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Application of Fine Tailings from Coal Preparation in the Ostrava-Karvina District

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1. Introduction

The most significant deposit of black coal in the Czech Republic is in the Ostrava-Karvina District (OKR) situated in the north-east of the Czech Republic. Black coal has been mined there for over 200 years. This deposit is found in the southern part of the Upper Silesian Basin, a greater fraction of which lies in Poland (over 75% of its area) [1–3]. The mass and volume of coal, rocks, water and gas (methane in particular) extracted in the Czech part of the basin since the beginning of the industrial coal mining can be given in general features only. It is though estimated that in the period from 1872 to 2000 about 1.6 billion tons of coal were extracted in the Ostrava-Karvina District [4]. The production of waste rock can be estimated at 0.65 billion tons and the total production of coal slurries at 40 million tons. The mining activities have significantly affected an area of 260 km^2. For the whole period of coal mining in the Ostrava-Karvina District the strain per one square km is as follows: 6.15 million tons of coal, at least 2.5 million tons of waste rock, 0.15 million tons of coal slurries and 8–12 million m^3 of drawn water. Due to the national economy policy, the district was long-term expected to comply with high mining requirements which were beyond its capacities. Moreover, the investment into coal preparation development was insufficient – especially as for fine fraction preparation, which apart others reflected in the increase in slurries and waste water produced by coal preparation plants. Fine-grained slurries with high coal substance content were sluiced into tailings ponds. After 1989 the Czech Republic reviewed its state policies in treating, utilization, search for and exploration of own mineral resources [5–7]. In connection with depletion or worse availability of resources, and due to economical reasons in particular, certain coal mines were closed down. Having closed down some mines the impact of mining is dealt with, which is in many cases understood as a process of ecological strain removal, reclamation and remediation of contaminated areas on the ground, including buildings, tailings ponds and heaps. In connection with this policy, the so-called surface coal reserves, stored in the heaps and tailings ponds, have been re-evaluated. Due to their petrographic and geochemical character, instability in the given conditions and large volumes, coal preparation wastes are considered to be an ecological strain for the landscape.

2. Refuse from preparation technologies

The preparation technologies used in the Ostrava-Karvina District (OKD) have always affected the fraction of residual coal not only in the waste rock but also in fine tailings stored in tailings ponds [8].

2.1. Classification of refuse from black coal preparation

Refuse from black coal preparation may be characterized in a number of aspects, most frequently with respect to the technological point of its origin [9, 10]:

a. washery refuse from the coarse separation system (10–200 mm)
b. washery refuse from the fine separation system (0.5–10 mm)
c. flotation tailings – the non-froth product of separation by flotation (0–0.5 mm)
d. waste rock – stockpiled or drawn waste rock or tailings from a heap.

Tailings ponds originally served for treatment of waste water from coal preparation plants. This process was reduced to the separation of solid particles from water. The basic condition for waste water treatment was an interception of a maximum volume of solid particles and their draining, either for further use or permanent disposal of coal slurries at minimum investment or operation costs. Tailings ponds used to be an attendant feature of mining activities. They were mostly situated in subsidence troughs formed by undermining. There have been problems with large reservoirs that due to ground subsidence dropped below the ground water level and the sediments could be extracted from there after long-term draining applying a conventional method or a non-standard method of water drawing directly from the pond water level.

Tailings ponds as waste water treatment systems for coal preparation plant water had a number of disadvantages:

- the necessity of long-term disposal of huge quantities of slurry of various qualities resulted in the occupation of large areas,
- high costs of sediment extraction, losses in energy fuel – especially in ponds unaddapted for extraction,
- environmental harm.

The utilization of settled black coal slurries from the tailings ponds is motivated by economic reasons in particular, i.e. production of flotation concentrates to make cokeable coal or fuel, and last but not least, by ecological reasons as the tailings pond operators are forced to reclaim the localities.

3. Material utilization of fine tailings

3.1. Energy utilization of fine tailings

Coal slurries that are not processed by reflotation (see below) are drawn from the existing tailings ponds mainly hydraulically and are used in power engineering [11–14].

The technological procedure of the granulate fuel production from settled coal slurries is as follows. Slurries are extracted from tailings ponds and drained on an intermediate storage. Then, they are transported on a belt conveyor into a rotary drier and are dried at the temperature of approximately 800°C. The dried product – granulate – is transported to the individual customers. Flue dust from the driers is intercepted using two methods. Ultrafine slurry is trapped by a Venturi washer as wet. The dry method uses electrostatic filters and intercepts ultrafine dust. Very fine waste from thermal drying can be used as a new fuel component combined with high-carbon and energy-rich substances.

Table 1 gives values which the granulate fuel for energy use must comply with.

Table 1. Characteristic composition of granulate fuel
Tabela 1. Charakterystyka paliwa granulowanego

Parameter	Minimum value	Mean value	Maximum value
Net heat of combustion	17 MJ/kg	18 MJ/kg	20 MJ/kg
Ash content		36.5%	40%
Water content		11.5%	13%
Sulphur content			0.33 g/MJ

Fluid combustion of high-ash fine refuse – flotation tailings – has never been operationally introduced in the Czech Republic.

3.2.Application of fine tailings in reflotation

In connection with hydraulical exploitation of tailings ponds with difficult water drawing a new method of material benefication of coal slurries was identified, i.e. reintroducing the refuse drawn from tailings ponds into the coal preparation plant technology of flotation lines where reflotation is applied. In the high-capacity tailings ponds (e.g. Pilnok – Darkov Mine, Doubrava – Karvina Mine) suction dredgers of ENVI company are applied to remove the sediments. A suction dredger, originally designed for a selective removal of sediments from the bottom of closed reservoirs – ponds, has proved to be very useful in the extraction of coal sludge. The foundation of a suction dredger is a pontoon made from one main and two auxiliary pontoons. On the pontoons there are further additions: a generating set, a cab, suction mechanism and a revolving shovel that enables the machine to change the direction of extraction. For the depth down to 2.5 m the shovel is fixed on a boom and lowered on ropes; for greater depths it is suspended on ropes. What makes part of the shovel is a dredge pump, hydraulic motor, conveyor worm and mobile flaps. The sucked material is transported by a flexible hose to the surface onto an auxiliary pontoon. From there it is transported to the shore by a flexible pipe. The transportation distance can be up to 800 m. Currently a number of such dredgers are applied in the OKD tailings ponds. The sludge is hydraulically transported back to the preparation plants where it is refloated. During hydraulic extraction from the tailings pond by means of suction dredgers it is not possible to ensure a stable quality of the extracted material as it varies in connection with the hydraulical separation of the sluiced slurries according to the grain size and their bulk density. Also, in the course of long-term deposition in the tailings ponds the points of inlet changed. Based on the above mentioned deposition method, it is clear that there is a high diversity in the sludge depending on the depth from which the material is drawn as well as on the locality of the immediate placement of the suction dredger directly in the tailings pond, etc.

In order to use the slurries as ingredients for cokeable coal within reflotation it is important to be aware of the tailings pond sludge properties, especially the grain size distribution because of the coking properties (determination of the swelling index, volatile combustibles and dilatation), i.e. parameters approved for the international classification of black coal. The objective was to determine coking properties for the mixture of black coal – slurries – in the laboratory conditions. It was identified that the settled and refloated slurries from the Pilnok Tailings Pond can be used in coal mixtures suitable for coking in limited quantities only (about 10%) without having a negative impact on other parameters, e.g. ash or water content.

In the Pilnok Tailings Pond the reflotation line has a hydrocyclone station of WARMAN 15 CE with the output of 100 m^3/h. The hydrocyclone helps to thicken the extracted sludge and separate the finest fractions of high-ash grains.

3.3. Application of fine tailings in the production of bricks

A brickmaking company of Severomoravske cihelny Hranice, Novy Jicin plant, began to use flotation tailings from the Paskov Mine Preparation Plant in 1981. Tailings with 65–70% A^d ash content, net heat of combustion of 4.18–5.02 MJ/kg, and 20–25% W^r_t moisture were used and added to the brickware materials as a 10–15% part by weight. In the production of bricks the flotation tailings have the function of an opening material, they reduce the sensitivity of the products to drying and firing, they enrich the clays with Al_2O_3, increase the sintering interval as well as the quality of the products and reduce scrap. Due to its carbon content they especially lower the consumption of technological fuel and act as pressed-in fuel in the products. The flotation tailings from Paskov Mine are irregularly taken (especially in the summer when the wet tailings cannot freeze in the wagons) in the annual quantity of up to 20,000 tons for the production of building materials by brickworks. of building materials.

This issue was again discussed at the end of the 1990s. The projects and their evaluations (assigned by the Ministry of Industry and Trade) state that the flotation tailings from the OKD, Paskov Mine in particular, are a suitable admixture for brickware materials, namely in terms of ecology, technology as well as power-engineering. They even find that the quantity of this secondary material is almost unlimited in the OKR. However, to date flotation tailings are mostly used only as filling materials in land reclamation.

3.4. Application of fine tailings in the production of cement sintered clay

The utilization of low-value fuels – coal refuse – with net heat of combustion below 17 MJ/kg and ash content higher than 40% have been tested both in the pilot and operational conditions. An important criterion for the application of coal refuse in the production of cement sintered clay is the chemical composition of ash and the content of harmful substances, i.e. Fe_2O_3, MgO, MnO, TiO_2, P_2O_5, alkali, heavy metals and chlorides. With regard to the fact that the refuse has a high ash content it is necessary to perceive it not only as fuel but also a material component for firing of sintered clay.

The chemical analyses of the sintered clay and technological tests of cement proved that the presence of slurries in the material did not have a negative impact on the product quality. A wider application in the cement works is currently hindered by both economic circumstances (the cement works want the refuse for free) and a widespread production of solid alternative fuels on the basis of sorted municipal waste (plastics, paper, wood, textile, etc.).

3.5. Application of fine tailings for backfilling in the mines

Fine refuse from coal mining – flotation tailings – mixed with fly ash is the most common technological material used in the mines for the following [15, 16, 17]:

- to drown the broken workings – it has a technological significance in case there will be mining activities along the old workings,

- to sluice the collapse – technological procedure with planes of break,
- to reduce the risk of breeding fire in the workings protective sealing ribs are used,
- to tightly close abandoned mine workings,
- for reinforcing grouting in the mines with tectonic disturbances,
- for mixtures to line long mine workings to produce a perfect contact of the lining with the rocks – this way there is a better distribution of forces and load on the lining.

3.6. Application of fine tailings in land reclamation post mining activities

The forms and types of technical and biological reclamation in the Ostrava–Karvina District, not only in case of tailings ponds, have been revised in the past years as a result of society's demands for landscape utilization and a decrease in the known reserves to be exhausted in the active Ostrava part of the Ostrava–Karvina District. Nowadays, the dominant are water management reclamation or forestry reclamation methods. In the southern part of the district, in the Paskov workings, the typical example of the finished biological reclamation is three reservoirs from the system of the Paskov – Piliky Tailings Ponds.

Currently, only flotation tailings are deposited into the vacant space after the sludge. Having been filled and drained, there is the technical stage of reclamation followed by biological reclamation. In the Karvina part of the district the former reservoirs of Solca I and Solca II have been successfully biologically reclaimed. For example, the extensive tailings pond of Pilnok is hydraulically drawn, the coal slurries are beneficiated by reflotation and at the same time flotation tailings are deposited into the dammed sections. A water area is planned in the part of the reservoir from where the sludge has been removed. From the biological point of view, the specific environment of wetlands, tailings ponds in the places of original ponds often form very valuable environment for permanent colonization of this biotope by new species or as a temporary station – refugium. The longer a tailings pond stays idle, the more new biological species can be identified there. These days, the landscape especially in the Karvina region as well as within the whole CR belongs among areas with high numbers of plant and animal species and reserves.

Research verified an application of flotation tailings in the layer of 0.5–1.5 m as a substitute for topsoil or undersoil in land reclamation. It was discovered that thanks to its physical aspects, the material resembles lighter soils. Chemical analyses identified high alkalinity and a sufficient amount of basic biogenic elements, except for nitrogen which is negligible there. The surface of the tailings can be seeded with selected cultivated grass. The grasses form a very thick cover on the surface of the flotation tailings and reinforce the loose surface.

Flotation tailings as a substitute for undersoil and topsoil have been used only in verification tests. This application is no longer topical at the current trends in the biological reclamation.

4. Application of refuse in the production of mixed fuels

As stated above, during thermal processing of black-coal slurries, refuse is formed in the form of ultrafine slurry or ultrafine dust currently being considered as waste. Within the grant project of Brown Coal Research Institute in Most and VSB-TU Ostrava, a new method of reprocessing and utilization of flue dust from thermal drying of black-coal slurries is tested. The objective of the project is to make use of this significant energy content waste material.

4.1. Input material characteristics

Sampling of the trapped fine flue dust from the coal slurry driers was carried out in two ways. The slurry was sampled from concrete pans or directly from the separators. Tables 2, 3 and 4 give the results of analyses of the individual types of ultrafine flue dust samples.

Table 2. Qualitative indicators of flue dust from the driers
Tabela 2. Wskaźniki jakości pyłu z suszarek

Sample description	W^a	W_t^r	A^r	A^d	Q_s^d	Q_s^{daf}	Q_i^r	Q_i^d	Q_i^{daf}	S^d	H^{daf}
	%	%	%	%	MJ/kg	MJ/kg	MJ/kg	MJ/kg	MJ/kg	%	%
No. 1	1.66	20.33	29.54	37.08	21.36	33.94	16.09	20.83	33.11	0.80	3.78
No. 2	1.28	1.77	16.00	16.29	29.60	35.36	28.18	28.73	34.32	0.75	4.75
No. 3	1.33	1.30	24.23	24.55	26.35	34.92	25.23	25.59	33.92	0.77	4.57
No. 4	1.24	1.29	24.86	25.18	25.98	34.69	24.86	25.22	33.71	0.76	4.48

Table 3. Determination of the basic elements in the drier flue dust
Tabela 3. Zawartość podstawowych pierwiastków w pyle z suszarek

Determination	unit	sample 1	sample 2	sample 3	sample 4
As	mg/kg solids	2.33 ± 0.34	0.471 ± 0.068	1.14 ± 0.17	0.74 ± 0.11
Pb	mg/kg solids	29.8 ± 5.9	26.3 ± 5.2	36.2 ± 7.2	37.5 ± 7.5
Cd	mg/kg solids	<0.1	<0.1	0.111 ± 0.015	<0.1
Cr-total	mg/kg solids	70 ± 8	20.9 ± 2.3	37.7 ± 4.2	36.6 ± 4.1
Cu	mg/kg solids	37.6 ± 7.8	23.8 ± 4.9	25.4 ± 5.3	25.0 ± 5.2
Hg	mg/kg solids	0.096 ± 0.007	0.072 ± 0.005	0.087 ± 0.006	0.085 ± 0.006
Zn	mg/kg solids	70 ± 7	20.3 ± 1.9	35.1 ± 3.4	28.2 ± 2.7
chlorine	%	0.0639 ± 0.0064	0.0622 ± 0.0062	0.0557 ± 0.0056	0.0521 ± 0.0052

Table 4. Chemical analysis of ash from the individual drier flue dust
Tabela 4. Wyniki analizy chemicznej pyłu z suszarki

Sample description	chemical analysis of ash [wt %]										
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	SO_3	P_2O_5
No. 1	55.80	1.38	21.50	11.94	0.05	1.60	3.90	1.08	1.90	0.68	0.30
No. 2	51.90	1.50	23.35	12.40	0.07	1.16	5.40	1.08	1.78	1.20	0.30
No. 3	53.70	1.30	22.15	12.52	0.07	1.20	4.60	1.08	1.78	0.72	0.45
No. 4	53.44	1.30	21.65	12.30	0.07	1.20	5.60	1.08	1.90	0.84	0.38

Dealing with the issue of utilization of energy properties (potential) of suitable waste substances, we studied the possibility of making mixed fuels on the basis of natural solid fuels or their fractions and waste substances with high energy potential and low content of pollutants. The objective is to propose and verify a suitable formula for artificially produced mixed fuels from low-grade fossil fuels and waste substances rich in energy. The newly produced fuel is designed for small and medium-size heat appliances. Its net heat of combustion must reach the level of commonly used fossil fuels and the emissions arising from its combustion must comply with valid legal regulations on air.

The following components were used to test and verify the two-part formula:

- mixture of black-coal flue dust and brown coal with sulphur content $S^d = 1\%$, $Q_i^d = 17.60$ Mj/kg,
- ground waste polyethyleneterephtalate – PET,
- plasticizer, mixture of water and wheat flour.

Charactistics of the fuel components is shown in table 5. Mass fractions of mixture for pelletisation is done in table 6.

Table 5. Qualitative characteristics of the fuel components for the production of pellets
Tabela 5. Wskaźniki jakości składników do produkcji peletów

Sample description	W^a	W_t^r	A^r	A^d	Q_s^d	Q_s^{daf}	Q_i^r	Q_i^d	Q_i^{daf}	S^d	H^{daf}
	[%]	[%]	[%]	[%]	[MJ.kg^{-1}]	[MJ.kg^{-1}]	[MJ.kg^{-1}]	[MJ.kg^{-1}]	[MJ.kg^{-1}]	[%]	[%]
coal mass	4.48	19.63	29.79	37.07	18.58	29.53	13.66	17.60	27.97	1.00	7.15

Sample description	W^a	A^d	S^d	C^d	H^d	N^d	O^d	V^d	Q_i^d	Fluorine	Chlorine
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[MJ.kg^{-1}]	[%]	[%]
Polyethylene-terephthalate PET	0.53	0.35	<0.01	61.94	3.78	<0.01	34.27	90.72	22.99	<0.001	0.0027±0.0003

The grain size of coal was processed to 0–3 mm size. The non-sorted PET waste was used including tops and labels. The grain size was refined by crushing and grinding to below 0.3 mm and 0–4 mm sizes.

The samples of the pelletizing mixtures were prepared from the original fuel components with a 10-percent mass rise in the fine-ground PET. The admixture of plasticizer in the amount of 60 g/kg of dry mixture was identical in all the samples.

Table 6. Mass fractions of pelletizing mixture components
Tabela 6. Udziały masowe składników do peletowania**.**

Pelletizing mixture sample	Coal constituent [wt %]	Fine waste PET constituent [wt %]
1	100	0
2	80	20
3	70	30
4	60	40
5	50	50

The prepared pelletizing mixtures were homogenized by mixing and pressed in a laboratory pelletizing press Kahl with a flat press die. Table 7 shows pellets quality idicators.

In the next phase of testing, the impact of feed graininess of the crushed waste PET on the quality of the produced pellets was verified. Press mixtures were prepared in the 50 : 50 mass per cent ratio of coal and PET. The size fractions of the PET component in the press mixture was adjusted to fine : coarse (1 : 1) and the fine size was completely substituted by the grain size of 0–4 mm. The other test conditions stayed unchanged.

Table 7. Qualitative indicators of the pellets in dependence on the PET content
Tabela 7. Wskaźniki jakości peletów w zależności od zawartości PET

Sample	W^a	W_t^r	A^r	A^d	Q_s^d	Q_s^{daf}	Q_i^r	Q_i^d	Q_i^{daf}	S^d	H^{daf}
	%	%	%	%	$MJ.kg^{-1}$	$MJ.kg^{-1}$	$MJ.kg^{-1}$	$MJ.kg^{-1}$	$MJ.kg^{-1}$	%	%
1	4.48	19.63	29.79	37.07	18.58	29.53	13.66	17.60	27.97	1.00	7.15
2	3.42	14.09	26.68	31.06	19.04	27.61	15.27	18.19	26.38	0.67	5.64
3	2.55	13.67	21.44	24.84	19.19	25.53	15.72	18.60	24.75	0.61	3.59
4	2.33	11.98	16.89	19.19	20.56	25.44	17.12	19.79	24.49	1.11	4.35
5	2.07	9.17	15.21	16.75	21.20	25.46	18.55	20.68	24.84	0.43	2.85

4.2. Test evaluation

Potential preparation of mixed fuels from low-grade fossil fuel and waste polyethyleneterephtalate was laboratory tested and verified. The objective was to make a mixed multi-component fuel for small and medium-size heat appliances of a net heat of combustion comparable to commercially produced types of fossil fuels and emission limits lower than those stipulated by valid legislations for good air quality. The best results were acquired with 50% proportion of fine-ground PET in the mixture. The net heat of combustion of the original coal mass rose from 13.66 MJ/kg to 18.55 MJ/kg in the produced pellets. There was a significant drop in the pellet ash content to 16.75% A^d and a decrease in the sulphur content S^d to 0.43%, compared to 1% sulphur content in the feed coal mass. The sulphur content is considerably lower than in case of the commercially supplied fuels in this customer segment. The tests verified pressing the mixture applying only fine-ground PET fraction, mixture of fine and coarse PET fraction in 1 : 1 ratio and pressing applying only the coarse fraction of waste PET in the mixture with coal. Considering the mechanical properties of the final pellets, the best results were obtained in case of the fine fraction only. Plasticizer on the basis of wheat flour was added into the pressing mixture. The applied plastification of the pressing mixture provides excellent results in quality pellet pressing.

Making use of low-grade types of fossil fuels or wastes from their beneficiation combined with wastes rich in energy allows preparation of mixed fuels with good net heat of combustion and emission limits complying with standards. This way, it is possible to utilize waste inexploitable on its own.

5. Conclusion

Evaluating the above stated material utilization possibilities of fine tailings from coal preparation it may be stated that the most suitable application methods for the refuse are in the power-engineering industry. Another very widespread application of the fine tailings is their use as materials suitable for technical land reclamation within drawn tailings ponds. Despite being tested both in a laboratory as well as in operation, further application methods of fine tailings in brickworks or cement works are currently least favourable from the economic point of view.

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References

1. **Hlavatá M., Čablík V., Fečko P., Tora M., Pasiowec P.:** *Odpady przemyslu wydobyczego i związane z nimi regulacje prawne w Czechach ze szczególnym uwzględnieniem górnictwa węgla kamiennego*. In Klich, A (ed.). *Innowacyjne i przyjazne dla środowiska techniki i technologie przeróbki surowców mineralnych*: KOMAG Gliwice, 47–52 (2011).
2. **Viestová Z., Hlavatá M., Wilkosz A.:** *Conditions of waste and waste mixture utilization in technical land reclamation*. Inżynieria Mineralna, Vol. XII, No. 1 (27), 51–60 (2011).
3. **Hlavatá M., Čablík V.:** *Rekultivace v Moravskoslezském kraji*. Odpadové fórum, roč. 12, č. 2, 17–17 (2011).
4. **Hlavatá M., Bartusek S., Čablík V.:** *Odpady z těžby a úpravy černého uhlí*. Odpadové forum. roč. 11, č. 5, 18–18 (2010).
5. **Hlavatá M.; Čablík V.; Fečko P., Tora B.:** *Mining industry waste – legal regulations in the Czech Republic with focus on black coal mining*. Inżynieria Mineralna, Vol. XI, 1(25)–2(26), 27–32 (2010).
6. **Fečko P., Čablík V., Havelek R., Kolomazník I., Tora B.:** *Classical and column flotation of black coal samples*. Inżynieria Mineralna, vol. X, Nr 1 (23), 37–48 (2009).

7. **Valeš J., Hlavatá M., Fečko P., Kusý J., Mádrová M.:** *Potential utilization of coal of an energetically quality for the preparation of mixed fuels*. 25th Annual Int. Pittsburgh Coal Conference, PCC – Proceedings. 2008.
8. **Cablik V., et al.:** *Nontraditional Reclamation Methods in North Bohemia Region*. In: MISHRA, B., et al. REWAS 2008 : Global Symposium on Recycling, Waste Treatment and Clean Technology. 1st ed. USA: The Minerals, Metals & Materials Society (TMS). 1843–1849 (2008).
9. **Hlavata M., Fecko P., Cablik V., Zavada J., Vales J., Sedlacek P., Kusy J.:** *Potential utilization of fine-grained tailings from hard coal drying.* In: Coal-Energy, 24th International Pittsburgh Coal Conference CD-ROM Proceedings, Johannesburg, South Africa, PCC. 2007.
10. **Dey S., Bhattacharyya K.K.:** *Split and collectorless flotation to medium coking coal fines for multi-product zero waste concept*. Fuel Processing Technology, Vol. 88, Iss. 6, 585–590 (2007).
11. **Fečko P., Valeš J., Hlavatá M., Čablík V., Gondek H.:** *Przeróbka węgla w Czechach*. In: Mineral Resources management, 22, Issue 4, Wydawnictwo IGSMiE PAN Kraków, 13–19 (2006).
12. **Sabah E., Yüzer H., Çelik M.S.:** *Characterization and dewatering of fine coal tailings by dual-flocculant systems*. International Journal of Mineral Processing, Vol. 74, Iss. 1–4, 303–315 (2004).
13. **Oats W.J., Ozdemir O., Nguyen A.V.:** *Effect of mechanical and chemical clay removals by hydrocyclone and dispersants on coal flotation*. Minerals Engineering, Vol. 23, Iss. 5, 413–419 (2010).
14. **Fusova L., Cechlova K., Cablik V., Tora B.:** *Utilization of Bentonite and Its Modification for Sorption.* Rocznik Ochrona Środowiska, Tom 13, Rok 2011, 163–172 (2011)
15. **Baic I., Blaschke W., Sobko W.:** *Identification of coal sludge deposits and technological development of strategy in the field of their economic usage*. Proceedings of 14th Conference on Environment and Mineral Processing. VSB-Tu Ostrava, 101–106 (2010).
16. **Baic I., Blaschke W., Szafarczyk. J.:** *Analiza możliwości wykorzystania mułów węglowych jako pełnowartościowego paliwa energetycznego.* Workshop: Vyzkum w oblasti odpadu. VSB-TU Ostrava, 215–218 (2010).
17. **Sobko W., Baic I., Blaschke W.:** *Depozyty mułów węglowych – inwentaryzacja i identyfikacja ilościowa.* Rocznik Ochrona Środowiska, t. 13, rok 2011, 1405–1415 (2011).

Wykorzystanie drobnouziarnionych odpadów ze wzbogacania węgla w Rejonie Ostrava Karwina (OKD)

Streszczenie

W artykule przedstawiono kierunki wykorzystania drobnouziarnionych odpadów ze wzbogacania węgli zdeponowanych w Rejonie Ostrava-Karwina w Republice Czeskiej. Odpady to w większości odpady poflotacyjne, zdeponowane w stawach osadowych. Pokazano możliwości wykorzystania odpadów w energetyce, produkcji materiałów budowlanych oraz do rekultywacji. Przedstawiono wyniki badania możliwości produkcji paliwa na bazie odpadów powęglowych z dodatkiem odpadowego PET.

Badania technologii produkcji paliwa z odpadów przeprowadzono dla różnych receptur obejmujących następujące składniki:

- mieszanina węgla kamiennego z węglem brunatnym o zawartości siarki $S^d = 1\%$, i wartości ciepła spalania $Q_i^d = 17.60$ MJ/kg,
- odpadowy PET,
- plastyfikator, woda, odpady z produkcji mąki.

Uzyskano paliwa alternatywne w formie peletów o wartości opałowej od 13.66 MJ/kg do 18.55 MJ/kg.