JACEK NOWAK, ALEKSANDER FREJOWSKI
Silesian University of Technology, Poland

MINE WASTE MANAGEMENT IN UPPER SILESIAN COAL BASIN (USCB)

The paper discusses some issues concerning coalmine waste management in Upper Silesian Coal Basin. Due to the ecological and economic conditions, the quantity of currently generated waste has been reduced and the quantity of recovered or recycled waste has increased. The main uses of the recovered waste include filling materials for mining headings, leveling works and other civil engineering tasks. Old waste coal heaps are also subject to reclamation projects and adjustment to serve the functions of recreation or leisure activities, or used as alternatives sources of natural aggregates. The lands reclaimed from the liquidation of waste coal heaps have found new applications, as attractive, centrally located sites are scarce in Upper Silesian Coal Basin.

Обсуждаются некоторые вопросы управления отходами угольных шахт в Верхнесилезском угольном бассейне. Вследствие экологических и экономических причин количество производимых в настоящее время отходов сокращается, а объемы восстановленных и переработанных отходов увеличиваются. Основные области использования восстановленных отходов включают производство наполнителя для горных выработок, работы по планировке поверхности и строительство. Старые угольные отвалы также являются объектом проектов по рекультивации земель и после соответствующей перепланировки будут использоваться для восстановительного и увеселительного отдыха либо в качестве альтернативных источников природных заполнителей. Территории, рекультивированные после ликвидации угольных отвалов, нашли новые применения, так как привлекательные, расположенные в центре участки достаточно редки на территории Верхнесилезского угольного бассейна.

Long-term excavation of hard coal deposits in Upper Silesian Coal Basin exerted a positive influence on the economic and social growth of the Upper Silesian Region, at the expense of a negative impact on the environment. Although the economic growth led to better living conditions of the society, the environmental conditions deteriorated, which, among others, was manifested in the presence of multiple mine waste heaps. Over 70 % of the total quantity of industrial waste produced in 2004 in the Silesian Region came from mining [1]. In view of the figures, proper coalmine waste management constitutes a relevant problem. Pursuant to currently binding legal regulations in Poland, the producers of waste are obliged to undertake measures aimed at minimizing the quantity of waste and prevent their environmental nuisance [2].

In the absence of the option of waste-free excavation, the main focus should be put on reducing the quantity and limiting the detrimental environmental impacts from the generated mine waste. Furthermore, mine waste should be recycled, or, if this is impossible for technological, ecological or economic reasons, neutralized. Accordingly, waste producers, including hard coal mine companies, are trying to minimize the quantity of the generated waste and, hand it over, as much as possible, for recycling or disposal. However, there still remains a great amount of mine waste previously deposited in the form of spoil heaps at the time when ecological reasons were not a priority. This waste constitutes a potential source of environmental pollution and nuisance to the inhabitants of Silesia.

The scope of the paper is the discussion of two methods of recycling and disposing of the waste generated by the coal mine industry as well as the ways of reclaiming and reviving old coalmine heaps. Nowadays Poland's coalmining industry is predominantly set within the boundaries of Upper Silesian Coal Basin. Only one of the 34 underground hard coalmines is located elsewhere [5, 11]. In 1990-2004 36 hard coal mines were closed down in Silesia [5, 11].

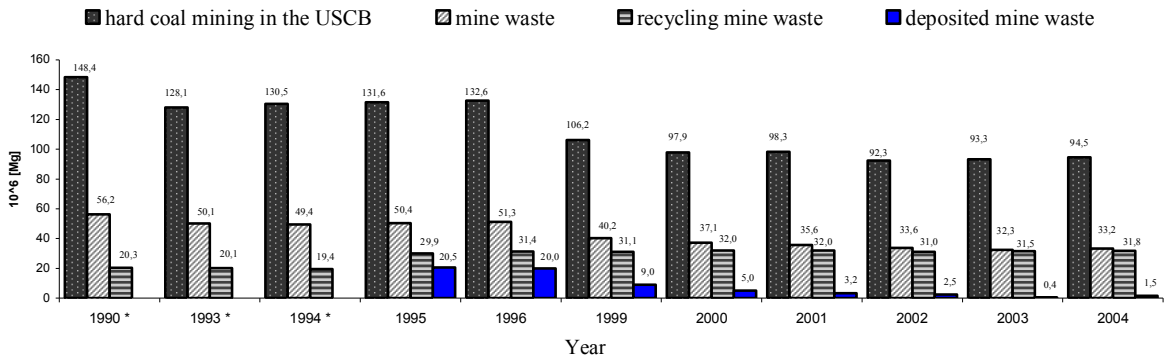

Fig.1. Hard coal mining and generation of mine waste in GZW in 1999–2004 [1, 10]
(* no data on the quantity of the deposited waste)

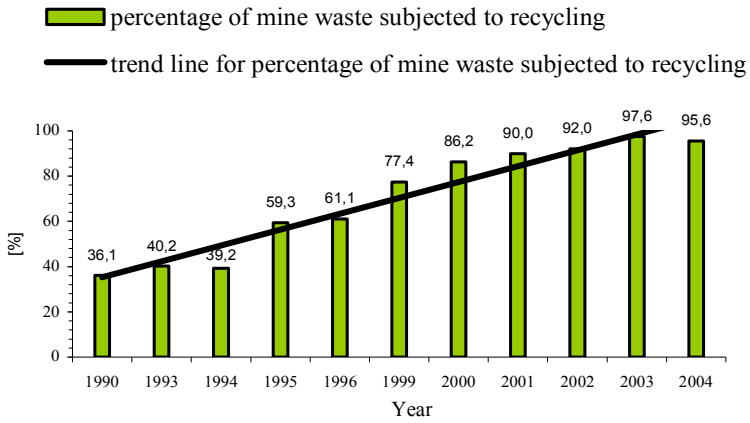

Fig.2. Percentage of mine waste subjected to recycling. [1, 10]

The quantity of mine waste reduced, respectively (Fig.1). However, the reduction in the quantity of the generated waste is not only a result of limited mining, but also an outcome of the implementation of the new criteria of balancing coal seams and increased focus on the extraction of coal with reduced sulphur and ash content, yet at increased balanced thickness of the seams deposited above 1m [10].

Moreover, more and more waste coal is subjected to recycling (Fig.2). In 1993 only about 36 % of mine waste was recycled, whereas in 2004 over 95 % [1].

In Upper Silesian Coal Basin coalmine in mainly recycled for further use in the following ways: depositing in underground headings, land reclamation, engineering works, levelling, construction of levees for watercourses and water basins [3, 4] and treatment or processing to obtain coal.

Mining works conducted with hydraulic stowing require the supply of appropriate filling materials. By replacing filling sand with waste coal, the costs are reduced, especially as far as transport and purchasing are concerned. Currently works are under way to design improved fillings based on waste coal or its mixture other materials [4].

Mine waste is also used for levelling works, filling sinkholes, construction of embankments or levees of watercourses. Mine waste deposited at land fill sites is also utilized as derivative source of coal or aggregates.

Due to the development of coal dressing technologies, coal recovery from waste is increasing. Coal recovering companies that operate in Poland use waste coal generated in the course of current mining works as well as from old spoil heaps. Nowadays the most popular method combines coal recovery with aggregate

and filling materials production. For example, Haldex is a manufacturer of coal mixtures based on waste coal with calorific value of Q_i^r 19–23 MJ/kg at the price of 35–45 $/t, obtaining, at the same time, the aggregate with grain size distribution of 0-150 mm, at the price of 0,5–4 $/t [12].

In the course of long-term mining works conducted in Upper Silesia numerous waste heaps emerged. In the 19th century and, to a lesser extent, in the 20th century, mine waste was dumped in the direct vicinity of coalmines. Housing settlements for workers founded in the neighbourhood of coalmines, as the coalmining and iron and steel industries were growing, developed into the cities of the Silesian agglomeration. Consequently, old waste dumps are still to be found even in central parts of Silesian cities. Many of them do not comply with the requirements of the environmental protection laws, and, as their subsoil and the surroundings were not properly prepared, constitute potential environmental and health hazards to the inhabitants.

Mine waste heaps, without proper biological lining, cause dusting. When the speed of the wind is 3 m/s, dusty fractions are blown out of the heap. In this way, in the course of one year, up to 30 kg of dust may escape from one 1 m^2 of the heap [6].

Another problem is hindered vegetation growth on waste heaps, due to soil deficiency, unfavourable water conditions and absence of mineral components [8]. Poor plant cover lead to increased vulnerability of mine heaps to erosion and dusting, which, in turn, contributes to the silting of the adjacent lands. Plants that managed to grow on mine heaps wither away in a short time and accumulate in the form of biomass, which, in the period of dry and hot weather, poses potential fire hazards.

Reclamation and revival of old mine waste heaps is an alternative to their liquidation. Attempts made at the reclamation of waste heaps in the 20th century often ended in failure. Thin layers of the soil brought in to the heaps gave in to erosion and, in the absence of mineral components, inappropriately selected plant species stunted, or died out. These days, however, in view of the availability of modern methods of subsoil fertilization and appropriate selection of plant species for growth, biological life on the old waste heaps may be completely restored [8].

The waste previously dumped on the heaps contained substantial quantities of coal and was not compacted, which obstructed the penetration of oxygen inside the heap and often led to fires breaking out. Nowadays fire protection measures applied in the course of waste disposal have significantly reduced fire hazards. Yet, occasional fires still breaking out on old mine heaps cause emissions of hazardous gases to the air.

Many waste heaps have good location and could be used as brown fields for development, especially in view of limited availability of attractively situated green fields in Silesian towns and cities. Some of the heaps may constitute obstacles to new transportation routes. Yet, one example of successful reclamation projects is the gigantic shopping and leisure centre constructed in Katowice at the site of the liquidated Katowice-Kleofas coalmine [4].

Many of the old waste heaps were partly or completely burned out. The self-burned waste coal in Upper Silesia is used as a substitute of natural aggregates and utilized in road building: for the construction of embankments, road bases, for engineering and hydro-technical works, and is popular due to low costs of purchase and easy availability. The prices vary in the range of 2-4 $/t. Companies supplying aggregates used in road building, as the demand is increasing, use up the nearest waste coal heaps, minimising the costs of transport, especially as the recovery of aggregate from successive heaps does not need bi financial outlays. A disadvantage of the materials recovered from self-burned waste coal is big variability of this raw material. Different types of waste coal were dumped at the heaps over the past years, as far as grain size distribution and petrographic composition is concerned. Further segregation of the waste coal occurred due to different intensity of the thermal processes evoked in the heaps, leading to substantial petrographic differentiation [7]. The results of the tests conducted on the waste material characterised by different degree of thermal transformation

indicate that, despite the variability of the geo-technical parameters, their properties comply with the requirements stipulated in Polish standard PN-S-02205 applicable to the materials permitted for use in the construction of road embankments [9]. Accordingly, self-burned waste coal offers cost-effective, good and easily accessible material to be utilized in road and highway building.

Conclusions

1. In view of current economic and ecological conditions coalmine companies have to face the challenge of minimising the quantity of generated waste and waste recycling. Accordingly, new ways of utilising the mine waste generated in the course of coal extraction and dressing are searched for.

2. Old waste coal heaps, which emerged in the course of the previous centuries, are still a potential sources of environmental hazards for the inhabitants of Upper Silesia.

3. Old waste coal heaps, including the self-burned waste coal, are potential sources of a good substitute for aggregate materials.

4. The liquidation of old waste heaps to obtain aggregate materials or coal contributes to the reclamation of new brown fields ready for development. This is particularly important in the case of the heaps located in attractive sites in city centers of the Upper Silesian agglomeration.

5. The heaps destined for reclamation should be adjusted to serve recreational functions (walking routes, bicycle tracks, ski pests, etc).

REFERENCES

1. Stan środowiska w województwie śląskim w 2004 roku. Biblioteka Monitoringu Środowiska, Katowice 2005. (i wydania wcześniejsze)
2. Ustawa o odpadach z 27 kwietnia 2001 roku. Dz.U. 2001 nr 62 poz. 628 (z późniejszymi zmianami).
3. *Gabzdyl W., Hanak B.*: Surowce mineralne Górnośląskiego Zagłębia Węglowego i obszarów przyległych. Przegląd Geologiczny, vol. 53, nr 9, 2005, s. 725-734.
4. *Gajos S.*: Katowicki Holding Węglowy S.A. – działalność w zgodzie z zasadami zrównoważonego rozwoju. Zeszyty Naukowe Politechniki Śląskiej, seria: Górnictwo, z. 269, s. 33-57. Gliwice 2005.
5. *Kicki J., Sobczyk E., Paszcza H.*: Ekonomiczne i technologiczne aspekty procesu likwidacji kopalń w warunkach polskiego górnictwa węgla kamiennego. Materiały konferencyjne Mine Planning and Equipment Selection 2005. Banff, Kanada 2005.
6. *Kotowski W.:* Gospodarka odpadami oraz rekultywacja hałd kopalnianych. Oficyna Wydawnicza Politechniki Opolskiej. Opole 2000.
7. *Nowak J.*: Przemiany mineralogiczne zachodzące w odpadach z wydobycia węgla kamiennego na przykładzie składowiska Nr IV KWK „Nowy Wirek". Prace Naukowe Wydziału Górnictwa Politechniki Wrocławskiej nr 116, s.171-180. Wrocław 2006.
8. *Patrzałek A.*: Ocena zbiorowisk roślinnych na zrekultywowanych zwałowiskach w Zabrzu w celu określenia ich dalszych funkcji w planie zagospodarowania przestrzennego. Zeszyty Naukowe Politechniki Śląskiej, seria: Górnictwo, z. 269, s. 207-219. Gliwice 2005.
9. *Porszke A.*: Wpływ zmienności parametrów geotechnicznych odpadów powęglowych ze składowiska KWK „Siemianowice" na możliwości ich wykorzystania w budownictwie drogowym. Zeszyty Naukowe Politechniki Śląskiej, seria: Górnictwo, z. 257. Gliwice, 2003.
10. *Probierz K., Gabzdyl W., Borówka B.*: Zasoby węgla kamiennego Górnośląskiego Zagłębia Węglowego w latach 1989 – 2003. Zeszyty Naukowe Politechniki Śląskiej, seria: Górnictwo, z. 269, s. 13-32. Gliwice 2005.
11. *Probierz K.*: Górnictwo na cenzurowanym. Wydawnictwo Politechniki Śląskiej. Gliwice 2000.
12. www. haldex.com.pl