



Application of Air Concentrating Table for Improvement in the Quality Parameters of the Commercial Product “Jaret®”

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Summary

Dry deshaling of raw coal is a method which allows to limit the amount of rock grains in raw coal. The result of this process is the ability to achieve a significant improvement in the quality parameters (calorific value) of the commercial products. There is also the possibility to limit the total sulfur content and ash content in the produced commercial products obtained from raw coal. This is confirmed by the tests carried out by “Centre of Waste & Environment Management” of the Institute of Mechanized Construction and Rock Mining with applying an air concentrating table – FGX. This chapter presents the results of desulfurization and ash removal from the commercial product JARET®, obtained from the production process of the Coal Company “Janina” being a part of TAURON-Wydobycie S.A. The technological requirements of the dry deshaling process are also presented.

Keywords: hard coal, dry separation, air concentrating table, desulfurization

Introduction

JARET® is a selected product of grain size from 6 to 25 mm, produced on the specially prepared for this purpose production lines of TAURON Wydobycie S.A. JARET® is a small steam coal. The product is dedicated to – implemented in the recent years – ecological (low emission) boilers with retort burners. Production of JARET® started in 2007 in “Janina” Coal Company. In 2009 the investment involving the development and adjustment of the technological lines for production of JARET® in „Sobieski” Coal Company was completed.

JARET® is produced in the classification process of coal concentrates obtained in the dense medium separation – Disa type and through the classification on the screens the concentrate from the fine coal jigs. The concentrate from the two chambers of the Alumineral fine coal jig is directed to dehydration process on the double-deck screens PWE 2,4x4,8 type. The upper deck of the screen is equipped with the set of metal screens of mesh size 10-16 mm, whereas the second one – with the membrane rubber screens of the mesh size – 1 mm. The product called “JARET®” is separated from the upper deck. The product, through the feed conveyor, is directed to the bunker and

then by belt conveyer, equipped with the scales, is transported to the car loading point.

The quality parameters of JARET® are as follows:

- size 6-25 mm
- calorific value (Q_{ir}) – 21 000 – 22 000 kJ/kg
- ash content (Ar) – 6 - 10%,
- sulphur content (Str) – do 1,2%.

One of the potential application of the JARET® product is using it as a component of so-called eco-pea coal of the commercial name “JARET PLUS®” which is a coal fuel developed in the cooperation with the Institute for Chemical Processing of Coal (IChPW) in Zabrze. It is a blend of coals produced in TAURON Wydobycie S.A. called JARET® with some high calorific fuels available on the Polish market. In 2007 JARET PLUS® received the certificate awarded by the Institute for Chemical Processing of Coal as a proof of being ecological safety.

Coal fields exploited in the “Janina” Coal Company and “Sobieski” Coal Company are located in the East part of the Upper Silesian Coal Basin (GZW). These coals are characterized by the higher – in the comparison with the other parts of GZW – value of sulphur. The sulphur is present in the significant quantities in the form of pyrite

and marcasite. These ferrous sulphides are of high density and should be removed during the gravity concentration in preparation plants. However, due to the imperfection in the processes of density separation, they get into – in the small quantities – to the concentrates, increasing the sulphur content in the commercial products. For this reason, it was decided to check if the FGX-type air concentrating table being in possession of the Institute of Mechanized Construction and Rock Mining – Katowice can be used for removing pyrite (marcasite) from the JARET® commercial product.

The Institute has already conducted a lot of research on materials of different sieve and float-and-sink composition [1-7]. They concerned inter alia:

- raw fine coals of particle size ranging from 12 to 0 mm, from 20 to 12 mm, from 20 and 0 mm and from 30 to 0 mm,
- raw coals of particle size in the range from 60 to 16 mm, from 50 to 25 mm, from 25 to 8 mm, from 25 to 6 mm, from 25 to 0 mm and from 20 to 0 mm.

The subject of the research works was also to carry out the tests aimed at improving the quality parameters of the commercial assortments of coal such as: washed fine coal of particle size in the range from 30 to 0 mm, pea coal of particle size in the range from 50 to 20 mm.

On the basis of the gained experienced, the research tests in the Institute were carried out in order to examine the possibilities of sulphur and ash content reduction in the JARET® commercial product [8].

The results of these tests are presented in this paper.

Construction of the air concentrating table type FGX and variable operating parameters

The tests were carried out with the use of the air

concentrating table of FGX-1 type and site for preparation and dosing station of material for the dry deshaling process. The FGX-1 unit consists of separating deck of 1 m² in the shape of trapezoid with a built-in perforated rubber sieve with a mesh of Ø 6 mm. There are 7 riffles on the deck whose task is to direct the movement of separated feed material. The separating deck of the FGX-1 unit is hanging on the rope slings with adjustable lengths. This construction solution allows to manipulate the longitudinal and cross-table slopes of the hanging deck in order to optimize the process of dry deshaling. In the end part of the plate two vibrators are built that set the working plate into asymmetric reciprocating motion.

The unit is equipped with a centrifugal blower producing air that is supplied through the collectors to the separated zones of the deck. Due to the type of obtained products there are 3 zones on the deck: 1st zone – at the beginning of the table – for collecting coal products, 2nd zone (in the middle) for collecting middlings, understood as a blend of coal and tailings particles or intergrowths of coal with rock. The end part of the table, being the 3rd zone, is for refuse collection. A collection bin for tailings is placed at the narrowing end of the separating deck. In the case of redirecting the stream of waste product to the narrowing end, a two-product separation process releasing coal product and middlings can be conducted on the working plate. The amount of air supplied to each zone is regulated with the use of regulated flow restrictor [2, 4, 5].

In the conducted dry deshaling process the capturing of dust takes place with the use of built-in air curtain, thickening-classifying cyclone and battery of bag filters. Dust is a separate product of the dry deshaling process.

The transport of the feed material to the separating deck is realized by a buffer bin and vibrat-



Figure 1 and 2. Separating deck of the FGX-1 air concentrating table [source: Photo by Wojciech Sobko]

Rys. 1 i 2. Płyta separacyjna powietrznego stołu koncentracyjnego typu FGX-1 [zdj. Wojciech Sobko]

ing feeder. Collecting the obtained products of separation from the particular conveyors is carried out by the built-in separator with baffle plates that regulate quantity and quality of the obtained separation products [4, 5].

The most important factors influencing the effectiveness of the separation include:

- size of the feed, especially the size of the biggest particles and the amount of the finest particles (fraction under 6mm)
- float-and-sink composition of the raw coal; density of particular grains, amount of the middling fractions, amount of waste fractions,
- way of presence of contaminants, especially the presence of rock and coal false middlings, contamination of coal grains with mineral matter (mineralization), contamination the particular grains with sulphur compounds (sulphate, organic), false middlings with ferrous sulphides, the amount of released grains of pyrite (marcasite),
- moisture of the raw coal, including surface moisture (7-9 %)

Whereas the technical (regulatory) factors of the air concentrating table are as follows:

- amount of supplied air,
- height of riffles,
- table slopes (longitudinal and transverse),
- frequency vibration of the working plate,
- position of baffle plates,
- position of flaps regulating the movement of the materials to the particular products,
- load (capacity) of preparation plant.

The deck of FGX-1 air concentrating table is presented on the figures no. 1 and no. 2.

The effect of ash removal and desulphurization of the JARET® commercial product

The subject of the dry deshaling process was the commercial product JARET® produced in the fine coal jig of the technological line in the preparation plant. The experience gained during the preliminary phase of the research tests on ash removal and desulphurization of the “JARET®” commercial product allowed to select the set of the variable operation parameters of the unit: longitudinal table slope and cross-table slope, the amount of air into supplied to the particular zones of collecting products of separation, the height of the baffle plates as well as the position of flaps separating the products of dry deshaling.

Tables 1-4 show the results (given in the operating status) of the “JARET®” product preparation on the air concentrating table. The tests were carried out on the four samples taken from

the production line of the “JARET®” commercial product at different times.

The above-presented results of tests, carried out on coal from the coal mines belonging to TAURON Wydobycie S.A., show that there is a possibility of effective application of the dry deshaling method on the air concentrating table.

The detailed analysis of the obtained results confirms the desirability of improvements of the quality parameters of the commercial products. The interesting results were obtained while examining the possibilities of reducing the amount of the total sulphur after the deshaling of the “JARET®” assortments (tables 1-4).

The test results should not be considered as optimal. The producer of air concentrating tables in his information materials indicates that selection (adjustment) of the particular technical parameters of the table should be carried out in continuous production over a longer period of time. It is recommended that the adjustment of these parameters to the technological properties of raw coal (float-and-sink and sieve tests) should be conducted by experienced professionals for at least one month. The producer even offers sending his own expert.

As it is easy to notice, the number of the regulated parameters is significant. Changing them results in obtaining different results of the quality parameters of the final products. This can be clearly seen in studies on reduction of total sulphur content conducted in the four tests on the four samples of “JARET®”.

The changes concerned the table slope (longitudinal and transverse), the frequency vibration of the working plate, the position of the baffle plates, the level of opening of air throttle, the position of flaps discharging products of separation, the heights of leaves on the riffles of the working plate, the position of the feeding flap (open, closed). While changing these technical parameters, the reduction of sulphur content in the concentrate to 0,86 - 1,07% was obtained with the fluctuations of the sulphur content in the feed from 1,15 to 1,46%. Other quality parameters were also been improved. The ash content in the concentrate decreased to the level of 6,4 - 9,5% with the ash content in the feed equalled 9,8-17,0%. The calorific value increased to 22 897 - 23 886 kJ/kg with the calorific value of the feed 19 853 - 22 364 kJ/kg. It is worth-emphasizing here that these are very good results, taking into consideration that JARET® product was obtained as a result of earlier preparation of the raw coal in the fine coal jig.

Tab. 1. Results of the qualitative determination of the feed and products of separation for the commercial product „JARET®”

Tab. 2. Wyniki jakościowego oznaczania wsadu i produktów separacji dla produktu handlowego "JARET®"

Type of parameter	Symbol	Unit	Feed [N]	Collection point of		
				Coal product Product no. 1	Middlings Product no. 2	Tailings Product no. 3
Total moisture	W_t^r	%	15,0	14,6	14,5	11,7
Hydroscopic moisture	W^a	%	7,5	9,5	9,4	6,1
Ash	A^r	%	17,0	7,2	5,8	28,5
Calorific value	Q_i^r	kJ/kg	19 853	23 338	24 027	16 938
Total sulphur	S_t^r	%	1,46	0,86	1,00	2,16
Yield	γ	%	100	48	10	42

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Type of parameter	Symbol	Unit	Feed [N]	Collection point of		
				Coal product Product no. 1	Middlings Product no. 2	Tailings Product no. 3
Total moisture	W_t^r	%	14,9	15,3	14,1	11,7
Hydroscopic moisture	W^a	%	8,9	9,9	10,3	7,7
Ash	A^r	%	13,6	6,7	10,4	25,8
Calorific value	Q_i^r	kJ/kg	21 305	23 568	22 541	18 086
Total sulphur	S_t^r	%	1,17	0,99	1,01	2,94
Yield	γ	%	100	76	5	19

Tab. 3. Results of the qualitative determination of the feed and products of separation for the commercial product „JARET®”

Tab. 3. Wyniki jakościowego oznaczania wsadu i produktów separacji dla produktu handlowego "JARET®"

Type of parameter	Symbol	Unit	Feed [N]	Collection point of		
				Coal product Product no. 1	Middlings Product no. 2	Tailings Product no. 3
Total moisture	W_t^r	%	15,0	13,8	14,2	13,17
Hydroscopic moisture	W^a	%	7,6	9,3	9,2	6,5
Ash	A^r	%	9,8	6,4	6,5	14,35
Calorific value	Q_i^r	kJ/kg	22 364	23 886	23 793	21 413
Total sulphur	S_t^r	%	1,31	1,07	0,98	1,78
Yield	γ	%	100	24,6	43,4	32,0

Tab. 4. Results of the qualitative determination of the feed and products of separation for the commercial product „JARET®”

Tab. 4. Wyniki jakościowego oznaczania wsadu i produktów separacji dla produktu handlowego "JARET®"

Type of parameter	Symbol	Unit	Feed [N]	Collection point of		
				Coal product Product no. 1	Middlings Product no. 2	Tailings Product no. 3
Total moisture	W_t^r	%	16,3	15,9	14,95	13,4
Hydroscopic moisture	W^a	%	8,4	9,7	9,5	7,1
Ash	A^r	%	10,1	7,5	7,08	14,6
Calorific value	Q_i^r	kJ/kg	21 794	22 897	23 464	21 137
Total sulphur	S_t^r	%	1,15	1,05	1,0	1,7
Yield	γ	%	100	24,8	40,6	24,7

In conditions of industrial preparation better results should be obtained (after optimizing the process as a result of selecting the most favourable technical parameters). On the test unit it is difficult to choose the optimal process parameters.

The FGX units produced in China are adjusted to the technological parameters of the raw coal extracted in coal mine purchasing this installation. Certain modernizations are made (according to producer's information). Employees of the IM-BiGS have introduced some structural modifications to the unit that is located on the territory of "Sobieski" Coal Company.

Conclusions

On the basis of conducted tests it can be concluded the usefulness of the air concentrating table for the process of pyrites grains removal from the "JARET" product.

Obtaining even better results will be possible after eventual moving the research unit to the "Janina" Coal Company. It will create a possibility to

perform tests on big samples of the input material (feed) in a continuous manner.

The coals from "Janina" Coal Company and "Sobieski" Coal Company belonging to TAURON Wydobycie S.A. are susceptible (washability) to the dry separation process conducted on the air concentrating tables of FGX type (reduction in ash and sulphur content and increasing calorific value).

The air concentrating tables allow to remove the pyrites grains when they are in the form of released grains and as the rock-pyrite false middlings.

Obtained results will depend on adjusting the technical parameters of the table to the characteristics of material directed to the preparation process. The technical parameters will be selected experimentally for the each type of table and for each feed.

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Literatura - References

1. Baic I., Blaschke W., Góralczyk S., Sobko W., Szafarczyk J.: Odkamienianie urobku węglowego metodą suchej separacji. Monografia: Innowacyjne i przyjazne dla środowiska techniki i technologie przeróbki surowców mineralnych. Wyd. KOMAG. Gliwice. 2013, s. 99 – 108.
2. Blaschke W.: Nowa generacja powietrznych stołów koncentracyjnych. Zeszyty Naukowe Instytutu GSMiE PAN nr 84, 2013. s. 67 – 74.
3. Baic I., Blaschke W., Szafarczyk J.: Dry deshaling of coal. Proceedings of the 18th Conference on Environment and Mineral Processing. Part II. Wyd. VSB -TU Ostrava 2014, s.191 -196.
4. Baic I., Blaschke W., Sobko W., Szafarczyk J.: Badania nad wzbogacaniem węgla kamiennych na powietrznych stołach koncentracyjnych. Wiadomości Górnicze nr 7-8, 2014, s.417 – 421.
5. Baic I., Blaschke W., Buchalik G., Szafarczyk J.: The first FGX unit in the European Union. in Collection of FGX Dry Coal Preparation Technology. Tangshan Shenzhou Manufacturing Co., Ltd, China, 2014, s. 21 – 27.
6. Baic I., Blaschke W., Szafarczyk J.: Dry coal cleaning technology. Inżynieria Mineralna z.2/34. Rocznik XV, 2014, s. 257 – 262.
7. „Prace studialne dotyczące możliwości implementacji w warunkach polskich technologii suchego odkamieniania węgla kamiennego”. Prace IMBiGS, oddział zamiejscowy w Katowicach 2013 r.,
8. „Raport z prac badawczych z wykorzystaniem powietrznego stołu koncentracyjnego typu FGX-1 wykonany za okres od 30 września do 9 października 2014 r.” Opracowanie dla TAU- RON-Wydobycie S.A..

Wykorzystanie powietrznego stołu koncentracyjnego w celu poprawy parametrów jakościowych produktu handlowego JARET®

Sucha separacja węgla jest metodą przeróbczą, której zastosowanie pozwala na ograniczenie ilości frakcji odpadowej w węglu surowym. Skutkiem prowadzonego procesu jest możliwość uzyskania znacznej poprawy parametrów jakościowych (wartości opałowej) uzyskiwanych z węgla surowych produktów handlowych. Istnieje też możliwość ograniczenia zawartości siarki całkowitej i zawartości popiołu w produkowanych węglach handlowych. Potwierdzają to wykonane przez „Centrum Gospodarki Odpadami i Zarządzania Środowiskowego” Instytutu Mechanizacji Budownictwa i Górnictwa Skalnego prace badawcze z wykorzystaniem powietrznego stołu koncentracyjnego typu FGX. W niniejszym artykule przedstawiono rezultaty odsiarczania i odpopielania produktu handlowego JARET®, pochodzącego z produkcji Zakładu Górniczego „Janina”, wchodzącego w skład TAURON Wydobycie S.A. Przedstawiono również niezbędne do spełnienia wymogi technologiczne prowadzenia procesu suchego odkamieniania.

Słowa kluczowe: węgiel kamienny, sucha separacja, powietrzny stół koncentracyjny, odsiarczanie