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Coal mining waste dumps as secondary deposits – examples from the Upper Silesian Coal Basin and the Lublin Coal Basin

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Abstract: Polish coal mining industry generates approximately 30 million Mg of mining wastes per year, which represents the largest amount of industrial waste in Poland. This results in the disposal of a huge volume of wastes at waste dumps. The coal mining waste dumps are spread within the area of over 4,000 ha in more than 220 dumping sites, where over 760 million Mg of wastes from hard coal mining have been disposed.

One of the most recent problems in Poland is the recovery of coal from mining waste. There is a possibility and necessity to recover coal from mining waste dumps, which should be linked with appropriate legal regulations.

In this paper, distribution and dimensions of coal mining waste dumps in the Upper Silesian Coal Basin and the Lublin Coal Basin are analyzed. Selected problems of negative environmental impacts of coal mining wastes – that may be reduced by the recovery of coal – are presented. Legal regulations referring to the mining waste management are analyzed. Some examples of a successful recovery of coal mining dumps as well as economic feasibility studies are given. The analysis of potential objects, which are the most valuable in terms of recovery processes, is presented.

Coal mining waste dumps may be considered as important secondary deposits. Feasibility studies and past experiences in the coal recovery show a need for new recovery sites. Sustainable coal recovery is not only economically but also ecologically justified. The re-using and managing of reclaimed dumping sites for local communities is also of importance.

Keywords: coal mining wastes, coal mining waste dumps, recovery of coal

INTRODUCTION

In Polish coal industry over 220 post-mining waste dumps are spread over an area of more than 4,000 ha. The amount of over 760 million Mg of wastes from hard coal mining is disposed in the coal mining waste dumps. According to various sources, it is estimated that for each 1 Mg of coal produced, there is 0.4–0.5 Mg of waste material (Szczepańska & Twardowska 1999). This material is deposited in the coal mining dumps. The production of hard coal in Poland in 2012 accounted for 79.2 million Mg, which was accompanied by 35.64 million Mg of waste material (www.stat.gov.pl).

Nowadays, the majority of mining wastes are re-used in civil engineering for e.g. construction of flood banks and polders, railway and highway embankments, ground leveling, and reclamation of areas prone to subsidence or impacted by industry (Gawor 2013).

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COAL MINING WASTE DUMPS IN THE UPPER SILESIAN COAL BASIN AND THE LUBLIN COAL BASIN

According to the recent study, in the Upper Silesian Coal Basin there are ca. 220 coal mining waste dumps, covering over 4,000 ha. The highest concentration of the dumps occurs in the central part of the USCB, i.e. in Bytom (21 dumps), Ruda Śląska (12 dumps) and Zabrze (34 dumps), as well as in the south-western part of the USCB, i.e. in Rybnik (13 dumps) and Jastrzębie-Zdrój (4 dumps). The largest dumps cover an area of over 250 ha (e.g. the Central Coal Mining Dump in Knurów). The largest coal mining waste dumps are listed in Table 1.

Table 1
Chosen waste dumps of USCB

Waste dump	Coalmine/City/Commune	Surface [ha]
Central waste dump	Numerous coal mines/ Knurów	255.10
Waste dump Kościelniok	Coal mine Pniówek/ Krzyżowice	193.60
Waste dump Number 1	Coal mine Sośnica/Gliwice	160.90
Waste dump Przezchlebie	Numerous coal mines/ Przezchlebie	150.00
Central waste dump	Numerous coal mines/ Smolnica	138.83
Waste dump Pochwacie	Coal mine Zofiówka/ Mszana	137.10
Waste dump Panewniki	Coal mine Halemba/ Mikołów	118.40
Waste dump Borynia-Jar	Coal mine Borynia/ Jastrzębie-Zdrój	97.00
Waste dump Czerwionka	Coal mine Debieńsko/ Czerwionka-Leszczyny	97.00
Waste dump Skrzyszów S	Coal mine Marcel/ Skrzyszów	71.30
Waste dump Świerklany	Coal mine Jankowice/ Świerklany	69.00

In the Lublin Coal Basin there is only one waste dump, which now covers 65 ha, but there are plans to enlarge it to 88 ha. Biological reclamation on the surface of the dump – afforestation and sodding – is now in progress. The Bogdanka coal mine generates ca. 11,000 Mg of wastes per day (www.lw.com.pl). The coal mining waste management over the last years is presented in Table 2.

Table 2
Coal mining waste management in Bogdanka Coal Mine in 2009–2012

Parameters	2009	2010	2011	2012
Mining wastes in total [thousands of Mg]	3,788.15	3,288.95	4,050.08	4,742.46
Mining waste stored [thousands of Mg]	2,291.66	885.67	1,957.30	2,187.99
Mining wastes re-used [thousands of Mg]	1,496.49	2,403.28	2,092.78	2,554.47

Source: http://www.lw.com.pl/pl,2,d1097,gospodarka_odpadami.html

ENVIRONMENTAL IMPACT OF COAL MINING WASTES

One of the most dangerous environmental impacts of coal mining waste dumps is fire hazards. The lack of waste material compacting, as well as the ignorance of rules regarding fire prevention, cause numerous spontaneous combustion processes, particularly in old coal mining waste dumps. Coal and pyrite present in waste material undergo intensive oxidization, which leads to self-ignition inside the dump. The fire resulting from waste materials deposited in dumps may be a consequence of two kinds of processes: exogenic processes – where the source of heat is external and endogenic processes, occurring as a result of low-temperature oxidation of coal and pyrite, in relation to the amount of available oxygen, characterized by massive emissions of heat. The temperature rises significantly, and that consequently may lead to dump fires. A burning dump may affect its surroundings due to spreading the fire and ensuing air pollution. Nowadays, the problem of fires in coal mining waste dumps still remains urgent, as well as the issue of emissions of toxic gases from mine wastes to the atmosphere (Szczepańska & Twardowska 2004, Gawor 2013, Kuna & Gwoździewicz 2013).

One of the environmental impacts of mining wastes is surface water and groundwater pollution. There is a well-known problem of AMD (acid mine drainage) processes. Recovery of coal may result in changes to the hydrogeochemical profile of the anthropogenic vadose zone, arising from the re-mining and re-disposal of coal extractive waste (Stefaniak & Twardowska 2005).

Another serious environmental problem related to the disposal of mining wastes is the danger of slope sliding. The old conical dumps are the most susceptible to this process, which usually starts with erosion troughs. The natural erosion processes may be intensified by anthropogenic activities.

The environmental impacts in question may be reduced by the recovery of coal from coal mining waste dumps. According to the data from companies that recover coal from mining wastes, it is possible to reduce the volume of the dumps up to 45% (M. Redoute – personal communication). It is possible by means of recovery of coal and selling part of waste rock as aggregates.

EXAMPLES OF RECLAMATION OF COAL MINING WASTE DUMPS

The ways of waste dump reclamation include technical and biological approach. Technical reclamation is related to three waste dumps generations: conical, tabular and landscape dumps. Biological reclamation methods comprise afforestation and sodding, as well as land fertilizing. After over 40 years of biological reclamation at waste dumps in the USCB it can be stated that sodding is the most proper reclamation method to be applied at waste dumps. The afforestation of waste dumps is regarded ineffective, and nowadays there are tendencies to afforest only parts of waste dumps as a way to cultivate parks and recreation areas (Gawor 2004, 2011, Gawor & Main 2007).

Due to the low efficiency of afforestation as biological reclamation of coal mining waste dumps, the presence of trees does not pose any obstacle to recovery processes.

POSSIBILITIES OF COAL RECOVERY

It is possible, and even necessary, to recover coal from the coal mining waste dumps. Firstly, coal recovery reduces hazards of self-ignition and dump fires. Secondly, the process of coal recovery is economically justified. From over 140 dumps in the USCB more than 100 dumps still remain, which may be considered as anthropogenic secondary deposits (considering objects which are not thermally active). In the past, there were several examples of successful recovery of coal from the dumps (e.g. Central Mining Waste Dump in Smolnica, waste dumps in Buków, Czerwionka – SW of the USCB), some of the dumps are still being exploited – e.g. a waste dump in Panewniki, a waste dump in Knurów (the central part of the USCB). There are several companies that conduct recovery of coal as well as reclamation of dumps using different extraction technologies. One of the examples of coal extraction plant may be a waste dump in Buków (Fig. 1).

Due to the fact that the amount of coal in the waste material may reach 10% (between 3–10%, with the assumption that an average amount of coal to be recovered accounts for 5–7%), it can be estimated that total potential amount of coal recoverable from the dumps in the USCB shall account for more than 45 million Mg (Gawor 2013).

The feasibility study of one dump in the USCB proves that coal recovery is economically justified. There is an example of one of the dumps called X, and related cost and benefit analysis presented in Table 3.

Table 3
Economical analysis of the coal-mining waste dump X in the USCB

Parameter	Thousands of PLN (general)
Total sales	160,000
Profit before taxation and interest	50,000
Interest	4.3
Taxation	8.5
Net profit	35,000
Add depreciation	20,000
Net cash generated	55,000
Purchase consideration capital expenditure	20,000
Net cash available	35,000

Source: Analysis of Ipas Polska sp. z o.o., unpublished

Fig. 1. *Coal extraction plant in Buków (phot. Ł. Gawor)*

The most valuable waste dumps in terms of their recovery are the largest ones (see Tab. 1). However, one shall take into consideration other features, such as: the ownership title (there are mainly two kinds of owners: coal mine companies and communities), localization regarding the neighborhood of protected areas, accessibility (road network, railway network) and local community interests. Past experiences show that there have always been problems with local communities during the planning phase of the coal recovery; nonetheless, as far as its advantages and disadvantages are concerned, benefits for the local community are indisputable.

LEGAL REGULATIONS REGARDING MINING WASTES IN POLAND

Legal regulations regarding mining wastes in Poland include environmental protection regulations, geological and mining law, statutes regulating waste management as well as environmental impact assessments. Legal provisions in force in Poland regulate in a very general way the issues connected with coal mining dumping sites. It is necessary to draw up supplements to the legal provisions or introduce new regulations pertaining to post-mining dumping sites. It would seem beneficial to create new regulations in the form of local law deeds.

One of the reasons of ineffective reclamation of waste dumps in Poland is absence of precise laws concerning mining waste, and particularly connected with negative environmental impacts (e.g. protection of groundwater, fire hazards) and evaluation of reclamation methods.

Poland has just recently implemented the first EU directive concerning mining waste (Directive 2006/21/EC of the European Parliament and of the Council on the management of waste from the extractive industries). There exists, however, a need to create regulations regarding waste dumps at the level of local governments, i.e. the Upper Silesia Province (Gawor et al. 2011).

The recovery of coal due to the latest legal regulations in Poland is essential. The main rule of waste management in Poland, pursuant to the Act on Waste (*Ustawa z dnia 27 kwietnia 2001 r. o odpadach*, art. 5 pkt 2), requires to ensure an environmentally compliant recovery, should there be no possibility to avoid the production of wastes. The owner of the wastes should, as matter of priority, treat them under the recovery process, and if it is not technologically possible or economically feasible, the owner shall take the necessary measures to ensure that waste management is carried out without endangering human health and without harming the environment with the use of Best Available Techniques (BAT's).

CONCLUSIONS

The coal mining waste dumps in Poland pose serious environmental dangers, particularly hazards of self-ignition and dump fires. The process of reclamation of many objects is not sufficient, although officially the described objects are deemed to have been reclaimed. The recovery of coal reduces environmental hazards; there is also a reduction of dump volume, which may be afterwards efficiently reclaimed.

Recovery of coal from disused waste dumps is possible and needed a situation which should result in appropriate legal regulations. Main legal acts in Poland treat recovery as a priority.

As far as legal regulations are concerned, no standards, technical specifications or legal acts have been prepared so far in Polish legislation, which would refer to dumping sites of hard coal mining waste. Valid legal acts (statutes and resolutions) regulate in a very general way the issues connected with dumping sites reclamation and development. It is necessary to draw up supplements to the legal provisions or new regulations concerning post-mining dumping sites in Poland. It seems to be beneficial to create new regulations based on the German example in the form of local law acts (e.g. resolutions issued by provinces), preparation of standards or technical specifications.

Not only does the effective recovery and reclamation of post-mining dumps within the area of the USCB, carried out in accordance with the guidelines specified by detailed legal regulations, prevent from environmental threats, but it also makes it possible to execute interesting (often spectacular) projects focused on land development.

Ongoing efforts related to the use and disposal of the continuously dumped material focus also on applying technical methods to reduce the production of waste underground, on opening up new markets for this material, on utilization of mining wastes as a construction material, and – consistently with the principle of sustainable development – on low-environmental-impact dumping.

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