: with the rotor $D_z = 2750$mm a) for various rotational speeds and parameter adjustment with a converter, b) for adjustment with a steering apparatus.](image-url)
Figures 3a and 3b show the characteristics of the WPK fan with an outside diameter of 2750 mm. As can be seen from Figure 3a, work points 1 and 2 will be achieved and the dissipative condition of stable work will be met. Unfortunately, the operating points 3 and 4 are still not achieved. Even with the engine speed limited to 600 rpm and with 50% closing of the steering apparatus, the required operating points are not achieved.

Due to the above, it is not recommended to modernize the fans with the use of a mixed method of fan regulation.

The analyzed variants of modernization of the main fan stations at the northern shaft of mine Y with the use of the current material and technical infrastructure did not show satisfactory results. The introduction of any of the proposed solutions while reducing the target ventilation network to just over 10 km of mine workings does not provide the required operating points for any of the fans owned by the mine. In turn, the prospect of maintaining a stationary pumping station at the level of 850m for the next years to protect active mining plants against water hazards in the current ventilation system is associated with a negative economic calculation and a real fire hazard. Due to these facts, it was necessary to consider the concept of building a new main fan station at the North shaft of mine Y, in order to determine the real costs of such an investment and the target benefits that this solution could bring in the coming years. For this purpose, a team of specialists from mine Y and Carboautomatyka S.A. analyzed the construction of a new main fan station in a three-fan system.

3.4. Analysis of the planned modernization of the fan station for variant D - construction of a new three-fan station
This variant assumed the construction of a new main fan station as a three-fan station in container (modular) design with ventilation ducts (Figure 4).

![Figure 4. An example of a main fan station in a container design on KWK Szczygłowice [9].](image)

According to the assumptions of variant D, the construction of the station is to consist of building new steel ducts from the end of the concrete ducts intended for the third fan. In the initial part, a common ventilation duct with dimensions of 2.6 x 3.2 m will be made. The first two fans will be connected opposite to each other to a common duct. Then the duct will be narrowed to the size of 2.4 x 2.6 m and ended with an elbow where the third fan will be connected. In front of each fan, there will be an electric damper installed. The fans will have reverse channels. For the fans no.1 and 3 installed on one side of
the ventilation duct, a common duct is provided, while the fan no.2 will have an individual reverse duct (Figure 5).

Figure 5. Location of the designed three-fan station at the North shaft.

Construction of the station in such a variant will allow for the continuous operation of the current station with two existing fans until the new station is put into operation. First, new ducts will be made and new fans installed without connection to the existing concrete duct. In the last stage, the connection of steel ducts will be made. After the trial run of the new station is completed, it will be possible to permanently block the ducts to the existing WPK fans, and then proceed to disassembly and demolition.

The three-fan station will be equipped with WPK fans with a rotor with an outer diameter of 1950 mm, which will operate at an increased speed of up to 1050 rpm. The fans will meet the requirements of Group I Category M2 devices.

The fans will work in a two out of three system, i.e. two fans will work in parallel on the mine network, while the third fan will be a reserve. Therefore, the required network parameters will be achieved in the following configuration:

- operating point No. 1 - with parallel operation of two fans, at 1030 rpm,
- operating point No. 2 - with parallel operation of two fans, at 940 rpm,
- operating point No. 3 - with the operation of one fan, at the speed of 810 rpm,
- operating point No. 4 - with the operation of one fan, at the speed of 730 rpm.

Figure 6 shows the flow characteristics of a selected fan with a rotor diameter of 1950 mm with one fan operating and two fans operating in parallel.

New fans based on the WPK 2.6 model: will be equipped with a reversible flap with a drive, an electric motor with a rated speed of $n = 1000 \text{ } \text{rpm}$. The shaft will be mounted on rolling bearings. The engine's power will be 450 KW and the voltage will be 6000V. For the purposes of the study, the Sh450H6A engine manufactured by EMIT Żychlin S.A. was adopted.

The fan body will be made of steel and placed in a concrete cavity so that the fan inlet is entirely above the ground. A noise silencer will be installed at the outlet of the diffuser.

On each ventilation duct, the fan will be equipped with dampers necessary for the proper operation of the station:

- main shut-off in the ventilation duct,
- shut-off in the reverse channel,
These dampers, like all other devices of the new fan station, operating in the exhaust air stream will meet the requirements for devices of Group I Category M2.

The design of the dampers must ensure failure-free operation at the maximum possible negative pressure, i.e. approx. 5800 Pa. New dampers should be made of corrosion-resistant materials. An electric swing actuator will be used to drive the flaps. The dampers will work in the open-close system.

**Figure 6.** Characteristics of WPK 2.6 fan with $D_z = 1950\text{mm}$ impeller for one fan and for parallel operation of two fans

The drive building of each fan will be made of aluminum alloys, equipped with:

– electrical installation (power, control and lighting),
– gravitational and mechanical ventilation controlled by the temperature in the room,
– heating
– a pillar jib crane for renovation purposes with a manual drive.

The building will also act as an acoustic shield. Additionally, control cabinets are installed in the room. There will be an opening in the roof of the building with a closure for assembly and disassembly of the engine with the use of a car crane.

**3.4.1. Cost analysis for the construction of a new three-fan station.** A summary of the costs of modernization of the main fan stations at the North shaft in mine Y was prepared to compare the economic profitability of individual variants.

The basis of the study were:

– offers and information from manufacturers of machines and devices,
- cost levels for individual types of works obtained from contractors,
- own calculations.

The following list, Table 3, should be treated only as comparative for individual variants, and in no case can it be treated as an investor's cost estimate. For the purposes of this article, the costs and works necessary to modernize the Y mine's main fan station by building a new three-fan station at the North shaft and adapting the existing infrastructure are presented in tabular form. This investment is the most expensive, but the rate of its return over the years is the fastest compared to the other analyzed variants. The total cost of this investment is PLN 11.8 million. PLN. (2.6 million euros).

Table 3. Financial calculation of the modernization of the main fan station by building a new three-fan station

| Description                                                                 | Quantity | Total expense, zł | Total expense, euro |
|----------------------------------------------------------------------------|----------|-------------------|--------------------|
| **Technology industry**                                                    |          |                   |                    |
| Deliveries and assembly of a new WPK 2.6 fan with full accessories         | 3        | 2700000,00        | 600000,00          |
| Deliveries and assembly of new dampers:                                     |          |                   |                    |
| - main butterfly valves with motors                                        | 3        | 360000,00         | 80000,00           |
| - dampers of reverse channels with drives                                  | 2        | 1200000,00        | 26667,00           |
| - throttles of reversible intakes with drives                              | 3        | 1800000,00        | 40000,00           |
| Deliveries and assembly of exhaust silencers on diffusers:                |          |                   |                    |
| - exhaust silencer on the diffuser                                        | 3        | 1050000,00        | 233333,00          |
| - supporting structure for the silencer                                    | 3        | 360000,00         | 80000,00           |
| Deliveries and assembly of engine protection buildings                     | 3        | 1350000,00        | 300000,00          |
| **Construction industry**                                                  |          |                   |                    |
| Construction of new facilities:                                            |          |                   |                    |
| - ground works                                                            | 1        | 312000,00         | 69333,00           |
| - construction of a steel channel 3.2 x 2.6 m with insulation              | 1        | 300000,00         | 66667,00           |
| - construction of reversible channels                                      | 2        | 500000,00         | 11111,00           |
| - construction of a foundation for a fan and a drive motor                 | 3        | 5100000,00        | 113333,00          |
| - construction of a slab for a protective building                         | 3        | 64350,00          | 14300,00           |
| - construction of foundations for silencers                                 | 3        | 70000,00          | 15556,00           |
| - construction of foundations for channel supports                         | 1        | 105300,00         | 23400,00           |
| Other construction objects:                                                |          |                   |                    |
| - maintenance works in the channels, closing the channels,                | 1        | 115000,00         | 25556,00           |
| replacement of the grating protecting the outlet of the ventilation lunette to the shaft, | 1        | 115000,00         | 25556,00           |
| Land use:                                                                  |          |                   |                    |
| Roads, squares, pavements, lawns                                          | 1        | 550000,00         | 122222,00          |
| **Electric industry i I&C equipment**                                      |          |                   |                    |
| Dismantling works (in the WII fan building)                                |          |                   |                    |
| - control cabinet, 400V switching station, 500V switching station          | 1        |                   |                    |
| - auxiliary installations (lighting, heating, ventilation)                 | 1        |                   |                    |
| - cable lines and connections, measuring apparatus                         | 1        | 40000,00          | 8889,00            |
| - fan drive (motor), exciter                                               | 1        |                   |                    |
| Delivery and assembly:                                                     |          |                   |                    |
| - 6 kV switchgear, container transformer station                           | 1        |                   |                    |
| - guaranteed voltage switchgear 110VDC and 230VAC                           | 1        |                   |                    |
| - RPW 400V auxiliary switchboard, teletechnical cabinet                    | 1        |                   |                    |
| - 6kV frequency converters, 400V switching station (fans)                  | 3        |                   |                    |
| - 6 / 0.4 kV transformers                                                  | 2        |                   |                    |
- control cabinets and I&C equipment 3
- cable lines and connections, visualization and supervision system 1 2747000,00 610444,00
- auxiliary installations (sockets, lighting, heating, ventilation) - in the station building 1
- auxiliary installations (lighting, heating, ventilation) 3

| Others                          |         |         |
|--------------------------------|---------|---------|
| - design work                  | 1       | 550000,00 122222,00 |
| - supervision                  | 1       | 550000,00 122222,00 |
| - service, training, commissioning | 1   | 220000,00 48889,00 |
| Sum                            | 11808650,00 2624144,00 |

Own source.

3.5. Effectiveness of the adopted solutions

When selecting the variant of the station modernization, the possibility of continuous ventilation of mine workings should be considered. Table 4 summarizes, depending on the variant, the duration of the investment and the operation period of the main ventilation station without a reserve.

| Table 4. List of options for the modernization of the main fan station at the North shaft |
|------------------------------------------|---------|---------|---------|---------|
| Description                              | Variant A | Variant B | Variant C | Variant D |
| Execution of fans                         | unusual  | unusual  | unusual  | unusual  |
| Deadline for commissioning the            | 24       | 24       | 24       | 24       |
| modernized station                        | months   | months   | months   | months   |
| Number of months of operation of one fan  | 22       | 22       | 22       | 0        |
| Required parameters                       | n/a      | n/a      | n/a      | applicable |
| Parameter adjustment                      | frequency converter | frequency converter | frequency converter, steering camera | frequency converter |

Another important criterion for selecting the variant of the modernization of the main fan stations at the North shaft is the reduction of electricity consumption, the purchase costs of which have recently been increasing. Table 5 presents the basic indicators of electricity consumption by station equipment.

| Table 5. Summary of electricity consumption by devices of the fan station |
|--------------------------------------|---------|---------|---------|---------|
| Description                          | Unit    | Variant A | Variant B | Variant C | Variant D |
| Engine                               | kW      | 1600     | 1600     | 1600     | 1000     |
| Oil pump, grease dispenser           | kW      | 1,1      | 1,1      | 1,1      | 0,05     |
| Pump operation during the billing period (1 year) | h     | 8760     | 8760     | 8760     | 365      |
| Oil system heaters                   | kW      | 2        | 2        | 2        | 0        |
| Heater operation in the billing period (1 year) | h     | 4380     | 4380     | 4380     | 0        |
| Oil level sensor                     | kW      | 0,05     | 0,05     | 0,05     | 0        |
| Sensor operation in the billing period (1 year) | h     | 8760     | 8760     | 8760     | 0        |
| Air cooler                           | kW      | 3        | 3        | 3        | 0        |
| Air cooler job (1 year)              | h       | 3504     | 3504     | 3504     | 0        |
| Energy consumption in the billing period (1 year) | MWh/a | 29,3     | 29,3     | 29,3     | 18,25    |

4. Conclusions

The conducted studies of variants of modernization of the main fan stations of mine Y show that:

- Variants A and B consisting in the modernization of the existing WPK 5.0 fans through the installation of new rotors, correction of the spiral shape, replacement of motors and the use of smooth speed control do not meet the required assumptions. These variants will not allow the
station to operate at the required operating points, which is clearly illustrated by the computational studies and analyzes of the current and target mine ventilation network. Modernization of fan stands according to these variants is on average PLN 2.2 million (EUR 0.5 million) cheaper than the most expensive variant, but these solutions will bring losses in the long run.

- Solutions according to variant C consisting in the modernization of the existing WPK 5.0 fans by installing new rotors, correcting the shape of the spiral, installing new steering apparatuses, and replacing motors, and using smooth speed control. They will not allow the station to operate at the required operating points, which have been determined based on calculations and analysis of the current and target mine ventilation network. This option will not bring the assumed financial benefits in the long run.

- The solution according to variant D, consisting in the delivery and installation of three new WPK 2.6 fans with rotors with an outer diameter of 1950 mm, seems to be the most rational based on the research carried out. The station parameters will be regulated by parallel operation of two fans and additionally by changing the rotational speed of each fan. The new fans will be installed in a place that has not been used so far for the installation of the third WPK 5.0 fan. The new WPK 2.6 fans will be characterized by higher efficiency at maximum and minimum parameters.

- The implementation of variant D means that practically throughout the modernization, the existing main ventilation station will operate as before, i.e. there will be a primary and a backup fan. In addition, this solution ensures flexible adjustment of station parameters to unplanned changes in ventilation conditions during the operation of the target model of mine Y.

- The research presented in the article is conceptual research and does not constitute the final solution for the modernization of the main fan station on the North shaft for mine Y, but they show the direction in which this modernization should go.

- Social financial support for the process of closing unprofitable hard coal mines is an important element for the entire mining industry and the national economy in Poland. Only the planned and well-thought-out liquidation of mining plants enables the rational use of the allocated funds and the use of the infrastructure of former mines for new goals and strategic assumptions.

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