

PAPER • OPEN ACCESS

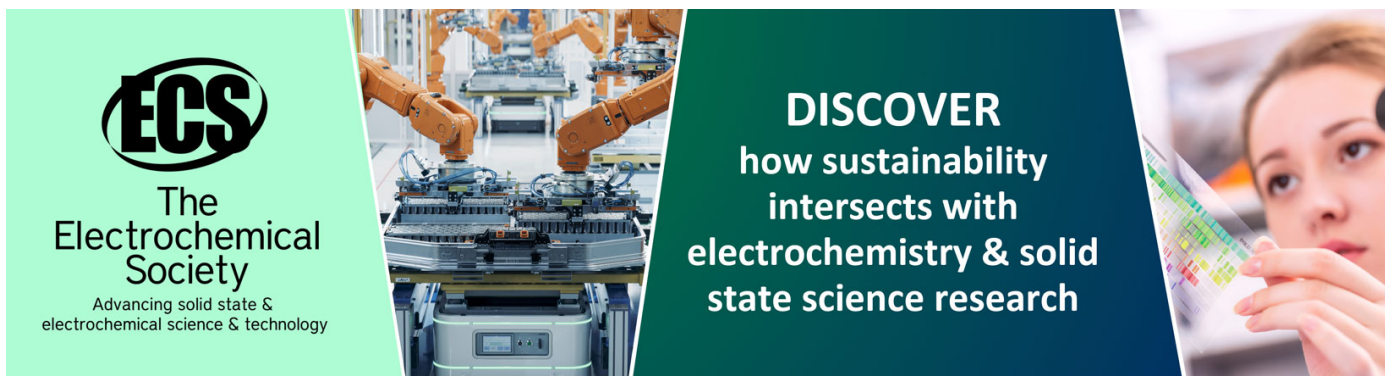
State-of-The-Art Pulsating Jigs of KOMAG Type

To cite this article: P Matusiak and D Kowol 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **545** 012008

View the [article online](#) for updates and enhancements.

You may also like

- [Historical background and development trends of minerals' processing – conclusions from KOMEKO–IMTech 2019 Conference](#)
M Malec
- [SCADA Class Software of the KOGA Control system of Jig Beneficiation Node](#)
J Rogala-Rojek, K Stankiewicz and S Jendrysik
- [Improving the quality of hard coal products using the state-of-the-art KOMAG solutions in a pulsating jig nod](#)
D Kowol and P Matusiak



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

State-of-The-Art Pulsating Jigs of KOMAG Type

P Matusiak and D Kowol

KOMAG Institute of Mining Technology, Division of Preparation Systems,
37 Pszczyńska Street, 44-101 Gliwice, Poland

patusiak@komag.eu, dkowol@komag.eu

Abstract. For several decades the KOMAG Institute of Mining Technology has been involved in a construction of pulsating jigs - devices for a gravity beneficiation of hard coal. The conducted research and conceptual work enables their constant development, resulting in their high reliability and efficiency. The article presents the latest design solutions and examples of implementations of the KOMAG state-of-the-art pulsating jigs in the Polish hard coal mines. The operational principle and possibilities of an innovative control system of the KOGASTER SSWO jig node are also discussed

1. Introduction

A beneficiation has a decisive influence on the quantitative and qualitative parameters of commercial products. It is the basic process in Polish preparation plants of mineral raw materials. The beneficiation process of hard coal in jigs is an extremely important part of a production process of commercial assortments, serving the purpose of improving the quality of extracted raw material and achieving quality parameters of the products required by recipients. The quality of raw coal is improved by subjecting it to a series of technological processes, among others a beneficiation process in pulsating jigs [1]. The following paragraphs present a historical outline and solutions of the latest devices designed at the KOMAG Institute of Mining Technology for a beneficiation process of hard coal. Particular attention is paid to state-of-the-art solutions of OM fine grain jigs and OS medium grain as well as to new solutions used in them.

2. Historical background of KOMAG pulsating jigs

The first jig constructions were developed at KOMAG in 1955. Since then, pulsating jigs in the Polish preparation plants have been the basic devices, used in hard coal beneficiation processes.

Initially, the devices, having air chambers placed along the axis of the jig, next to the working bed [2], were constructed. They had the following markings:

- OBM (fine coal air pulsating jig),
- ODM (fine coal double trough air pulsating jig) ,
- OBZ (grain coal air pulsating jig).

These jigs were characterized by big dimensions and big weight.

In the 1970s, at Komag, the first Polish jigs were designed with air chambers located under the sieve deck, built in lower boxes, transversely to the longitudinal axis of the jig [3]. This solution is used until today. Jigs for beneficiation processes of various grain classes are constructed, including:

- fine grain jigs - OM (figures 1 and 2), grain class 20-0(0.5) mm,



- medium grain jigs - OS, grain class 80 (50) -0 (2) mm,
- grain jigs - OZ, grain class 120 (200) -20 mm.

A construction is subject to continuous modernizations, in line with the expectations of customers, both in terms of the shape geometry of the of lower boxes, fixing of sieve plates, an improvement of automatic reception control devices of heavy products, pulsation valves and working air collectors [4].

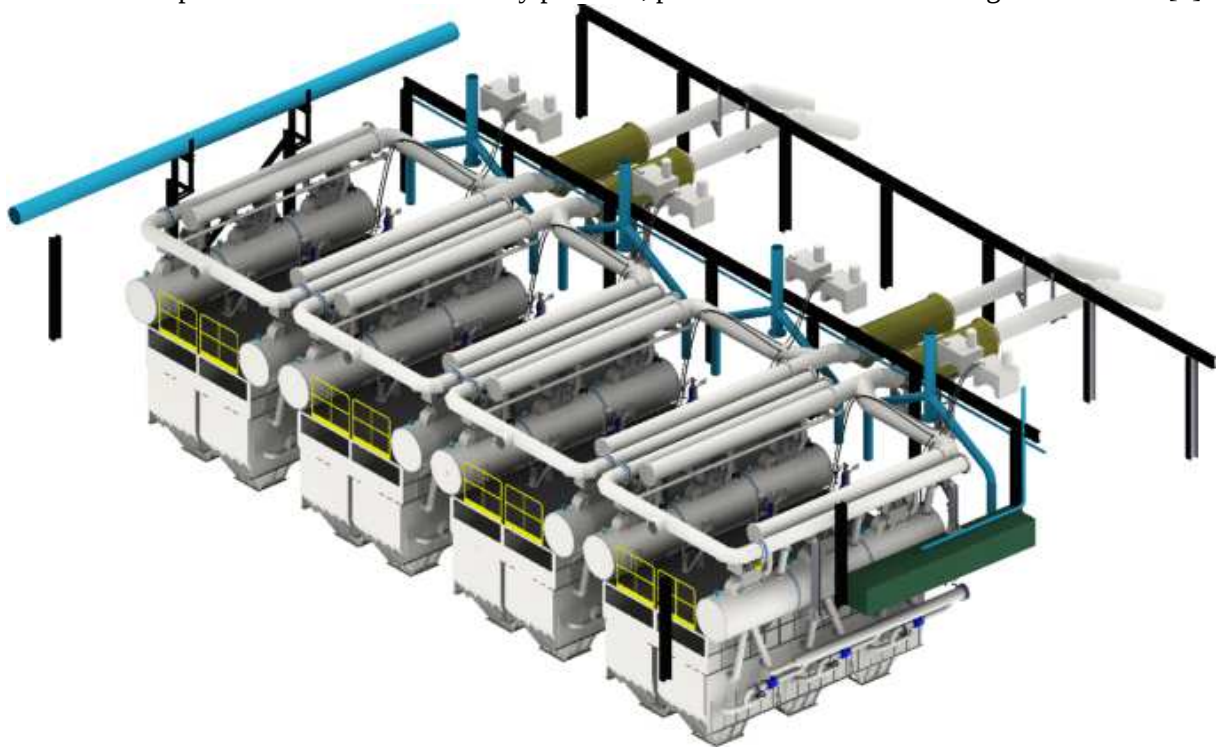


Figure 1. "Pniówek" Mine – a replacement of old OM24D3E double trough jigs for OM15 single trough.

3. Construction and operational principle of a pulsating jig

3.1 Construction of main components

The jig is composed of working compartments, which include lower boxes and upper boxes called working trough. The jig upper boxes are equipped with sieve plates, working air collectors, pulsating air timing gear and collecting devices of beneficiation products. In the lower boxes there are two pulsating chambers in the shape of a bell, to which working air is supplied, causing a pulsating movement of water and the collectors feeding the lower water at adjustable flow [5].

3.2 Jig principle of operation

A beneficiation process in jigs consists in using the rate of sinking in the water of grains differing in density. The beneficiated material undergoes cyclical loosening in the pulsating water medium, which causes its stratification and transport to the surface of the sieve bed towards the separation zone of the beneficiation products. The pre-prepared mixture of hard coal grains, fed to the working box, is subject to pulsation in the water medium on the sieve plates in the subsequent working compartments of the jig [6]. The pulsating movement of water, in the working chamber, generated by compressed air, causes stratification of the material [6]. During the water upward movement, the material resting on the sieve, is raised, then it falls down towards the sieve deck.

Subjecting the material to multiple pulsations (50-80 cycles per minute) results in a separation of the material into layers, from the grains with the highest falling speed, located on the sieve board, to the grains with the lowest falling speed, carried to the surface of the material under beneficiation. The stratified material moves continuously towards the separation zone, at the end of the jig working compartment [3].

On the basis of measurement signals and control of the collection system of beneficiation products, the beneficiated material is separated into the upper product (coal concentrate) which flows over the overflow threshold, ending the single jig compartment and the bottom product (waste), discharged to bucket conveyors through the collecting channel located below the sieve deck [5, 7].

3.3 Designs of KOMAG jigs

Table 1 [8, 9] presents a list of pulsating jigs designed at KOMAG in the years 1955-2019.

Table 1. List of jigs designed at KOMAG over the years 1955-2019 [8, 9].

Production period	Jigs type	Place of application
1955-1970	OBM12, OBM15, OBSZ15, OBZ10, OBZ12	Coal mines: "Anna", "Dębieńsko", "Knurów", "1-Maja", "Nowy Wirek", "Mysłowice", "Rydułtowy", export to China, India and Vietnam
1971-1985	ODM10, ODM18, ODZ15, OM12, OM12-2, OM12-3, OM12-3S, OM12G3, OM12P3, OM12L3, OM18P3, OM18L3, OM24-3, OM24D, OM24B3, OM24D3, OZ18L, OZ12, OZ12L, OZ12P3, OS36D3, OZ36D3, OC8, OC10	Coal mines: "Bogdanka" "Borynia", "Dębieńsko", "Gliwice", "Halemba", "Knurów", "Krupiński", "Jankowice", "Makoszowy", "Marcel", "Pniówek", "Dymitrow", "Rydułtowy", "Sośnica", "Staszic", "Wujek", "Szczygłowice", "Wawel", "Zabrze", "Zofiówka", "Moszczenica", export to Brazil, India and Romania.
1986-2014	OM8L2e, OM8L2E, OM10L2E, OM15P3E, OM12P3E, OMPE-3x6,5, OM18L3E, OM18P3E, OM20P3E, OM20L3E, OM24P4E, OM24L4E, OM24D3E, OS24D3E, OM30-3E, OM18 3x8, OM30D3E, OS30D3E, OM30, OZ18, OZ18L3E, KOD Jig	Coal mines: "Andaluzja", "Anna", "Barbara-Chorzów", "Bogdanka", "Borynia", "Budryk", "Dębieńsko", "Halemba", "Jastrzębie", "Jasmos", "Knurów", "Krupiński", "Marcel", "Pniówek", "Rozbark", "Rymer", "Rydułtowy-Anna", "Sośnica", "Staszic", "Szczygłowice", "Wawel", "Wujek", "Zofiówka", export to Czech Republic and India. „Budryk“ Mine for destoning of the run-of-mine.
2003-2018	Pulsating Classifiers K-100, K-150, K-50, K-80, K-101, K-102, K-151	KSM sp. z o.o. in Borzęcin, PPMD KRUSZBET S.A in Suwałki, PRInż. Surowce Sp. z o.o. in Januszkowice, PUHM "M+" Sp. z o.o. in Kędzierzyn Koźle, Żwirownia Bierawa, PRESTO Emil Potręć, Rokitno, Rent-Pol - Przezchlebie
2014-2020	OM30, OS18 L, OS18P, OM15L, OM15P, OS4, OM20, OS18L, OS18P, OM24, OM15L and OM15P, OM30, OM24	Coal mines: "Sośnica", "Krupiński", "Pniówek", "Budryk", "Zofiówka", ZG "Eko-Plus", ZG "Sobieski". "Bielszowice" Mine, "Bogdanka" Mine.

Within 65 years, KOMAG developed technical documentations of over 200 types of jigs and 120 other beneficiation devices.

4. New solutions used in KOMAG jigs

The followings examples show implementations of jigs, designed at KOMAG over the years 2016-2020.

4.1 Coal Mechanical Processing Plant at "Pniówek" Mine

In 2016, at Komag, a modernization project of a beneficiation node for the Coal Mechanical Processing Plant at "Pniówek" Mine was developed. A modernization mainly involved a replacement of 4 OM24D3E double trough jigs for 8 OM15 single trough jigs, and a use of more efficient bucket conveyors. The first system of the upgraded beneficiation node was started in 2017. The next ones will start in 2019 and 2020. The modernized beneficiation node (figure 3) consists of 4 beneficiation systems, each of them is equipped with:

- two fine coal jigs OM15L and OM15P (20-0 mm),
- two bucket conveyors B-1000 of capacity 250 t/h and 150 t/h.

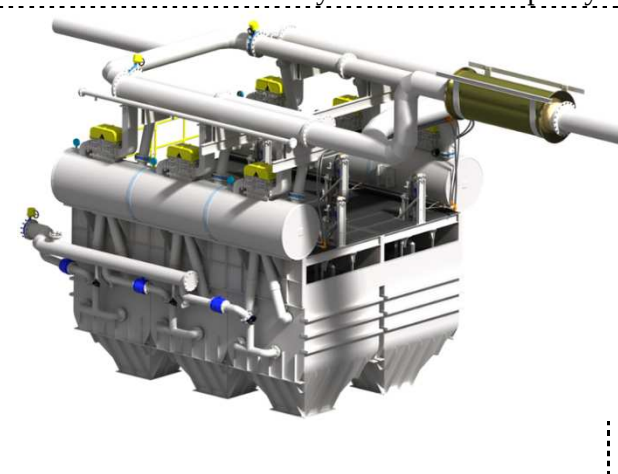


Figure 2. OM30 fine coal jig „Sośnica” Mine [8].

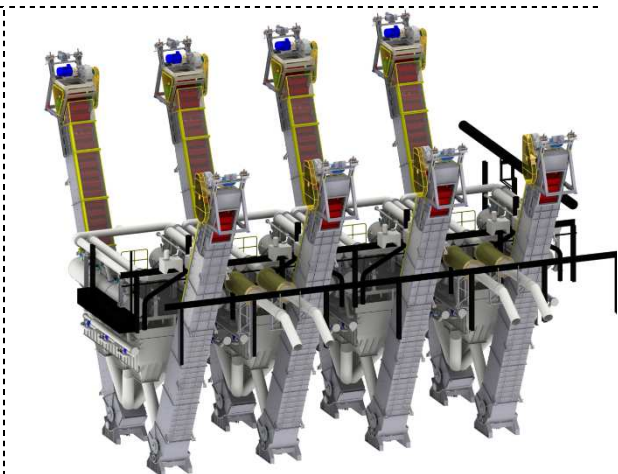


Figure 3. Coal fines beneficiation node at “Pniówek” Mine after modernization.

Designed OM15 fine grain jigs working in the 20-0 mm grain size class (figure 6) achieve a capacity up to 300 t/h. They use a new solution of the Festo pneumatic actuator control system (figure 4), reducing the sensitivity of the system to the control air contamination. A modernization of the plant was carried out in cooperation with the Wrębowa Company. The jig uses a new type of product discharge (figure 5), extending the working surface of the working deck and reducing disturbances of the material layer at the threshold.

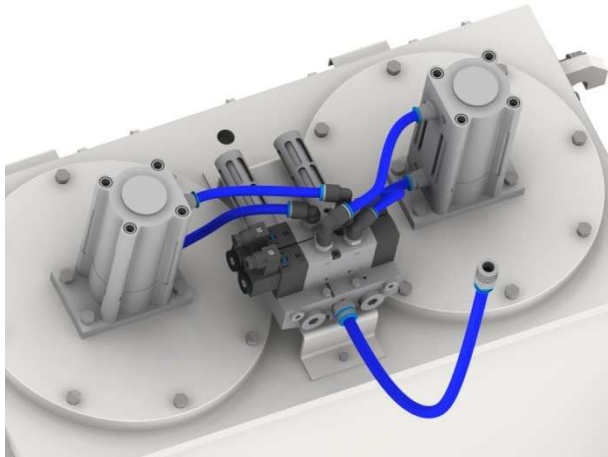


Figure 4. KOMAG pulsation valve.



Figure 5. Discharge of product - sliding damper.

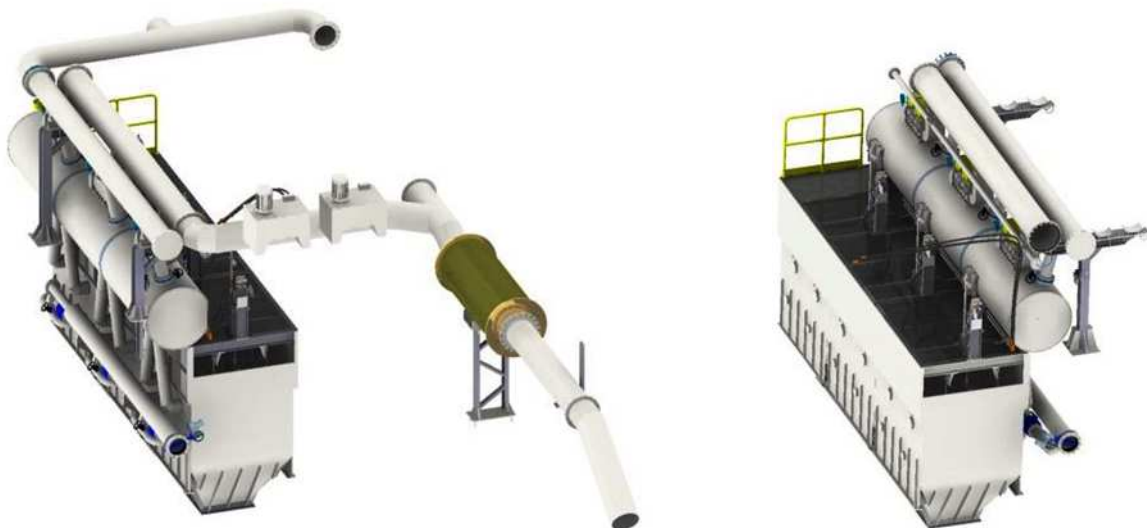


Figure 6. OM15L and OM15P new jigs - "Pniówek" Mine.

4.2 Coal Mechanical Processing Plant at "Budryk" Mine

In 2017, new jigs and bucket conveyors were designed at KOMAG for the Coal Mechanical Processing Plant at the "Budryk" Mine. The first system of the upgraded beneficiation node is scheduled for commissioning in 2019. The modernized beneficiation node (figure 7) consists of 2 beneficiation systems, each of which is equipped with:

- 3 medium grain jigs OS18 (L and P) (70-2 mm),
- 5 bucket conveyors B-1000 of capacity 220t/h.

OS18 medium grain jigs (figure 8), of 250 t/h capacity, are intended for a beneficiation of grain sizes 80-0.5 mm. Slotted sieves $S = 5\text{mm}$ are used in them. Additionally the hypertrophic product is directed to the UP 1000x1500 crushers, where it is recycled up to 12 mm after crushing. The second beneficiation system is equipped with:

- 2 fine coal jigs OM20 (12-0 mm),
- 4 bucket conveyors B-1000 of capacity 220 t/h.

A construction of the secondary beneficiation system enables an operation of only one jig. In the secondary fine coal jigs OM20 (figure 9), for a beneficiation in the grain size class of 12-0 mm with a maximum capacity of up to 250 t / h, a rubber sieve deck is used. A modernization was carried out in cooperation with the following companies: Famur S.A., Pemug S.A. and Fugor Sp. z o.o.

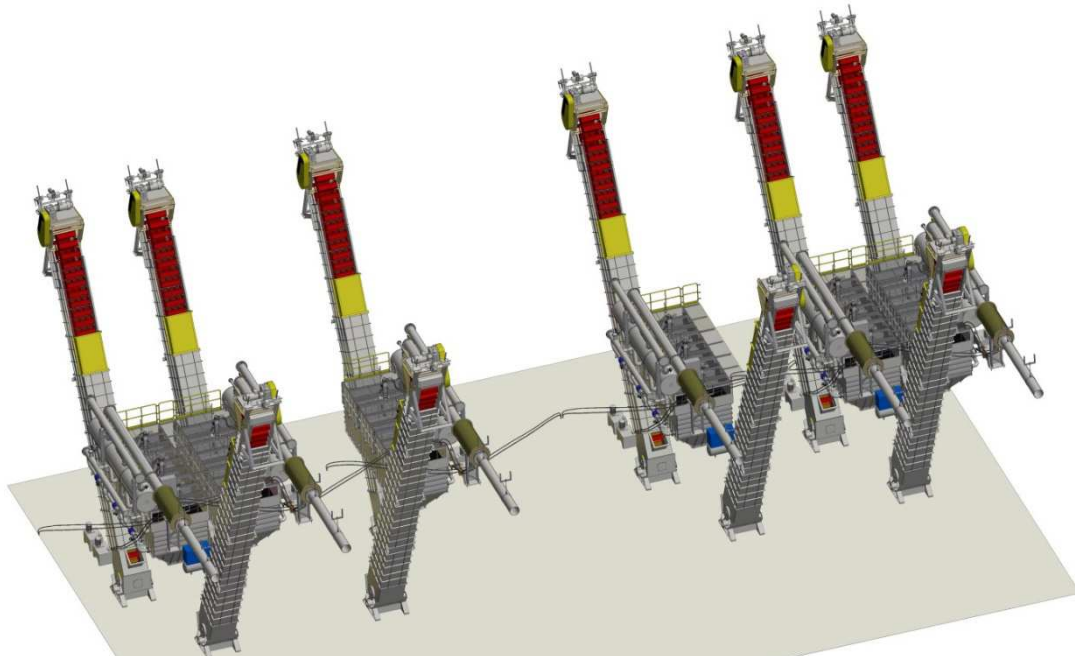


Figure 7. Two beneficiation systems - OS18 medium grain jigs.

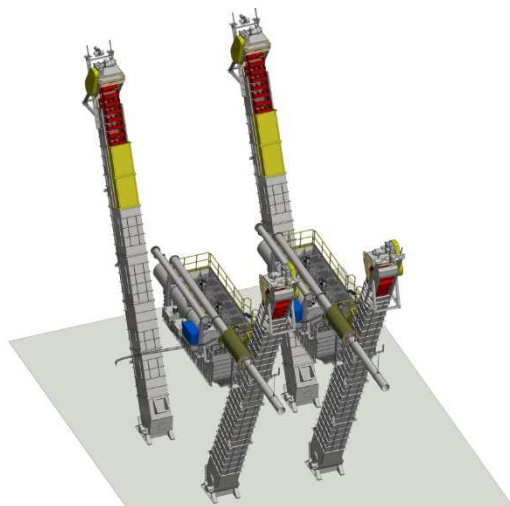


Figure 8. The secondary beneficiation system – OM20 two fine coal jigs.

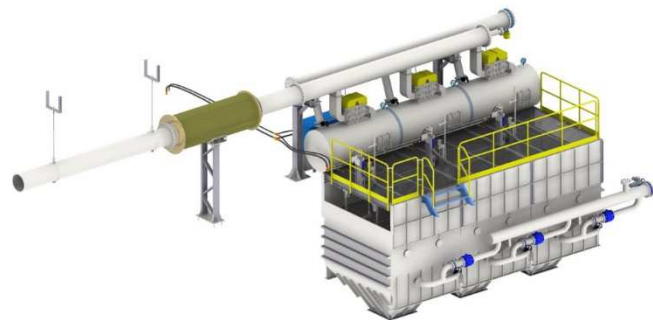


Figure 9. OM20 fine coal jig - "Budryk" Mine.

4.3 Coal Mechanical Preparation Plant at "Borynia-Zofiówka-Jastrzębie" Mine," Zofiówka" Mine

In 2018, a jig design was made for the Coal Mechanical Processing Plant at "Borynia-Zofiówka-Jastrzębie" Mine, "Zofiówka" Mine. The new system will be started in 2019. The first modernized beneficiation node system (figure 10) consists of a OM24 fine grain jig (20-2 mm), of maximum capacity up to 640 t/h. It uses perforated sieves decks Lv 25x5 30x20. The presented jig is the only device in Poland having the working bed width of 3500 mm.

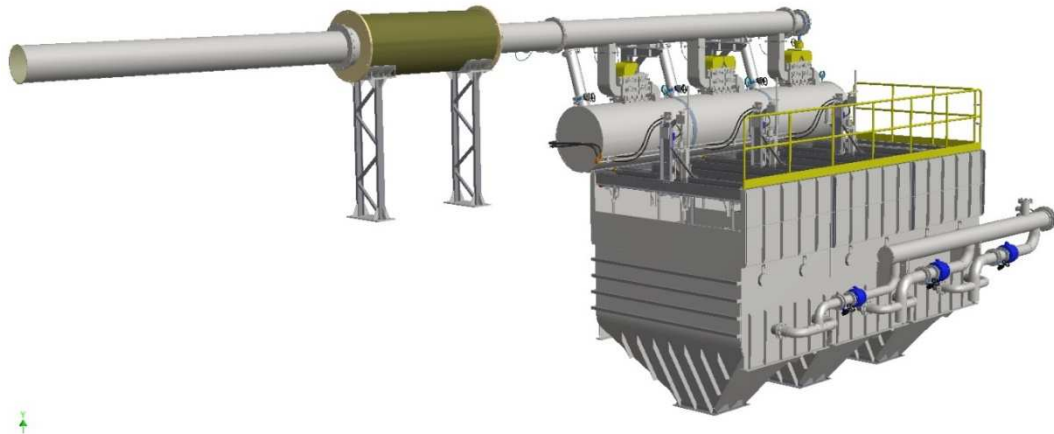


Figure 10. OM24 fine coal jig - "Zofiówka" Mine.

In the modernized beneficiation system an innovative solution of the jig feed boxes, with an overflow channel and a spray, which improve an uniformity of the material distribution before the jig and a better use of the working bed (figure 11) was used. The modernization is under realization in cooperation with the following companies: Carbo-Eco Sp. o.o and Fugor Sp. z o.o.

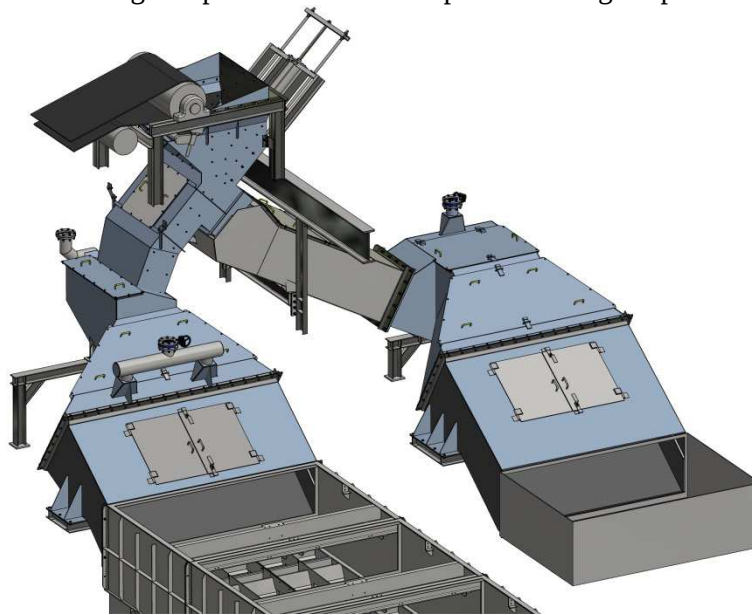


Figure 11. The system of directing feed to the OM24 jig.

4.4 Coal Mechanical Processing Plant at "Sobieski" Mining Plant

In 2019 the jigs for Coal Mechanical Processing Plant at "Sobieski" Mining Plant will be commissioned. The project was completed in 2018. The modernized beneficiation node consists of two fine coal jigs (figure 12) OM15L and OM15P working in the grain class of 30-2 mm, with a maximum capacity of up to 320 t/h each.

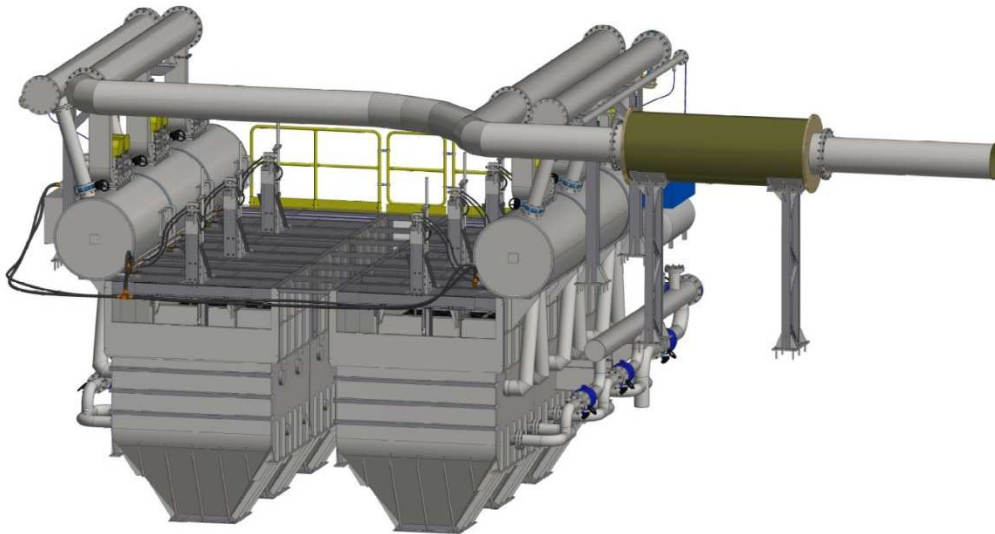


Figure 12. OM15L and OM15P fine coal jigs at "Sobieski" Mining Plant.

They will replace worked out two-compartment Allmialer jigs. The new jigs will beneficiate three products. An installation of three working compartments replacing two jigs, due to an insufficient length of the working area, required shortening of the working compartments to 2200 mm. The decks made of slotted sieves $S = 5$ mm, were used in them. Modern WZL1 2.8x6.0 screening machines, washing the material below 2mm, shown in (figure 13), were applied in front of the jigs.

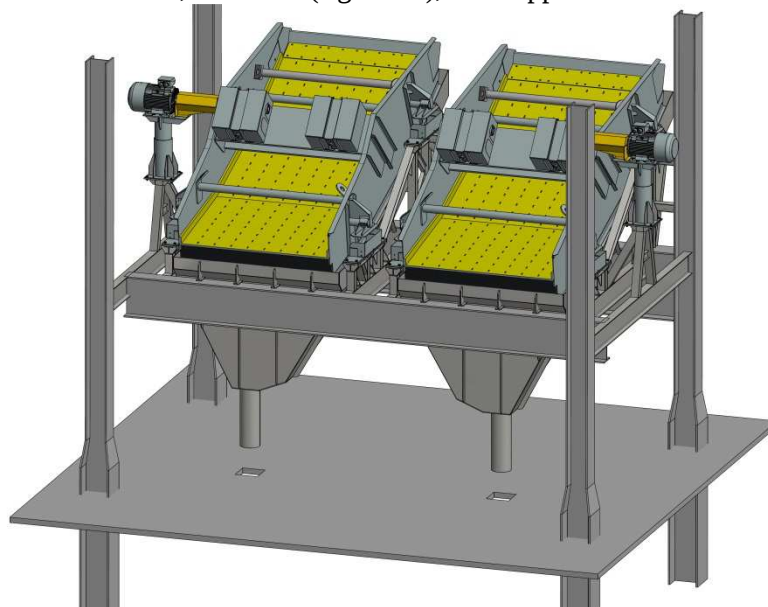


Figure 13. WZL1 2.8x6,0 screening machines at "Sobieski" Mining Plant.

5. Summary

Modernized beneficiation node systems in the "Budryk", "Borynia-Zofiówka-Jastrzębie", "Zofiówka" Mines and "Sobieski" Mining Plant will be equipped with KOGASTER SSWO - modern jig node control system (figure 14).

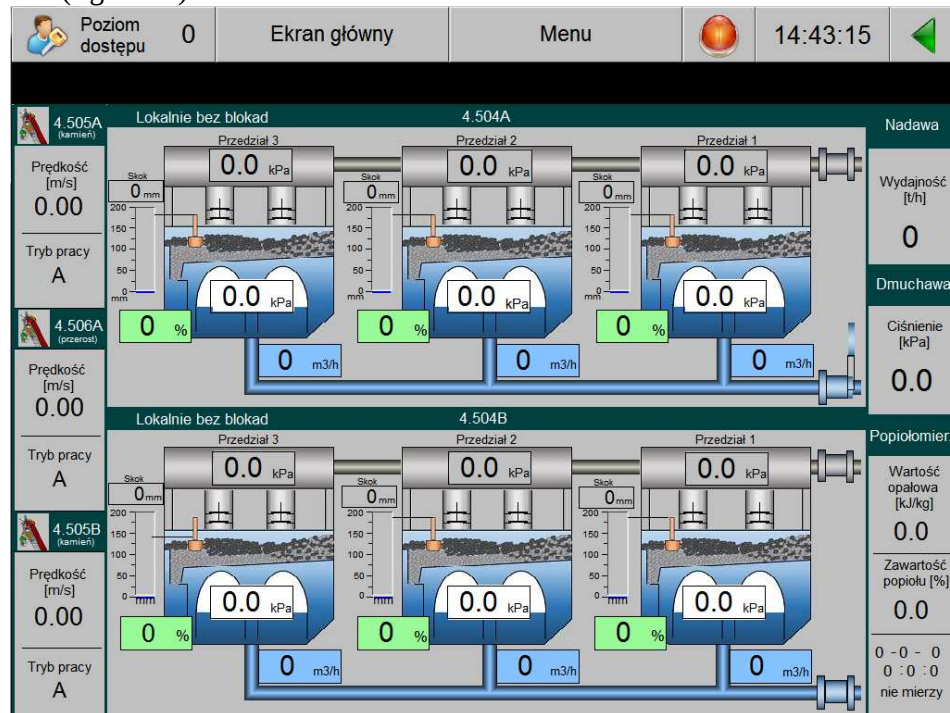


Figure 14. KOGASTER SSWO jig node control panel.

Among many functions of the system, it enables, among others:

- a control of water pulsation process, with a possibility of changing the length and number of phases (inlet, outlet and gaps between them) of the pulsation cycle, independent for each working compartment,
- an automatic adjustment of heavy products collection including a measurement of the culvert,
- a selection of the opening range of heavy product discharges,
- monitoring of the jig operation with a possibility of signalling irregularities,
- a speed control of bucket conveyors,
- a measurement and recording of monitored parameters, individually for each compartment [10]

The system, based on online measurements, shows ash content and it estimates calorific value of produced coal concentrate.

6. Conclusions

The modernization projects on beneficiation systems, conducted at KOMAG, were carried out in cooperation with their users, which resulted in a creation of innovative technological and design solutions. KOMAG researchers also cooperated with other research and development centres, universities and producers. During more than 60 years of jig design history at KOMAG, all their components were subject to structural changes. The main innovative features of developed jigs are:

- an efficiency increase,
- an improvement of beneficiation accuracy indicators,
- a reduction of technological water consumption,
- a reduction in the installation area which resulted in a weight reduction.

An improvement of the coal concentrate quality, at given technological parameters, was achieved, among others, due to:

- an installation of KOGASTER jig control systems,
- an automation of media control,
- a modernization of the air supply system (pulsation valves),
- a modification of the heavy product collection assembly.

References

- [1] Blaschke S 1982 *Przeróbka mechaniczna kopalin*. Wydawnictwo Śląsk. Katowice
- [2] Matusiak P, Kowol D and Jędo A 2011 Rozwój konstrukcji i technologii w osadzarkach pulsacyjnych typu Komag do wzbogacania węgla kamiennego i innych surowców mineralnych *Innowacyjne i przyjazne dla środowiska techniki i technologie przeróbki surowców mineralnych Bezpieczeństwo - Jakość - Efektywność KOMEKO* pp73-86
- [3] Osoba M and Jędo A 2000 Wpływ modernizacji osadzarek na uzyskiwane parametry jakościowe produktów wzbogacania *Produkcja surowców mineralnych z uwzględnieniem problemów ochrony środowiska* pp 1-7
- [4] Matusiak P and Kowol D 2013 Maszyny do przeróbki mechanicznej konstruowane w ITG KOMAG *Masz. Gór. 2* pp 71-76
- [5] Cierpisz S and Kowol D 2012 Wpływ zmian parametrów nadawcy na efekty działania pływakowego układu sterowania odbiorem produktów osadzarki *ITG KOMAG*
- [6] Kowol D, Lenartowicz M, Łagódka M and Matusiak P 2009 Przegląd rozwiązań konstrukcyjnych zespołów rozrządu powietrza pulsacyjnego w osadzarkach pulsacyjnych *Automatyzacja Procesów Przeróbki Kopalin*
- [7] Kowol D, Lenartowicz M and Łagódka M 2009 Rozwiązania konstrukcyjne układów odprowadzania produktu dolnego w osadzarkach pulsacyjnych *Innowacyjne i przyjazne dla środowiska systemy przeróbcze surowców mineralnych w aspekcie zrównoważonego rozwoju* pp 225-236
- [8] Matusiak P and Kowol D 2018 Rozwój osadzarek pulsacyjnych typu KOMAG *Masz. Gór. 2* pp 40-52
- [9] Kowol D, Matusiak P and Łagódka M 2018 Możliwości zwiększenia efektywności procesu produkcji mialów węgla koksowych poprzez wzrost dokładności wtórnego wzbogacania półproduktu w osadzarkach pulsacyjnej *Masz. Gór. 2* pp 53-64
- [10] Matusiak P, Kowol D and Łagódka M 2016 Nowe wdrożenia wzbogacalników pulsacyjnych typu KOMAG *Innowacyjne i przyjazne dla środowiska techniki i technologie przeróbki surowców mineralnych. Bezpieczeństwo - Jakość – Efektywność KOMEKO* pp 175-189