**Coal mining waste dumps as secondary deposits exemplified on Upper Silesian Coal Basin and Lublin Coal Basin**

**Abstract**

Polish coal mining industry produces approximately 30 million Mg of mining wastes per year, what represents the largest amount of industrial wastes in Poland. This results in disposing of a huge volume of wastes on waste dumps. The Iron mining waste dumps are stored at the area of over 4000 square feet in more than 140 objects and there are disposed over 760 millions Mg of wastes from hard coal mining.

One of the most recent problems in Poland is recovery of coal from mining wastes. There is a possibility and necessity of recovering of coal from post-mining waste dumps, what should be linked with appropriate legal regulations.

In the paper there is analyzed distribution and dimensions of coal mining waste dumps in Upper Silesian Coal Basin and Lublin Coal Basin. There are presented chosen problems of negative environmental impacts of coal-mining wastes, which may be reduced by the recovery of coal. There are analyzed legal regulations referring to the mining wastes management. Some examples of successful recovery of coal mining dumps as well as economical feasibility studies are given in even many science articles. The analysis of potential objects which are the most valuable for the recovery processes is presented.

The coal mining waste dumps may be considered as important primary deposits. The feasibility studies and experiences of the recovery in the past shows that there is a need of new recovery sites. It must be outlined that sustainable coal recovery is not only economically but also ecologically justified. There is also significance of the re-using and managing of reclaimed dumping grounds for the local communities.

**Key words**: Coal mining wastes, coal mining waste dumps, recovery of coal

**1. INTRODUCTION**

In Polish coal industry the post-mining waste dumps are stored at the area of over 4000 ha in more than 150 objects. The Central Statistic Office of Poland (Główny Urząd Statystyczny - GUS) reports that on the coal mining waste dumps there are disposed 762,8 millions Mg of wastes from hard coal mining, what represents 51% of all stored wastes in Poland.

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. This material has to be deposited in the coal mining dumps. The production of hard coal in Poland in 2012 counted 79,2 million Mg (www.stat.gov.pl). This allows to estimate that approximately 31,68 – 39,6 million Mg of waste material was produced in the year as well. In the past, due to the poor coal preparation technology the majority of this waste material was stored in coal mining waste dumps (Szczepańska, Twardowska, 1999).

Nowadays even over 90% of mining wastes is reused in civil engineering (for construction of flood banks and polders, railway and highway embankments, ground leveling, and reclamation of areas impacted by subsidence or industry) (Gawor, 2013).

**2. COAL MINING WASTE DUMPS IN UPPER SILESIAN COAL BASIN AND LUBLIN COAL BASIN**

According to the literature study in the Upper Silesian Coal Basin there are ca. 140 coal-mining waste dumps, covering over 3500 ha. The highest concentration of the dumps occurs in the central part of USCB e.g. in Bytom (18 dumps), Ruda Śląska (10 dumps) and Zabrze (9 dumps) as well as in the south-western part of USCB e.g. Rybnik (13 dumps) and Jastrzebie-Zdroj (9 dumps). The largest dumps cover the area of over 250 ha (e.g. Central Coal Mining Dumps in Knurów).

The largest coal mining waste dumps are presented in the table 1.

Tab. 1

In the Lublin Coal Basin there is only one waste dump which covers 65 ha and there is planned enlargement of the dump till 88 ha. There is done a biological reclamation on the surface of the dump – afforestration and sodding. The coal mine Bogdanka generates ca. 11 000 Mg of wastes per day (www.lw.com.pl). The coal mining waste management in the last years is presented in the table 2.

Tab. 2

**3. ENVIRONMENTAL IMPACT OF COAL MINING WASTES**

One of the most dangerous environmental impacts of coal mining waste dumps are fire hazards. The lack of compacting of waste material, as well as ignoring rules regarding fire prevention are nowadays a cause of numerous spontaneous combustion events particularly in old coal-mining waste dumps (mostly conical dumps). Coal substance 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 the result 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, what in a consequence can lead to dump fires. A burning dump may affect its surroundings due to spreading the fire and causing air pollution. Nowadays the problem of fires in coal-mining waste dumps still remains present, as well as the issue of toxic gas emissions from mine wastes to the atmosphere (Szczepańska, Twardowska, 2004; Kuna Gwoździewicz, 2013, Gawor, 2013).

In the USCB there are over 140 coal-mining waste dumps and 15 of them are thermally active ones ([www.cools.pl](http://www.cools.pl/)).

Another important environmental impact of mining wastes is surface water and groundwater pollution. There is well known problem of AMD processes (acide mine drainage), which occurs on the dumps due to the leaching of chlorides and sulphates. Recovery of coal may result in changes in the hydrogeochemical profile of the anthropogenic vadose zone resulted from the re-mining and re-disposal of coal extractive waste (Stefaniak, Twardowska, 2005).

One of the serious environmental problems connected with disposing of mining wastes is a danger of mass movements on the slopes. The old conical dumps are the most susceptible for these processes, which usually start with erosion troughs. The natural erosion processes may be intensify by anthropogenic activities.

These environmental impacts may be reduced by the recovery of coal from coal mining waste dumps. According to data from companies which recover the coal from mining wastes it is possible to reduce the volume of the dumps up to 45%.

**4. EXAMPLES OF RECLAMATION OF COAL MINING WASTE DUMPS**

The ways of reclamation on waste dumps comprise technical and biological reclamation. Technical reclamation is connected with three waste dumps generations: conical, tabular and landscape dumps. This reclamation method is also strictly connected with fire hazards. Many waste dumps (especially in USCB) represent the conical type, which intensifies ignition hazards. Biological reclamation methods comprise afforestation and sodding as well as manuring of the land. After over 40 years of field works on waste dumps in USCB connected with biological reclamation it can be evaluated that sodding is the most proper reclamation method applied on waste dumps. The afforestation of waste dumps is believed as ineffective and nowadays there are tendencies to afforest only parts of waste dumps as a means of park and recreation cultivation (Gawor, 2004, 2007, 2011).

Due to the low efficiency of afforestration as biological reclamation of coal mining waste dumps the presence of trees does not present obstacle for recovery processes.

**5. POSSIBILITIES OF RECOVERY OF COAL**

There is a possibility and necessity of recovery of coal from the coal-mining waste dumps. Firstly, coal recovery reduces hazards of self-ignition and fires of the dump. Secondly, the process of coal recovery is economically justified. From over 140 dumps in USCB only 15 are thermally active, so it still remains more than 100 dumps which may be consider as anthropogenic secondary deposits. In the past there were several examples of successive recovery of coal from the dumps (e.g. Central Mining Waste Dump in Smolnica, waste dumps in Buków, Czerwionka – SW of USCB), some of the dumps are still being exploitated – e.g. waste dump in Panewniki, waste dump in Knurów (central part of USCB). There are several companies which conduct recovery of coal as well as reclamation of the dumps using different preparation technologies. One of the examples of coal preparation plant may be waste dump in Buków (Fig. 1).

Fig. 1

Regarding the fact that the amount of coal in the waste material may be up to 10% (between 3-10%, supposing the average amount of coal which can be recovered 5-7%, it can be estimated that total potential amount of recovered coal from the dumps in USCB counts over 45 million Mg (Gawor, 2013).

The feasibility study of one dump in USCB proves that recovery of coal is economically justified. There is an example of one of the dumps called `X` costs and benefits analysis presented in table 3.

Tab. 3

The most valuable waste dumps for the recovery are of course the largest ones (see table 1). There must be taken into consideration other features though, like e.g. the ownership (there are mainly two kinds of ownership: coal mine companies and the communes), localization with regard to neighborhood of protected areas, accessibility (road net, railway) and local community interest. The experiences show that there are always problems with local communities at the planning phase of the recovery of coal, but in the comparison of advantages and disadvantages the benefits for local community are not disputable.

**6. LEGAL REGULATIONS REGARDING MINING WASTES IN POLAND**

The legal regulations regarding mining wastes in Poland include the regulations of environmental protection, geological and mining law, statutes regulating the management of wastes as well as environmental impact assessments. The valid legal regulations in Poland regulate the issues connected with coal mining dumping grounds in a very general way. It is necessary to prepare supplements to the legal provisions or new regulations concerning post-mining dumping grounds. It seems to be beneficial to create new regulations in the form of local law deeds.

One of the reasons of non-effective reclamation of the waste dumps in Poland is a lack of law regulations concerning mining waste, particularly connected with negative environmental impacts (e.g. protection of groundwater, fire hazards) and evaluation of reclamation methods.

The implementation of 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) has taken place in Poland recently. There is, however, a need of creating regulations regarding waste dumps on the level of self-government, i. e. Voivodship in Upper Silesia (Gawor et al., 2011).

The recovery of coal due to the latest legal regulations in Poland is very important and compulsory. The main rule of managing of wastes in Poland according to legal deed about wastes (Ustawa z 27.04.2001r. o odpadach, art. 5 pkt. 2) requires ensuring environmental compliant recovery if there was no possibility of avoiding of origination of wastes. The owner of the wastes should in the order of priority to treat them in a recovery process, and if it is not possible from the technological point of view or not economically justified the owner should treat the wastes as harmless rendering using Best Available Techniques (BAT`s).

**7. CONCLUSIONS**

The coal mining waste dumps in Poland cause serious environmental hazards, particularly danger of self ignition and dump fires. The state of reclamation of many objects is not sufficient, although officially these objects are considered as reclaimed. The recovery of coal reduces environmental hazards, there is also reduction of dump volume, which may be afterwards efficiently reclaimed.

There is a possibility and necessity of recovering of coal from post-mining waste dumps, what should be linked with appropriate legal regulations. The main legal acts in Poland require recovery as the priority.

As far as the legal regulations are concerned so far no standards, technical specifications or legal law acts have been prepared in Polish legislation which would refer to dumping grounds of hard coal mining waste. The valid legal acts (statutes and resolutions) regulate the issues connected with dumping grounds’ reclamation and development in a very general way. It is necessary to prepare supplements to legal provisions or new regulations concerning post-mining dumping grounds in Poland. It seems to be beneficial to create new regulations modeled on the German example in the form of local law acts (e.g. Voivod’s Resolutions), elaborations of standards or technical specifications.

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

Efforts related to the use and disposal of the material up to now dumped are also concentrating on applying technical methods to reduce the production of waste underground, on opening up new markets of this material, on utilization of mining wastes as a building material, and – what is consistent with the rule of sustainable development – on low-environmental-impact dumping.

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