Characteristics of some solid industrial wastes and prospects for their disposal

M.A. Sadenova, G.B. Zhakupova, T.B. Anuarbekov

Priority Development Center VERITAS EKSTU D.Serikbayev Ust-Kamenogorsk 070004 Kazakhstan
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Presenting author email: sadenova@mail.ru

In the course of processing of initial raw materials at the enterprises of mining, concentrating and especially metallurgical industry of production technogenic products (slags, enrichment tails, dumps overburden are formed and theore containing breeds, etc.) they in process of the accumulation and formation of big dumps begin to turn into technogenic mineral educations eventually.

Now in Kazakhstan the problem of use of technogenic mineral educations which by quantity and quality are commensurable with large-scale deposits of ore raw materials is relevant. They differ in complex structure, considerably differ on density, material structure and technological properties. Technogenic mineral educations gold and the rare metalof the enterprises considerably concede to volumes of technogenic formations of nonferrous and ferrous metallurgy, but differ in rather higher maintenance of useful components (gold, tungsten, and others). In the near future a technogenic product of processing of polymetallic sulphidic ores have to become an essential element of mineral resources of metals of platinum group.

In the lump of the saved-up waste over 32 billion tons, more than 16 billion tons of technogenic mineral educations, including about 6 billion tons make toxic products of which over 5.2 billion tons make the toxic industrial solid waste which is saved up at the enterprises of nonferrous metallurgy of them. In the country it is annually formed about the 700th million tons of industrial wastes, of them toxic - near the 250th million tons.

All types of industrial wastes are divided into firm, liquid and gaseous. Solid waste can be three categories: industrial, agricultural and household waste. The bulk of solid industrial wastes is formed at the enterprises:

- mining industry (dumps, etc.);
- metallurgy (slags, slimes, dust, etc.);
- metal-working industry (marriage, etc.)
- forestry and wood industry (waste of wood, pitch and paints and varnishes, etc.);
- thermal power plants (ashes, slag);
- chemical industry and allied industries (rubber, plastic, etc.);
- light industry (waste of fabric, leather, etc.).

Industrial wastes as sources of secondary raw materials conditionally are divided into four categories

• the waste representing high-quality secondary raw materials
• the waste representing secondary raw materials of average quality
• hardly recyclable waste (which processing in modern economic conditions is unprofitable),
• unutilized hazardous waste which processing is carried out as their neutralization.

Waste of the first two groups is the most perspective for replenishment of resources. From inorganic waste it is necessary to allocate very valuable metallic waste. Generally it is scrap of non-ferrous and ferrous metals which can be processed only in the regions having rather powerful metallurgical and machine-building industrial complexes. The main part of waste as on the tonnage (sometimes tens of millions of tons per year), and on the range is occupied by inorganic nonmetallic waste. Classification of these materials, definition of the directions of the most effective technologies of processing and use it is possible only when accounting features of origin, a technogenesis and other factors.

It is known that joint warehousing various on the chemical composition and physicomechanical properties of materials leads to their hashing and the subsequent unpredictable change of properties under the influence of various factors. Traditionally technogenic mineral educations are used for additional recovery of the remained useful components, as construction materials, mineral fertilizers and for other purposes. The main shortcoming limiting use of technogenic raw materials in the construction industry and other purposes is the instability and heterogeneity of structure. In practice of utilization of solid industrial wastes methods of enrichment of the processed materials are used: gravitational, magnetic, electric, floatation and special. Many processes of utilization of solid waste are based on use of a method of leaching (extraction), dissolution and crystallization of the processed materials. Besides, at utilization and processing of solid waste various methods of heat treatment of solid materials and products are used: pyrolysis, melting, roasting and a detoxication (burning) of fire of many types of solid waste on an organic basis.

From the industries consuming industrial wastes the most capacious is the industry of construction materials which raw materials share in product cost reaches 50% and more. It is established that use of industrial wastes allows to cover up to 40% of need of construction for raw material resources. Application of industrial

wastes allows to lower by 10 ÷ 30% costs of production of construction materials in comparison with production them from natural raw materials. Besides, from industrial wastes it is possible to create new construction materials with high technical and economic rates.

The most part of mineral waste consists mainly of silicates and aluminosilicates of calcium and magnesium. This results from the fact that 86.5% of mass of crust are natural silicates. Respectively and the waste received at production in processing of natural silicates has silicate structure too. Silicate waste is classified also by structure and the chemical composition, under the terms of education and to others. Classification of waste by the industries forming them and classifications for separate types of waste has the greatest practical applicability.

The greatest value for the construction industry and the first place on volume among waste of ferrous metallurgy is taken by domain slags — a by-product when smelting cast iron from iron ores — domain, martin, ferromanganese. An exit of slags is very big and makes from 0.4 to 0.65 tons on one ton of cast iron. About 30 various chemical elements, mainly in the form of oxides are their part. Main oxides: SiO_2, Al_2O_3, CaO, MgO. At smaller quantities there are FeO, MnO, P_2O_5, TiO_2, V_2O_5 and others.

In production of construction materials 75% of total amount of domain slags are used. The main consumer is the cement industry.

Today there are positive examples of implementation of projects of use of technogenic mineral objects on the developed innovative technologies of processing of tails of enrichment, slags, technogenic metal-containing waters and others (Singh et al, 2017) and (Keppert et al, 2018). It confirms that various approaches allow to provide involvement in effective operation earlier not used resources.

Researches showed that the majority of technogenic raw materials on structure and properties are close to natural raw materials. Studying of their structures and properties will allow to expand the fields of their use not only in the road and construction industries, but also in other sectors of economy. It is supposed that along with natural minerals technogenic mineral educations can attract practical interest for production of new materials in the form of ceramics on the basis of use of methods of powder metallurgy too. A series of ceramic materials of the domestic natural aluminosilicates synthesized from mix with metallurgical slags of lead, copper and domain productions of the metallurgical enterprises of Kazakhstan is developed and investigated.

For characteristic of ceramic materials it is necessary to determine morphology (the size of a specific surface, total amount of a time and distribution of a time by the sizes), properties of a surface (the nature and the number of active places), a chemical condition of elements on sample surfaces, volume properties (the chemical and phase composition) and some other properties. Methods of the X-ray phase analysis, thermogravitation measurements, raster electronic microscopy studied structures, the building, surface morphology, thermal stability and other characteristics of pilot batch of samples of ceramics. The received materials are suitable for their use as carriers for the catalysts intended for an ecological catalysis.

Thus, assessment of technogenic products as an additional source of raw materials is an important scientific and practical task. The correct use of the gained knowledge will serve strengthening of an economic basis of the enterprises and the countries in general. The modern technologies based on the principles of resource-saving have to minimize education and emission in the environment of gaseous, liquid and solid production waste.

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Abstract review

Singh Sunpreet, Ramakrishna Seeram, Kumar Munish Gupta, 2017. Towards zero waste manufacturing: A multidisciplinary review. Journal of Cleaner Production Volume 168, 1 December 2017, Pages 1230-1243. https://doi.org/10.1016/j.jclepro.2017.09.108.

Keppert Martin, Doušová Barbora, Reiterman Pavel, Koloušek David, Zálesk Martina, Černý Robert, 2018. Application of heavy metals sorbent as reactive component in cementitious composites. Journal of Cleaner ProductionVolume 199, 20 October 2018, Pages 565-573. https://doi.org/10.1016/j.jclepro.2018.07.198.