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Mineral waste raw materials and their importance in the domestic management of mineral raw materials

Key words

Industrial wastes, mineral waste raw materials, sources of mineral information, minerals yearbook

Abstract

The paper presents increasing importance of secondary (waste) raw materials in the domestic management of mineral raw materials. The definition of mineral waste raw material is proposed. Paper reviews various types of mineral waste raw materials and their use in the economy. Sources of information on manufacture and use of mineral waste raw materials are analysed. In the conclusion, current and future significance of such materials in the domestic management of mineral raw materials is evaluated.

Introduction

Preparation of minerals yearbook (or mineral commodities yearbook) is one of the main research tasks of mineral commodities management. Such annual publications analyse current phenomena on domestic and world minerals' markets. Moreover, they allow to estimate future trends on these markets. That is why the minerals yearbooks were started to be prepared in some developed countries a few dozens years ago (in the U.S. since 1883!), while in Poland it has been issued on annual basis since 1993.

Primary sources of minerals, i.e. mineral deposits, were the main sources of the mineral raw materials for centuries. However, due to some ecological, technological and economic reasons, importance of secondary mineral raw materials (including mineral waste raw materials) has been

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rising step by step in recent years. Such secondary materials have increasing importance in the management of various types of mineral commodities and should be taken into account, both in minerals markets analyses and in preparation of minerals yearbook.

1. Definition of mineral waste raw materials

The precise definition of mineral waste raw materials is the crucial starting point for analysis of their importance. According to traditional definitions, mineral wastes are named as products obtained in course of mining or processing activity, application of which is unknown or economically not viable (Encyklopedia... 1992). Technological development, as well as continuously more stringent environmental constraints of mining activity result in increasing use of secondary mineral products, which previously were treated as mineral wastes.

Wastes are defined in the Act on Wastes, passed on 27th April 2001, as follows: "Wastes are all substances or things, which belong to one of categories listed in Appendix No. 1 to the Act, and are disposed by the owner or are to be disposed by the owner (§3). Categories of wastes listed in Appendix No. 1 are not precisely defined and may be interpreted in various ways. However, the statement that they are not useful in the economic activity of the owner, is very important. On the basis of §4 of the Act, Minister of Environment issued Ordinance on Catalogue of Wastes, where new European Catalogue of Wastes was transposed. Catalogue of Wastes divides wastes — depending on their source — into 20 groups (two digit code), subgroups (four digit code) and types (six digit code). It takes into account practically all types of wastes obtained during economic and living activity, when they are disposed or are to be disposed by owner. However, treating of some types of materials listed in this Catalogue as wastes, is controversial. There are technological and economic possibilities for their use and — in fact — a substantial percentage of these materials find economic use. So, despite they are formally called wastes, they can be defined as secondary waste mineral commodities (mineral waste raw materials).

There are many various definitions of the term "mineral commodity". It traditionally applied to minerals in deposits and to their extraction (mineral commodity in exact sense). However, the definition of mineral commodity undergone significant changes in time. Currently, by-products obtained during production of other mineral commodity (e.g. silver from the sludge after electrorefining of copper), products manufactured from secondary sources (e.g. synthetic gypsum from desulphurisation), or mineral products obtained in course of chemical synthesis (e.g. synthetic magnesia, synthetic soda) are also considered as mineral commodities. Therefore, mineral commodity in the broad sense should be defined as all sorts and varieties of raw materials, coming from various sources (primary, secondary), which are obtained in various ways and stages of production activity (mining, processing, thermal processing or smelting, etc.). It means that such definition covers also such mineral products as electrolytic copper or cement, being practically the first commercial products of the technological process.

Mineral waste raw materials can also be divided into raw materials in the precise sense and in the broad sense. All mineral wastes classified in the group 01 of the Catalogue of Wastes, i.e. wastes coming from prospecting, mining, physical and chemical processing of ores and other minerals, if they could be utilised economically, should be called mineral waste raw materials in the precise sense. These are the materials, where mineral composition was not substantially changed as a result of thermal or chemical processing. A list of mineral waste raw materials in the broad sense should be much longer. In the author's opinion, it should include waste commodities from groups, subgroups and types listed in the Table 1.

TABLE 1

Proposed list of mineral waste raw materials in the broad sense

TABELA 1

Proponowana lista mineralnych surowców odpadowych sensu largo

Code according to Catalogue of Wastes	Type of wastes (potential mineral waste raw materials)
01	Wastes from prospecting, mining, physical and chemical processing of ores and other minerals
1001	Wastes from power plants
1002	Wastes from steelworks
1003—1008	Wastes from non-ferrous metals smelting
1011	Wastes from glassworks
1012—1013	Wastes from ceramic plants
150104	Metallic containers
150107	Glass containers
1606	Batteries and accumulators
1608	Spent catalysts
1611	Spent refractories
1701	Wastes of building materials
1704	Metallic wastes and scraps

Certainly, the proposed list of potential mineral waste raw materials is not complete as it can be supplemented by some wastes from inorganic chemistry (group 06), e.g. sodium sulphate, phosphogypsum, wastes from foundries (subgroups 1009, 1010), wastes from ferroalloys production (subgroup 1080), wastes from scrapped vehicles (subgroup 1601), etc.

2. Types of mineral waste raw materials and directions of their use

List of potential mineral waste raw materials in the broad sense, proposed above, should be discussed in detail, regarding both type of obtained materials and their present and potential directions of use. A large portion of mineral wastes, coming especially from mining and processing of minerals, is used for ground levelling and other engineering works. However — in author's opinion — they should not be considered as mineral waste raw materials.

The total amount of industrial wastes generated in Poland declined from 143.9 Mt in 1990 to 122.8 Mt in 2001. Amount of utilised wastes grew from 77.1 Mt (53.6%) to 96.3 Mt (78.4%), respectively. The majority of these wastes are generated in the three southern voivodeships: Śląskie (37%), Dolnośląskie (26%), and Małopolskie (8%) (Ochrona środowiska 2001).

2.1. Wastes from mining and processing (code 01)

Wastes from mining and processing (code 01) are the largest group of wastes generated and deposited in Poland. In 2001 ca. 74.0 Mt of mining and processing wastes were generated, what makes ca. 60% of total amount of wastes generated during economic activity. The total amount of mining and processing wastes deposited on dumps achieved 1.5 billion t, i.e. 73% of total tonnage of wastes deposited (Ochrona środowiska 2001). The three main sources of such wastes are: mining and processing of hard coal, mining and processing of non-ferrous metals ores, rock minerals extraction.

In the hard coal industry, 38.4 Mt of wastes were generated in 2001, and 35.0 Mt of them were utilised. The majority of them (35.0 Mt, i.e. 91%) is obtained during processing in jigers, heavy liquids and slurry circulation. Flotation wastes make 6% of total amount (2.1 Mt), while mining wastes make the rest. High level of economic utilisation of hard coal industry wastes is reported (ca. 90%). However, only ca. 30% of wastes is utilised in industrial application, while over 70% for ground levelling and other engineering works (Krajowy plan... 2002). The main industrial applications are: component of hydraulic filling (over 1 Mtpy), and production of building ceramics and cement (Bilans... 1996).

In the non-ferrous metals ore mining and processing, ca. 30.3 Mt of wastes was generated in 2001, and 22.8 Mt of them was utilised. Flotation wastes from copper ores processing constitute a majority of them (ca. 27.0 Mt, i.e. 88%). Flotation wastes from Zn-Pb ores processing make 10%, while mining wastes only 2%. Economic utilisation of this wastes significantly rose, but primarily due to formal reasons. 75—78% of flotation wastes from copper ores processing has recently started to be used as material in hydrotechnical engineering, i.e. for construction of barriers and sealing of the Żelazny Most settling pond (Jasiński et al. 2003). Typical industrial uses of these wastes include: component of hydraulic filling (flotation wastes from Zn-Pb ores), and crushed aggregates (dolomite rock wastes from gravity separation of Zn-Pb ores). Total utilisation of such wastes does not exceed 1—2 Mtpy. Use of flotation wastes from copper ores processing as component of solidified filling material is anticipated in coming years. Level of utilisation of this type of waste in such application can achieve even 7 Mtpy (Jasiński et al. 2003).

Wastes coming from rock minerals extraction constitute the third important source of mineral wastes in this group. The volumes of these wastes generated and utilised, reported by the Central Statistical Office, are substantially underestimated. According to this official information, generation of wastes from rock minerals mining varies between 2.3—3.6 Mtpy, and the majority of them are utilised (Ochrona środowiska 2001). However, it is estimated, that total volume of these wastes exceeds 10 Mtpy, while the level of their utilisation does not exceed 40%. There is a lack of detailed information about it, and estimates are based on information from "Balance of mineral waste raw materials from mining and power plants" published by the Institute of Waste

Management in 1996, as well as on information coming from MIDAS database at the Polish Geological Institute. The following types of wastes are classified into this group: wastes obtained during extraction of compact rocks (limestone, dolomite, sandstone, magmatic rocks), as well as of clays, sand and gravel, etc. (Bilans Zasobów... 2002). They are used mostly in civil engineering (road construction, ground levelling and other engineering works), crushed aggregates and concrete production, in agriculture (limestone and dolomite fertilisers), in the ceramics (e.g. granite wastes for ceramic tiles).

2.2. Wastes from power plants (code 1001)

Wastes generated in course of fuels burning in power plants and central heating plants are the second important group of industrial wastes. In 2001, ca. 18.5 Mt of wastes from power plants was generated, what makes 15% of total amount of wastes generated. 13.2 Mt of these wastes (71%) was utilised. The total amount of wastes from power plants deposited on dumps approached 330 Mt (Ochrona środowiska 2001).

The main wastes of this group are: furnace slag from hard coal or brown coal combustion, fly ash from hard coal or brown coal combustion, ash&slag mixes, microspheres from fly ash, wastes from desulphurisation by wet lime methods, wastes from desulphurisation by semidry and dry methods, mixtures of fly ash and desulphurisation products, etc. The largest amounts are generated in case of: ash-slag mixes (8.6 Mt in 2001, i.e. 46%), fly ash (5.2 Mt, 28%), furnace slag (2.3 Mt, 12%), and — lately — wastes from desulphurisation by wet lime methods (2.4 Mt, 13%). In the coming years, due to introduction of new techniques of coal combustion, amount of traditional slag and ash should diminish, while ca. 4 Mtpy of sulphate-calcium ashes from fluidised-bed combustion will be generated (Krajowy plan... 2002; Galos et al. 2003).

The range of use of wastes from power plants has been continuously increasing. In terms of tonnage it rose from ca. 7.5 Mt in 1994 to over 13 Mt in 2001. In recent years, the term "by-products of combustion" is often used instead of term "wastes from power plants". They find use especially in the building materials industry, for cement, concrete, lightweight aggregates, building and special ceramics, insulation materials (Brylska et al. 2001). Significant quantities of these wastes are used in engineering works (ground levelling, road embankments). Increasing amounts — especially of fly ashes — find use as components of hydraulic filling. The highest percentage of utilisation (over 90%) is reported in case of fly ash, furnace slag, and wastes from desulphurisation by wet lime methods, while the lowest for ash-slag mixes (under 50%). Demand for some types of power plant wastes, like microspheres from fly ash, is sometimes larger than supply. In the coming years, further significant growth of utilisation of power plant wastes is expected as a result of construction of numerous installations for production of: self-thickening concrete, some cement binders, activating additives to concrete, granulated aggregates, filling materials, materials for: ground stabilisation, ground levelling, land reclamation, etc. (Krajowy plan... 2002; Galos et al. 2003).

2.3. Wastes from steelworks and non-ferrous metals smelters (codes 1002—1008)

Wastes from metallurgical processes are one of the most important wastes generated by industry. In 2001, ca. 7.5 Mt of such wastes was obtained, what makes 6% of total amount of wastes generated. 6.3 Mt of these wastes (84%) was utilised (Ochrona środowiska 2001).

The main types of metallurgical wastes are:

— in steelworks — primarily steel-making and blast furnace slag, also melting losses, slimes and dusts from gases cleaning, iron sulphate; total quantity 4.5—5.0 Mtpy, 85% is utilised;

— in copper smelting — mainly shaft furnace and converter slag (95%), also dust and slimes from gases cleaning and melting losses; total quantity ca. 1.3 Mtpy, 75% is utilised;

— in zinc smelting — primarily shaft and rotary furnace slag, also slimes from gases cleaning and melting losses; total quantity ca. 0.17 Mtpy, over 98% is utilised;

— in lead smelting — mainly slag and melting losses; total quantity under 30,000 tpy, under 25% is utilised as a result of low rate of slag use;

— in aluminium smelting — primarily melting losses, foundry slag and slimes from gases cleaning; total quantity under 20,000 tpy, 70% is utilised (all melting losses and slag).

A large portion of metallurgical wastes are used as metalliferous raw materials being recirculated into metallurgical process (Krajowy plan... 2002). Other non-metallurgical applications of that group of wastes are:

— crushed aggregates production — steel-making and blast furnace slag from steelworks, shaft furnace and converter slag from copper smelters, slag from zinc smelters (Pawełczak 2003; Bilans gospodarki... 2002);

— additive for building ceramics production — dust from steelworks;

— additive for cement clinker production — dust and slimes from steelworks, blast furnace slag;

— substitute for filling sand — blast furnace slag;

— additive for colour glass production — dust from steelworks (Krajowy plan... 2002; Bilans gospodarki... 2002).

2.4. Wastes from glassworks and ceramic plants (codes 1011—1013)

These groups of industrial wastes are generated in glassworks and ceramic plants. Glass wastes are generated during process of glass manufacturing and working. They are recirculated into the production process, unless they are contaminated. Ceramic wastes obtained during manufacture of porcelain, ceramic tiles, refractories, abrasives, can be treated as a home scrap. That could be unburnt scrap, practically recirculated to the stage of ceramic mass preparation, as well as burnt products breakage, which can be used — after grinding — as component of ceramic mass at maximum level of 10—20% (Bolewski et al. 1991). There is a lack of detailed data on quantity of ceramic home scrap, but usually it does not exceed 5—10% of ceramic plant production. Glass cullet collection in glassworks amounted to ca. 340,000 t in 2001, i.e. almost 20% of glass products manufacture (Gospodarka materiałowa 2002).

2.5. Metallic containers (code 150104)

The two most common metallic containers that can be recycled are: steel sheet (commonly tinplated) and aluminium containers. It is estimated, that ca. 130,000 tpy of steel sheet containers wastes and ca. 40,000 tpy of aluminium containers wastes has been generated in recent years. Hitherto, the level of steel sheet recycling is under 5%, though such wastes can be separated from municipal wastes by magnetic separators. The problem is a lack of technology for sheet detinning, therefore these containers can be added as component of furnace charge in small percentage. It is expected that level of steel sheet recycling in the next five years will approach 20%, i.e. ca. 30,000 tpy.

The present rate of aluminium containers recycling is ca. 9%, but in the next few years it should increase to ca. 40%, i.e. ca. 20,000 tpy. Currently, the collection and processing of aluminium cans is the most effective, while processing of aerosol aluminium containers is much more difficult. The recycling of aluminium containers is favoured by high price of aluminium scrap. However, improved organisation of containers collection, appropriate level of product fee, as well as better social consciousness regarding containers recycling, is required (Krajowy plan... 2002).

2.6. Glass containers (code 150107)

Glass cullet is traditionally important component for glass production. Wastes of window glass obtained during repair or demolition of buildings (code 170202) are of minor importance. System of glass cullet recycling has been improved in recent years, and the level of recycling has risen to ca. 10%, i.e. over 80,000 tpy. However, the rate of recycling is still unsatisfactory. It is expected that in the next five years it should rise to ca. 40% (i.e. 400,000—500,000 tpy). It will depend on improvement of collection effectiveness, better social consciousness regarding wastes segregation, as well as development of glass cullet processing facilities (Krajowy plan... 2002).

2.7. Batteries and accumulators (code 1606)

Two main types of batteries are distinguished: large-size accumulators (lead-acid and nickel-cadmium ones), and small-size batteries and accumulators (alkaline, manganic, lithium, silver, nickel-cadmium, hydrogenous and other types). Currently, only large-size accumulators are recycled. Used lead-acid batteries are the important source of lead. Their annual supply is estimated at 60,000—100,000 t, their collection is managed by ca. 1,000 companies of various size, while processing is conducted by two plants: Orzeł Biały in Bytom and Baterpol in Świętochłowice. The quantity of accumulators processed have a chance to increase substantially after introduction of deposit fees (since 1.01.2002), what should allow to recycle almost 100% of used lead-acid accumulators (Lewicka 2003). Cadmium-nickel accumulators are of much lower importance. Their recovery does not exceed 600 tpy and will diminish in the next years due to decreased use of such accumulators. Small-size batteries and accumulators have not been recycled yet (Krajowy Plan... 2002). Recovery of lithium from lithium batteries used in mobile phones may be developed in the future.

2.8. Spent catalysts (code 1608)

Various types of catalysts are used in many chemical and petrochemical processes. Such catalysts usually contain some precious metals and/or other elements. Spent catalysts containing platinum group metals and gold are the most important as a secondary source. These metals are recovered from spent catalysts in the State Mint at the level of dozens kgpy (Bilans gospodarki... 2002).

2.9. Spent refractories (code 1611)

Refractories must be periodically replaced in furnaces. Spent refractories may be disposed to wastes dump or — after grinding — used as component for new refractories production. Level of use of spent refractories is not precisely known, but undoubtedly does not exceed 5% of the whole quantity used in the production of new refractories. Higher recovery of spent refractories is reported in case of some basic, chamotte and fused alumina-zircon refractories (Bolewski et al. 1991).

2.10. Wastes of building materials (code 1701)

Wastes from construction, repair or demolition of buildings are very diversified depending on the origin. Their generation is very dispersed which makes the estimation of their quantity very difficult. Some of these wastes arouse or may arouse interest as secondary raw material. These are especially concrete wastes and debris used in rising amounts as material for crushed aggregates production. In the future, likewise in developed countries, increasing recovery of such wastes for crushed aggregates production is expected. However, it is necessary to organize selective collection of these wastes.

2.11. Metallic wastes and scraps (code 1704)

Metallic scrap, especially non-ferrous metals scrap and iron scrap, for many years was important secondary source for production of metals and their alloys. It is somewhat strange that they are classified in the Catalogue of Wastes, however it can be explained by the fact that they must be properly collected and processed before they are utilised. Metallic scrap is collected by trade companies (after collection they sell scrap to production plants or export it), as well as directly by production companies. Total collection of metallic scrap by trade companies amounted to 2.62 million t in 2001 (including 2.49 million t of iron and steel scrap, 64,800 t of aluminium scrap and 40,200 t of copper scrap), while in production companies 3.87 million t (including 3.62 million t of iron and steel scrap, 69,500 t of aluminium scrap and 97,300 t of copper scrap) (Gospodarka materiałowa 2001). Share of scrap in the total domestic supply of main metals varies between 3% in case of zinc to over 40% for aluminium and steel. Detailed information on metallic scrap management is given by Lewicka (Lewicka 2003).

3. Preparation of Minerals Yearbook of Poland

The need of preparation of minerals yearbook of Poland, which would be comparable to minerals yearbooks issued in a few developed countries, for the first time has been emphasised by professor Andrzej Bolewski. First trials of analysis of mineral commodities management were undertaken in an annual "Mineral resources and underground waters register in Poland", which — on professor Bolewski initiative — started to be edited in 1953. Since the 1970s, problem of analysis of mineral commodities management was diminished in this yearbook. In the late 1970s "Study of mineral commodities management in Poland in the years 1971—1976" was prepared in the Geological Institute (Bolewski et al. 1979), and later on it was extended by the years 1977—1981 under auspices of Committee of Minerals Management of the Polish Academy of Sciences (Ney 1983).

The idea of preparation of "Minerals Yearbook of Poland" was reverted in the beginning of the 1990s in the Mineral and Energy Economy Research Centre of the Polish Academy of Sciences in Kraków (currently Mineral and Energy Economy Research Institute). In 1993, the first edition of yearbook was edited. Content of the consecutive editions of "Minerals Yearbook of Poland" edited under auspices of the Ministry of Environment was systematically expanded, covering extended list of mineral commodities, as well as increasingly detailed information on their management in Poland and in the world. That was possible thanks to systematic market analyses of particular mineral commodities conducted by the team of the Mineral Policy Department in the Institute (Bilans gospodarki... 2002). The Yearbook is edited in Polish language version, and — since 1997 — also in English language version. Currently, the 11^{th} edition of Polish version and the 7^{th} edition of English version of "Minerals Yearbook of Poland", covering years 1998—2002, is under preparation.

The management of each of over 110 mineral commodities is characterised in separate chapters. All aspects of management are analysed, i.e. primary and secondary sources, mining production, production of concentrates and derivative goods (if occurs), quantity and value of foreign trade, quantity and structure of consumption, as well as prices. The structure of "Minerals Yearbook of Poland" is patterned on similar mineral yearbooks edited in other countries for years, e.g.: U.S. Minerals Yearbook (the U.S.), United Kingdom Minerals Yearbook (U.K.) or Bundesrepublik Deutschland Rohstoffsituation (Germany). The main sources of information are: statistical data collected by the Central Statistical Office — pertaining to domestic production and foreign trade of mineral commodities; data from annual "Mineral resources and underground waters register in Poland" prepared under auspices of the Ministry of Environment by the Polish Geological Institute — regarding information on mining output; direct information from domestic mineral producers — production quantity, prices, economic and market phenomena.

For decades, primary raw materials coming from mineral deposits have the dominant importance on mineral commodities markets. However, the significance of secondary sources (scrap, wastes) has been continuously increasing, especially since the beginning of the 1990s. Importance of secondary sources is diversified depending on type of mineral commodity (i.e. it is not the case for fuels). For some minerals, the share of commodities produced from secondary sources in total supply may approach 10—20%, sometimes even 50% (gypsum). Raw materials from secondary sources may possess quality parameters comparable to parameters of raw materials obtained from primary sources, being their substitutes of full value. More frequent situation is when such raw material is a substitute of not full value, but it can compete due to very competitive price. Another very frequent situation is when mineral wastes find application (e.g. for ground levelling), but they cannot be regarded as mineral commodity (they do not possess such features as commodity turnover, quality standarisation, etc.).

Problem of obtaining and application of mineral commodities coming from secondary sources is analysed in "Minerals Yearbook of Poland", especially in case of metals, gypsum and aggregates. The newly introduced law regulation in Poland is expected to result in intensification of industrial wastes utilisation. It will strongly influence the markets of some mineral commodities. However, in order to properly establish market position of such materials in the next editions of "Minerals Yearbook of Poland", appropriate sources of information on generation and utilisation of mineral waste raw materials must be recognised.

4. Sources of information on generation and utilisation of mineral waste raw materials

Availability of information on generation and utilisation of mineral waste raw materials is a serious problem, especially regarding the need of including such a data in the analyses of separate mineral commodities management in Poland. These data are not complete, being also very dispersed.

Data collected and processed by the Central Statistical Office should be the first and basic source of information regarding management of mineral waste raw materials, as it is in case of primary mineral raw materials. However, it is not so simple. The difficulty arises from the fact that only larger companies, generating annually over 1000 t of wastes, are obliged to report wastes management (special statistical form OS-6). As a result, there is no information from small and medium-size companies, which generate ca. 2—8% of total amount of wastes (Krajowy plan... 2002). Available data are not fully comparable year by year, because data were aggregated in different reporting schemes: until 1997, between 1998 and 2002 (after introduction of the first Catalogue of Wastes), and since 2002 (on the basis of new Catalogue of Wastes). The data collected are highly aggregated, what makes difficult to separate particular groups of mineral wastes, which play or may play important role as mineral waste raw materials. Moreover, data collected by the Central Statistical Office do not allow to establish directions for particular wastes application (only total amount of utilised wastes, including industrial applications, is reported).

Questionnaires OS-21 to OS-28, collected by the Polish Geological Institute under auspices of the Ministry of Environment and the Central Statistical Office for preparation of annual "Mineral resources and underground waters register in Poland", are the supplementary source of information. Information on the volume and level of utilisation of mineral wastes from mining and processing, is included in these questionnaires. Total amounts of generated and utilised mineral wastes from mining and processing, reported in this annual register, is unfortunately significantly higher than amounts reported by the Central Statistical Office on the basis of OS-6 questionnaires.

"Balance of mineral waste raw materials from mining and power industry, as of 31.12.1994", prepared in 1996 by the Waste Management Institute, was the first significant trial of presentation of mineral wastes management in Poland, though it covered only mineral wastes from mining and power industry. This report based on separate survey of companies, which generate, store or utilise such wastes. In parallel, special information system of mineral waste raw materials SIGOM was constructed. Unfortunately, the above-mentioned "Balance..." was the only single edition, and was not continued in the following years. However, conducting of SIGOM/SIGOP database is still managed by the Waste Management Centre.

It is clear that there is a need of creation and maintenance of uniform and reliable information system on generation, storage and utilisation of mineral wastes (Sroga 2003). It should be correlated with valid circulation of documents related to wastes management, on the basis of the Act on Wastes and related ordinances. It is provided that all information on generation, storage, utilisation and neutralisation of wastes will be completed at local/province (voivodeship) level, i.e. at the Office of Marshall of Voivodeship. Subsequently, this information will be sent to the central database in the Ministry of the Environment. The proper operation of such a system is expected in the near 2—3 years. In this system, however, also information from small companies should be included, in opposite to data recorded by the Central Statistical Office.

For the preparation of "Minerals Yearbook of Poland", information sources related to mineral waste raw materials and presented above, are supplemented by independent survey of producers of some mineral waste raw materials. The examples are gypsum or crushed aggregates. Additional information about directions of application of such materials comes from scientific publications, scientific and technical conferences, website pages of manufacturers and users of such materials, etc.

5. Present and future significance of mineral waste raw materials in the domestic management of particular mineral commodities

The share of mineral waste raw materials in the domestic management of mineral commodities is diversified. They can be substitutes of full value for primary mineral commodities, e.g. crushed aggregates made of steel or converter slag, synthetic gypsum from flue gas desulphurisation, metals manufactured from scrap. Mineral waste raw materials can be used as components of input for the production of mineral commodity in the broad sense, e.g. wastes from mining and from power plants for cement clinker and cement production. Such waste materials can also be used — partly or entirely — instead of primary mineral commodities in the technological process, which bases on such raw materials. The examples are: various mineral wastes used in backfilling instead of filling sand, spent refractories instead of part of raw materials input for new refractories production, glass cullet instead of primary raw materials for glass containers production.

Mineral waste raw materials are or can be potentially used in the coming years as substitutes for ca. 30 types of primary mineral raw materials, reported in "Minerals Yearbook of Poland". Metallic scrap, especially scrap of non-ferrous metals and iron scrap, have traditionally the largest importance. Share of scrap in the total domestic supply of some metals is substantial: over

50% for lead (together with lead from lead-acid batteries), 45—50% for iron and steel, 30% for aluminium, 25—27% for copper, 3—8% for zinc, 2—3% for silver. Cadmium, nickel and magnesium metals and alloys are also obtained from scrap. On the contrary, gold and platinum group metals are recovered primarily from spent catalysts.

Mineral and processing wastes have a significance as sources for production of:

— kaolin — from wastes after glass sand washing;

— ceramic clays — from old dumps near closed mines;

— natural aggregates — from industrial sand mines;

— crushed aggregates — from rock wastes coming from production of grades of dimension stone, industrial limestone and dolomite, as well as from hard coal mining wastes;

— fertilisers — from fine grained wastes in limestone and dolomite mines.

Various mining wastes, as well as wastes from power plants, are increasingly used in the cement industry. Now they constitute 15—20% of input for cement clinker and cement production. Large quantities of synthetic gypsum from flue gas desulphurisation cover over 50% of demand of domestic gypsum building materials industry. Some types of metallurgical slag are utilised for manufacture of crushed aggregates, competing with aggregates made of compact rocks.

Spent refractories have in general increasing importance as material for new refractories production. Traditionally, it is the case for magnesite, chamotte and fused alumina-zircon refractories, but probably also recovery of spent andalusite and alumina refractories will be developed. Glass cullet currently makes ca. 15% of input for glass containers production, but in the near future this share should reach even 40%. Other interesting examples of current or future production of raw materials from mineral wastes are: production of chromium compounds from various chrome-bearing wastes, production of cryolite (sodium-aluminium fluoride) as by--product during sulphuric acid production, production of lithium compounds from spent lithium batteries.

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KRZYSZTOF GALOS

MINERALNE SUROWCE ODPADOWE I ICH ZNACZENIE W KRAJOWYM BILANSIE GOSPODARKI SUROWCAMI MINERALNYMI

Słowa kluczowe

Odpady przemysłowe, mineralne surowce odpadowe, źródła informacji surowcowej, bilans gospodarki surowcami mineralnymi

Streszczenie

Artykuł prezentuje rosnącą rolę wtórnych (odpadowych) surowców mineralnych w krajowej gospodarce surowcami mineralnymi. Przedstawiono w nim propozycję definicji mineralnych surowców odpadowych. Zaprezentowano ważniejsze grupy mineralnych surowców odpadowych oraz ich zastosowania gospodarcze. Analizie poddano także źródła informacji o wytwarzaniu i użytkowaniu mineralnych surowców odpadowych. W podsumowaniu przedstawiono ocenę obecnego i przyszłego znaczenia tego typu surowców w krajowej gospodarce poszczególnymi grupami surowców mineralnych.