DOI: 10.32056/KOMAG2021.1.5

Application of Progress Eco equipment for modernization of mechanical coal processing plant at PG Silesia

Published online: 30-04-2021

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Keywords: coal preparation, sieving, heavy media cyclone, jig, dewatering

Słowa kluczowe: przeróbka, przesiewanie, cyklon ciężkich mediów, osadzarka, odwadnianie

Abstract:

Application of a new generation of sieving machines made by PROGRESS ECO is shown, based on Coal Processing Plant at PG Silesia. Screens are used as classifier and dewatering units. Brief characteristics of machines are shown. The article presents the results of the selection of screens in the PG Silesia coal processing plant. The modernization of the PG SILESIA coal mechanical processing plant resulted in the optimization of classification and dewatering processes in order to improve the parameters of the final product obtained. The optimal selection of the designed and delivered screens influenced the economic aspects of this project. The screening efficiency was increased by 95% and the water content after the material dewatering process was increased to less than 6%. Obtaining the above-mentioned optimal results was possible thanks to the effective cooperation of PROGRESS ECO designers with the design office and with the future user himself at every stage of the process.

Streszczenie:

Przedstawiono zastosowanie nowej generacji przesiewaczy firmy PROGRESS ECO w oparciu o Zakład Przeróbczy PG Silesia. Sita służą jako jednostki klasyfikujące i odwadniające. Przedstawiono krótkie charakterystyki maszyn. W artykule przedstawiono wyniki doboru przesiewaczy w zakładzie przeróbki mechanicznej węgla PG Silesia. Efektem modernizacji zakładu przeróbki mechanicznej węgla PG SILESIA była optymalizacja procesów klasyfikacji i odwadniania celem poprawienia parametrów otrzymanego produktu końcowego. Optymalny dobór zaprojektowanych i dostarczonych przesiewaczy wpłynął na aspekty ekonomiczne tego przedsięwzięcia. Podwyższono skuteczność przesiewania o 95% oraz zawartość wody po procesie odwadniania materiału poniżej 6%. Uzyskanie powyższych, optymalnych wyników było możliwe dzięki efektywnej współpracy konstruktorów firmy PROGRESS ECO z biurem projektowym oraz z samym przyszłym użytkownikiem na każdym etapie procesu.

1. Introduction

The literature on screening and screens are very wide, for the most important item to be considered [1, 2, 4]. The article presents the effects of the modernization of the classification systems in the coal enrichment plant at PG Silesia. The modernization included, among others, the replacement of all screens and the implementation of modern PROGRES ECO screens. In each node of the technological system, a screening system was used, selected in accordance with the previous research results presented in the previous publications of the Authors [5-13].

The modernization of the PG SILESIA coal mechanical processing plant resulted in the optimization of classification and dewatering processes in order to improve the parameters of the final product obtained. The optimal selection of the designed and delivered screens influenced the economic aspects of this project [15-21].

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2. Brief characteristics of the coal processing technology at PG Silesia

Coal production at Silesia PG consists of two main processes: the enrichment of fines in the class of 6 – 20 mm in wet cyclones and enrichment of medium and coarse grains in the class of 20 – 100 mm in Disa concentrator (Fig. 1). The enrichment in both processes (separation of coal from so-called gangue) proceeds via using differences in density in aqueous medium, which is a mixture of water and magnetite. In both processes so-called "heavy liquid" is maintained in density range of 1.4 g/cm3 and 1.6 g/cm3 and is dependent on the current production needs and densimetric composition of the feed. The products of above processes are density fractions, whose density is lower than that of the heavy liquid. The resulting product (coal), separated from gangue during enrichment processes and having size classes of 6 – 20 mm and 20 – 100 mm, is then dewatered. Coal class 20 – 100 mm, after dewatering on vibrating sifters, goes to the final classification node where it is separated into narrower graining classes so-called assortments, i.e. nut coal – grains ranging 40 – 100 mm; nut coal I – grains ranging 20 – 40 mm; pea coal – grains ranging 6 – 20 mm. Then, assortments are directed to the appropriate tanks from which they are loaded on the wagons by means of conveyor belt. Coal class of 6 – 20 mm is dewatered in vibrating centrifuge and, without final classification, directed to tanks and, in consequence, to wagons. Coal class of 0 – 6 mm, secreted in the preliminary classification node as well as in reseeding node, does not undergo any enrichment process and it is treated as a commercial product, called raw fines of 0 – 6 mm class.

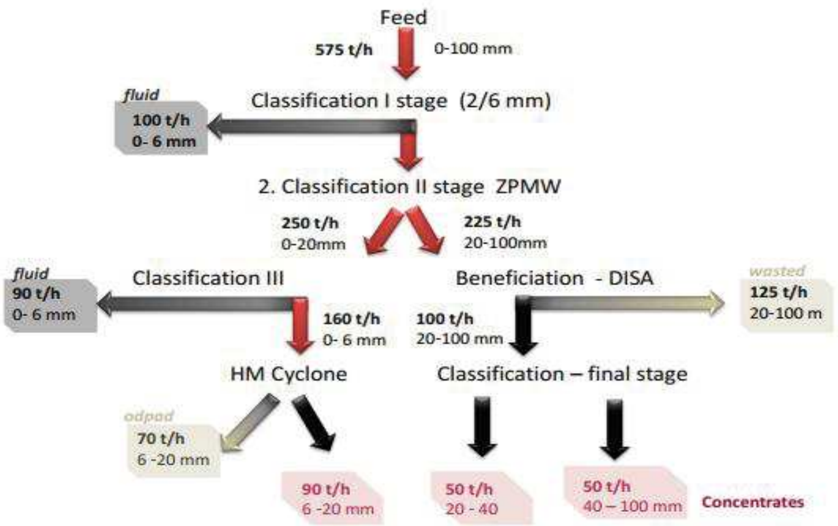

Fig. 1. Coal processing technology at PG Silesia [3]

3. Fines enrichment node

Raw output is directed on the control sifter WK1-2.0x4.0 (Fig. 2) equipped with one heavy sieve of 100 mm mesh diameter and welded sieves of Progress Tytan type having square mesh of 100 mm. Overflow product from the sifter (+100 mm class) is headed, through picking belt where wastes are hand-selected (wood, stone, scrap), to the single drum crusher for grain crushing to the size less than 100 mm, then the product is mixed with sifter's underflow product of 0 – 100 mm class. Raw output of 0 – 100 mm class, prepared in this way, is then directed to preliminary classification on two parallel sifters PWP2-2.2x5.25 (Fig. 3) equipped with two open grid plates. Protective upper grid plate in the form of woven sieves of TL type and mesh size equal 20 mm takes over the feed impact and thereby protects the lower grid plate equipped with steel harp sieve of T type and mesh size equal 6 mm. The underflow product of 0 – 6 mm class is directed to the raw fines tank in station 2.6, then transported with mine cars to the heaps and loaded to wagons.

Product of 0 – 100 mm class, already devoid of 0 – 6 mm class, is directed to initial classification on two tandem lines of PWP1-2.2x5.25 sifters (Fig. 4, 5). These sifters are equipped with woven sieves of TL type and 20 mm meshes.

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Overflow product from screens of 20 – 100 mm class is directed to enrichment process in the DISA concentrator. The underflow product in the class of 0 – 20 mm is directed to the PWP1-2.6x5.9 screen (Fig. 6) equipped with longitudinally stretched harp sieve of T type and 6 mm mesh.

The underflow product from the screen is directed to raw fines tank in the class of 0 – 6 mm, then loaded to wagons. The overflow product in the class of 6 – 20 mm is directed to enrichment process in heavy liquid cyclones. Harp sieve used in the screen (Fig. 7), with its distinctive design, through vibration screening and feed undergoes additional discordant vibrations, which prevent from clogging the sieve. Thus, they are characterized by a high degree of self-purification.

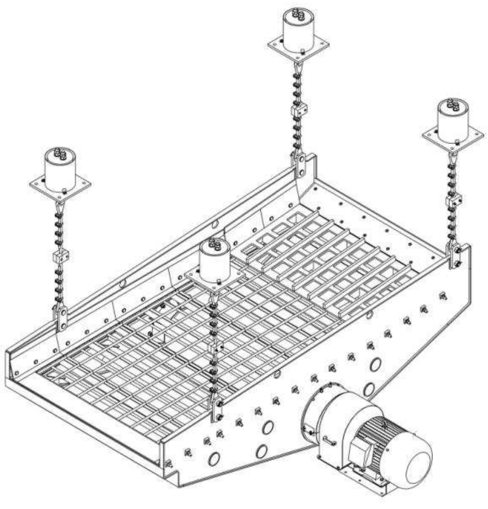
4. Metodology

The efficiency of screens is of particular importance in the selection of the size or number of screens in a system, as well as in the optimization of technological parameters. A calculation of the technical efficiency of machines in the coal processing system is crucial for the proper assessment of production efficiency. The complete processing plant is a set of basic and auxiliary machines. The basic ones include crushers, screens and belt conveyors. Other machines and devices, such as feeders, tanks, cranes, scales, monitoring or automation devices, fulfil auxiliary functions. The article presents the issue of the selection of basic machines in the design of aggregate production technology. This is the reference to the author's previous articles [5-15] as the third phase of the process of designing and analyzing production systems. Machines are selected in terms of the quality of the products, operations and performance.

The quality in the case of crushing is the so-called grain cubic capacity, and in the case of screening, it is the ability to effectively separate grains smaller than the mesh size into the under-screen product, i.e. to remove fine grains from the over-screen product. In general, the quality of the products of processing operations depends simultaneously on the design solutions of the machines and their geometric and dynamic parameters, as well as on the physical and morphological properties of coal, as well as on the moisture content, grain composition of the feed and the size of the load.

The issue of the efficiency of basic machines is of particular importance in the selection of the size or number of screens in the system, as well as in the optimization of technological parameters of these machines. The selection of machines in terms of efficiency is not easy, because it requires specialist knowledge and the ability to predict the performance of these machines in changing conditions of their work.

5. Selection of screens for subsequent stages of enrichment



Characteristics	
Purpose	Classification
Quantity	600 Mg/h
Feed diameter max	400 mm
Sieve surface	8.0 m^2
Sieve type PROGRESS TYTAN	100 mm
Frequency	12.2 Hz
Leap	11 mm
Angle	12^o
Motor power	18.5 kW
Weight	4.4 Mg

Fig. 2. WK1-2.0x4.0 vibrating screen

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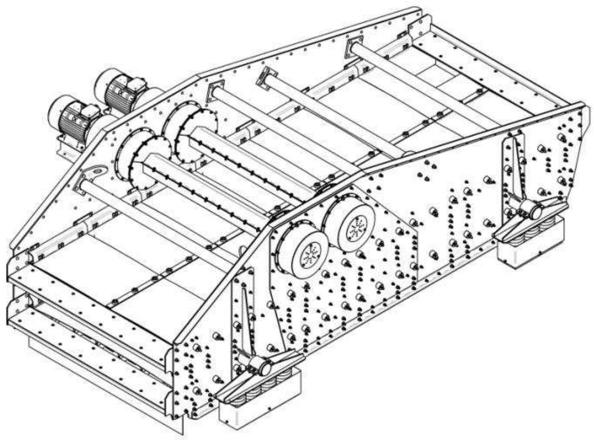
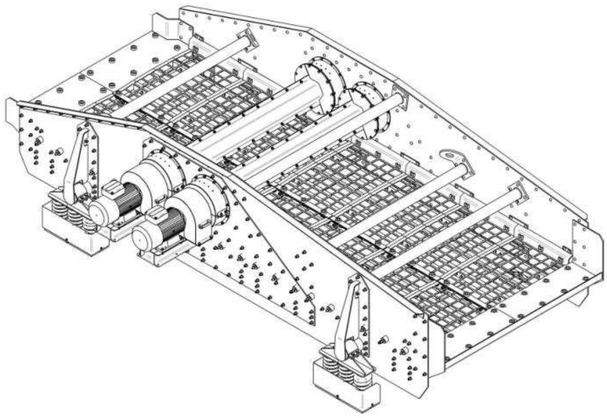


Characteristics	
Purpose	Classification
Feed diameter max	100 mm
Surface	2x11.5 m^2
Upper deck diameter	20 mm
Lower deck diameter	6 mm
Frequency	16 Hz
Leap	9 mm
Angle	10^o
Motor power	2x15 kW
Weight	8.6 Mg

Fig. 3. PWP2-2.2x5.25 vibrating



Characteristics	
Purpose	Classification
Feed diameter max	100 mm
Surface	11.5 m^2
Frequency	16 Hz
Leap	8 mm
Angle	2^o
Motor power	2x11 kW
Weight	5.8 Mg

Fig. 4. PWP1-2.2x5.25 vibrating screen

Fig. 5. Two tandem vibrating screens PWP1-2.2x5.25

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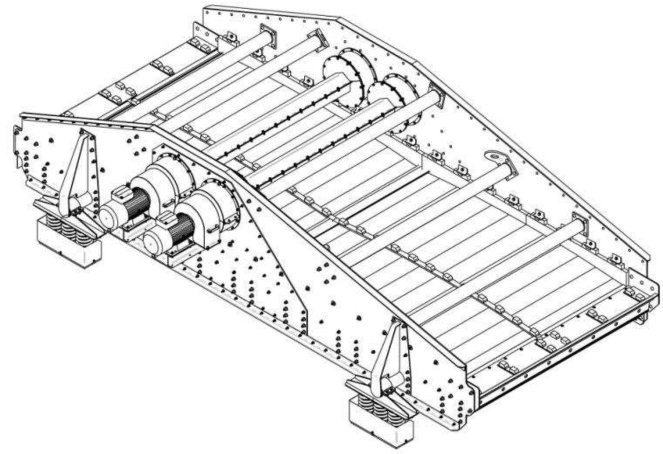

Characteristics	
Purpose	Classification
Quantity	250 Mg/h
Surface	15.3 m^2
Diameter	6 mm
Frequency	16 Hz
Leap	8 mm
Angle	8^o
Motor power	2x11 kW
Weight	8.0 Mg

Fig. 6. PWP1-2.6x5.9 vibrating screen

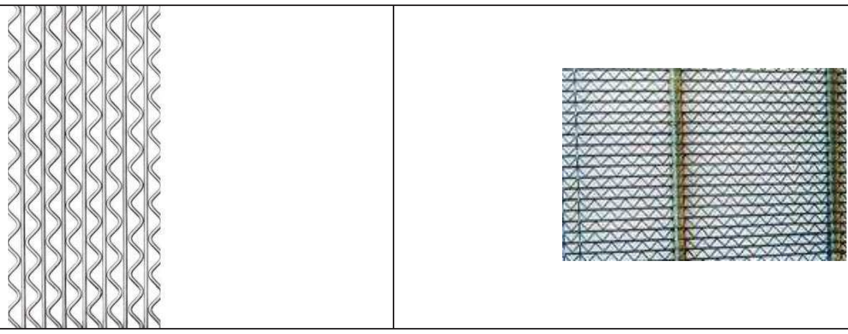

Fig. 7. The structure of harp screen type (part of PWP1-2.6x5.9 vibrating screen)

6. Enrichment in DISA concentrator

The feed material for the enrichment process is raw output in the class of 20 – 100 mm. Enrichment is carried out based on density difference related to aqueous medium (heavy liquid – water and iron ore mixture). Grains weighing more (waste – stone) than medium fall down to the bottom of the concentrator and are transported by means of wheel to the chute, and then to the dewatering process and tank. Grains weighing less than medium (coal product) float on the surface and go to the dewatering screen PWP1-2.4-5.25 (Fig. 8, 9) equipped with welded sieves mounted in the PRO-CLIN system.

The material from dewatering screen is directed to the PWP1-2.1x4.5 control screen (Fig. 10) equipped with rubber modular sieves of 100 mm mesh. Grains larger than +100 (screening overflow product) get to the double-roll crusher, where they are degraded to the size smaller than 100 mm, then they are mixed with the grains of underflow product and together directed to the final classification screen equipped with sieves of 20 and 40 mm. After the classification on the screen, the commercial products of proper graining are obtained i.e. nut coal (40 – 80 mm); nut coal I (20 – 40 mm); pea coal (6 – 20 mm). Commercial products are directed to the appropriate tanks, from where they are loaded to wagons or transported to the heap. The stone separated in the DISA concentrator (Fig. 11) goes to the PWP2-1.8x5.25 dewatering screen (Fig. 12) equipped with upper polyurethane grid plate mounted in the PRO-CLIN system of 20 mm mesh. The lower grid plate comprises slotted welded sieve with a gap of s = 2 mm, mounted in the same system. After dewatering, the stone in directed to the stone tank, where it is loaded for transport.

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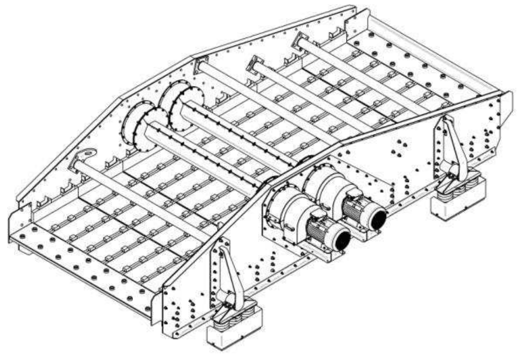
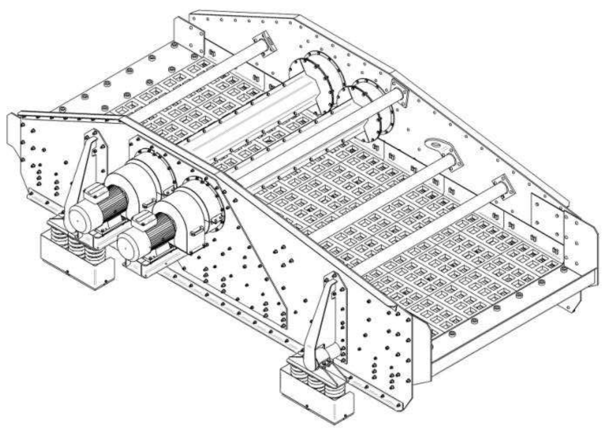


Characteristics	
Purpose	Dewatering
Surface	12.6 m^2
Sieves of slot	2 mm
Frequency	16 Hz
Leap	8 mm
Angle	2^o
Motor power	2x11 kW
Weight	7.6 Mg

Fig. 8 PWP1-2.4x5.25 vibrating screen

Fig. 9. Installation of deck in the PWP1-2.4x5.25 screen



Characteristics	
Purpose	Classification
Sieve surface	9.4 m^2
Clearance	100 mm
Vibration frequency	16 Hz
Riddle	8 mm
Inclination angle	2^o
Motor power	2x11 kW
Weight	5.6 Mg

Fig. 10. PWP1-2.1x4.5 vibrating screen

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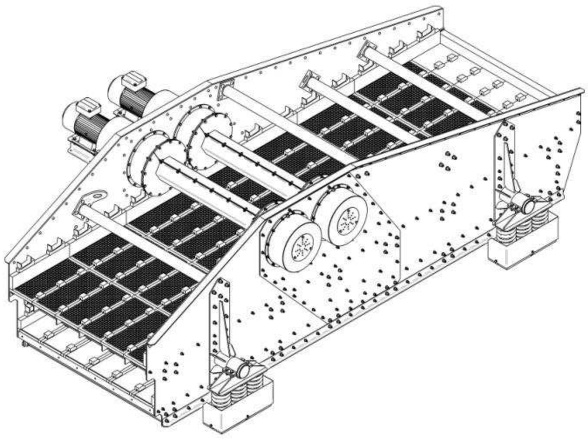
Fig. 11. DISA concentrator coal output, feed to dewatering and sorting sieve



Characteristics	
Purpose	Classification, dewatering
Surface	2x9.45 m^2
Upper deck	20 mm
Lower deck	2 mm
Frequency	16 Hz
Leap	8 mm
Angle	2^o
Motor power	2x11 kW
Weight	7.3 Mg

Fig. 12. PWP2-1.8x5.25 vibrating screen

7. Enrichment in cyclones

Feed material for the enrichment process is raw output of 6 – 20 mm class. Enrichment, similarly as in the DISA concentrator (Fig. 11), takes place based on the density difference related to aqueous medium (heavy liquid – water and iron ore mixture), except that the feed is premixed in the tank with heavy liquid, then it is directed under pressure to two cyclones. In the cyclones the grains are subject to additional centrifugal force, which forms counter-current. Feed, separated to wastes and coal product, is directed by pipes to the PWP1-2.4x5.25 vibrating dewatering screens (Fig. 9) to the equipped with slotted welded sieve with the gap of 1 mm, mounted in the PRO-CLIN system (Fig.13, 14). In addition, coal product is directed for dewatering purposes to the vibrating centrifuge, from where as dry material it is directed to the tank and then to loading. In the PRO-CLIN system, the sieve forms a module, which is mounted to the support structure using hooks and wedges. Offered system is characterized by an absence of screwed joints, which greatly accelerates a replacement of an individual sieve as well as of the whole grid plate. The advantage of using mounting hooks for screen construction purposes is scattering of the material on the grip plate and thus limiting the impact of so-called skip zone. The transverse bumps, which increase the effectiveness of screening and dewatering processes, can be used instead of the clamping wedges. An important advantage of the system is

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a lower grid plate weight, which greatly reduces the impact on the structure of the screen. The PRO-CLIN system is ideal for screens characterized by low grid plates.

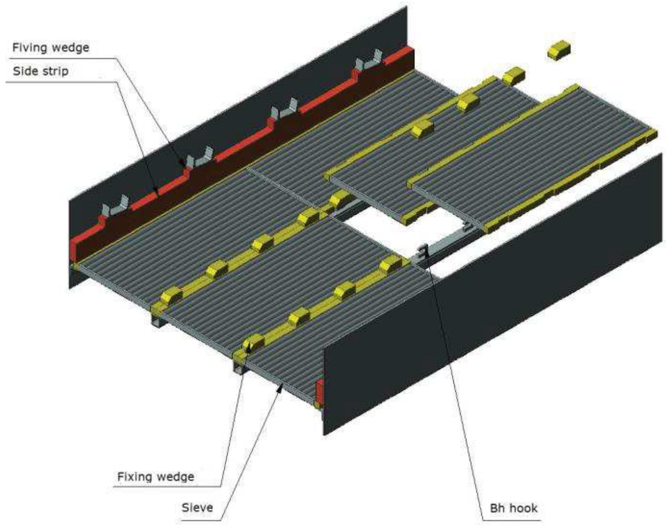

Fig. 13. Schematic PRO-CLIN screen fixing system

Fig. 14. Sieve deck, slotted, welded, built-in PRO-CLIN system

By analyzing the world solutions presented in the literature [14-20], it can be concluded that national solutions reach the world level. Specific considerations on the further development are presented in the article [21]

8. Conclusions

After an implementation of the screens industrial tests were performed at the PG Silesia. The obtained results were: efficiency of screening 95%, moisture content after products dewatering in the screen less than 6%.

The modernization of the PG SILESIA coal processing plant resulted in the optimization of classification and dewatering processes in order to improve the parameters of the obtained final product. The optimal selection of designed and delivered devices also affects the economic aspects of this project. After the implementation and commissioning of the modernized PG Silesia Processing Plant, material samples were analyzed. Obtaining the above-mentioned optimal results was possible due to the effective cooperation of the PROGRESS ECO designers with the design office and with the future user at every stage of the process.

References

[1] Banaszewski T.: Przesiewacze, Wydawnictwo Śląsk, Katowice 1990.

[2] Sztaba K.: Przesiewanie, Wydawnictwo Śląsk, Katowice 1993.

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[3] Laskowski J., Łuszczkiewicz A.: Przeróbka kopalin, Wydawnictwo Politechniki Wrocławskiej, Wrocław 1989.

[4] Blaschke S., Blaschke W.: Maszyny i urządzenia w przeróbce kopalin. Sita. Skrypt uczelniany nr 1145. Wydawnictwo AGH, Kraków 1989.

[5] Jonczak P., Pasiowiec P., Śmiejek Z.: *T*echnologiczne i ekonomiczne racje istnienia nowych rozwiązań w obszarze stosowania sit produkcji Progress Eco S.A. In: Nowoczesne systemy przeróbcze surowców mineralnych z uwzględnieniem problemów ochrony środowiska; KOMEKO 2004 Ustroń.

[6] Tora B., Pasiowiec P., Śmiejek Z.: The possibilities of using the centrifugal dewatering sieve In the system of classification. In: 7th Conference on Environment and Mineral Processing, VŠB – TU Ostrava 2003.

[7] Pasiowiec P., Wajs J., Bańczyk K., Borkowski W., Bogusław A., Tora B.: Rozbudowa układu klasyfikacji i odwadniania w Zakładzie Przeróbczym PG Silesia na bazie przesiewaczy wibracyjnych produkcji Progress Eco In: Innowacyjne i przyjazne dla środowiska techniki i technologie przeróbki surowców mineralnych: bezpieczeństwo – jakość – efektywność. KOMEKO 2015, ITG KOMAG. Gliwice 2015.

[8] Hycnar J.J., Pasiowiec P., Bańczyk K., Wajs J., Tora B.: Zwiększenie skuteczności odwadniania i klasyfikacji zawiesiny wody odciekowej w instalacjach odwadniania żużla przy zastosowaniu sit OSO. In: XXIX konferencja z cyklu: Zagadnienia surowców energetycznych i energii w gospodarce krajowej pt. Paliwa dla energetyki – mix energetyczny. Zakopane, 2015.

[9] Pasiowiec P., Bańczyk K., Wajs J., Gawlista S., Tora B., Burek A.: Comparative analysis of dewatering efficiency and distribution of materials in centrifugal dewatering sieve with steel and polyurethane insert. In: 19th Conference on Environment and Mineral Processing, VŠB – TU Ostrava 2015.

[10] Pasiowiec P., Bańczyk K., Tora B., Brożyna J., Wajs J.: Uniwersalne zastosowanie sit szczelinowych zgrzewanych w procesach wydobycia i przeróbki węgla kamiennego, ropy naftowej, gazu ziemnego oraz uranu. In: XXXI Konferencja Energetyczna, Zakopane 2017.

[11] Pasiowiec P., Wajs J., Bańczyk K., Babczyński J., Tora B.: Nowoczesne rozwiązania w układach klasyfikacji ziarnowej - zastosowanie przesiewaczy produkcji PROGRESS ECO. In: XXXII Konferencja Energetyczna, Zakopane 2018.

[12] Materiały reklamowe, prace badawcze i dokumentacje firmy Progress Eco Sp. z o. o. Sp. K.

[13] www.progresseco.pl [accessed: 12.02.2021].

[14] Vu Van Tan, Mac Van Giang, Nguyen Thi Hong Nhung, Ngo Trung Kiên: Structural Analysis of a Charcoal Sieving Machine Under Dynamic Load, International Journal of Engineering Research, Vol.6, Issue No.7, pp : 346-348, 2017.

[15] Ugur Ulusoy, C. Igathinathaneb: Particle size distribution modeling of milled coals by dynamic image analysis and mechanical sieving. Fuel Processing Technology, Volume 143, Pages 100–109, 2016.

[16] Oladeji Akanni Ogunwole: Design, Construction and Testing of a Dry Sand Sieving Machine. Appl. Sci. Environ. Manage, Vol. 16 (3) 241 – 243, 2012.

[17] Jacek Sitko. Rastislav Mikuš, Pavol Božek: Analysis Of Device Failure In The Mechanical Production. PLMAPE, volume 1, issue 1, pp. 93-99, 2018.

[18] Biały W.: Application of quality management tools for evaluating the failure frequency of cutter loader and plough mining systems. Arch. Mining Sci. vol. 62 iss. 2, s. 243-252, 2017.

[19] Guo Qingliang, Gong Gu: Application of flip flow screen in Sihe Coal Preparation Plant. In: XVIII International Coal Preparation Congress, Springer, pp 913-918, 2016.

[20] Zhenqian Wang Linyi, Wu Jida , Yuemin Zhao: Impact of screening coals on screen surface and multi-index optimization for coal cleaning production. Journal of Cleaner Production, March 2018.

[21] Michał Kopacz, Dominik Kryzia, Katarzyna Kryzia Assessment of sustainable development of hard coal mining industry in Poland with use of bootstrap sampling and copula-based Monte Carlo simulation. Journal of Cleaner Production, Vol. 159, Pages 359-373, 2017.

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