

Lapshyn Ye.S.,
Leading Researcher, Doctor of Technical Sciences (D.Sc.), Senior Researcher;
Shevchenko O.I.,
Senior Researcher, Doctor of Technical Sciences (D.Sc.), Senior Researcher;
M.C. Polyakov Institute of Geotechnical Mechanics under the National Academy
of Science of Ukraine (IGTM NASU), Dnipro, Ukraine,
office.igtm@nas.gov.ua

JUSTIFICATION OF THE POSSIBILITY OF OBTAINING SECONDARY RAW MATERIALS FROM INDUSTRIAL WASTE BY FINE VIBRATORY SCREENING AS A CONDITION FOR THE IMPLEMENTATION OF THE TRANSITION TO A CIRCULAR ECONOMY

As a result of production activities of the mining and processing, energy, metallurgy, construction and other industries, a huge amount of watered fine-grained waste with a particle size of +0-5.0 mm has been accumulated. Waste storage is a significant environmental and economic problem, as existing storage facilities are overloaded, have large areas, require significant operating costs, are potentially dangerous sources of environmental pollution and create risks to the health of the population living in adjacent areas. At the same time, the waste accumulated over many years has a huge resource potential, a unique mineral composition, a complex distribution of useful components that is not typical for natural deposits, representing, in fact, man-made deposits. The complexity of their processing is increased by the presence of a useful component in different size classes, an increase in the substandard part towards the smallest classes, increased humidity up to 45%, the lack of equipment and technology for processing raw materials of the specified size, which leads to the relevance of finding solutions in this area. This will reduce operating costs for the maintenance of storage facilities, produce new types of products, and reduce the impact on the environment. [1, 2].

In industrialized countries such as the European Union, the USA, etc., waste disposal is an integral part of the technological process, which involves the involvement of various types of waste in new technological cycles or their use for other useful purposes. Much attention is paid to this problem, which is the most important link in the overall chain of creating waste-free production systems. At the legislative level, programs have been adopted to promote a closed-loop economy (circular economy): changing waste management systems, focusing on the maximum extraction of secondary resources from waste and their use in industrial production instead of natural mineral raw materials. This model is based on large volumes of cheap, readily available materials and energy. The circular economy keeps products, parts and materials in economic circulation as long as possible, using as few resources as possible. The implementation of these solutions should help reduce the negative impact of waste on the economy not only in environmental, but also in socio-economic aspects. Turning waste into useful products is an integral part of improving resource efficiency. As a result of this approach, the rationality of resource use, including natural resources, will increase in general, the economy will become more transparent, predictable, and its development will be fast and systematic. This solution saves natural resources, reduces the cost of finished products and the level of environmental pollution [3]. In the context of the energy crisis and environmental problems associated with the pollution of territories, Ukraine, taking into account its desire to join the EU, should use the experience of industrialized countries and strive to implement the transition to a circular economy. *At coal preparation plants in Ukraine* there are 39 sludge ponds and 47 settling ponds containing more than 170 million tons of watered sludge with a particle size of +0-5 mm and an average carbon content of 35-40%, essentially man-made coal deposits that cannot be called waste given the current level of technology. Research of the characteristics of coal sludge from a number of storage tanks showed that, mainly, as the size of the content decreases, the ash part increases, and the maximum is in classes of less than 0.1-0.2 mm. Therefore, to obtain a product with a high carbon content from high-ash sludge with standard ash content, fine separation by class 0.1-0.2 mm is required, while it is necessary to reduce the moisture content of the product on the sifting surface (oversize product) to the standard standards [2].

In the energy sector, coal combustion at thermal power plants (TPPs) in Ukraine annually generates ash and slag waste (ASW). About 360 million tons have already accumulated in the dumps on an area of about 3,170 hectares. The largest type of ASW (75-80% of ASW) is fly ash (FA). In Ukraine, ashes from coal-fired TPPs contain unburned carbon in an amount of 5 to 30%, which does not allow for the widespread use of ash, for example, in the construction industry in large volumes (for concrete – prohibited by standards). Research has shown that the highest carbon content in ash is in size classes from -0.315 to +0.02 mm inclusive. Experiments show that the products of FA processing are the silicate part and carbon. If the +0.02 mm classes are separated from fly ash, it is possible to obtain low-ash coal concentrate for power engineering and the silicate part, suitable for the construction industry [2]. Considering the diversity of rocks containing coal seams, their mineralogical composition, the development of enrichment of fly ash for the purpose of extracting other useful minerals and metals is of practical interest. It is known that the host rocks contain aluminum, germanium, iron in quantities of industrial interest. Magnetic and electrical separation, flotation, etc. are necessary for their extraction [1]. In this case, when processing ash, it is necessary to pre-separate the finest classes of +0-0.05 mm, since these classes are characterized by high ash content and a significant amount of dust and clay particles, which, in the presence of water, get wet, stick together in the form of lumps, clog the working areas of the equipment, made in the form of narrow gaps (for example, magnetic separation) and reduce the efficiency of its operation. The presence of clay particles also worsens flotation indicators. Additional research is needed to improve and develop the processing of ASW, develop enrichment technologies, and conduct a feasibility study directly for each man-made storage facility [1, 2].

Metallurgical production in Ukraine is accompanied by the formation of a huge amount of industrial waste, which is 30% of the volume of steel output. Sludge is one of the main wastes of the metallurgical complex. In total, more than 70 million tons of sludge have been accumulated at metallurgical enterprises of Ukraine, 21 million tons of which are suitable

for reuse. The presence of 37 to 52% iron and more than 6.5% carbon in sludge allows us to consider them as valuable metallurgical raw materials. Research has shown that the highest iron and carbon content is in the +0.02-0.6 mm classes. If these classes are separated, commercial products can be obtained. About 70% of the sludge is represented by particles larger than 0.02 mm. Relatively large particles (more than 3 mm) are found in agglomeration sludge. In coal preparation shops of coke plants of Ukraine, about 3 million tons of waste with a size of 0.5-80 mm and over 0.7 million tons of flotation waste, which is clay sludge with a size of mainly less than 0.5 mm, are obtained annually during coal jigging. The area (about 600 hectares) is occupied by accumulators of coke plants, which pollute the environment, annually increasing by 2-3 hectares for each of the enterprises [2, 4].

In the process of mining construction materials (granite crushed stone, marble, basalt, etc.), hundreds of thousands of tons of waste (screenings with a particle size of +0-5 mm) are generated, the output of which reaches up to 35% of the original product. The widespread use of screenings is constrained by the high content of dust and clay inclusions (up to 15-20%, with regulatory requirements of no more than 3-3.5%). If there are appropriate technologies for their processing, it is necessary to separate the class with a size of less than 0.16 mm, screenings can make up for the deficit in sand of the required quality [2].

One of the most environmentally friendly, effective and economical methods is the extraction of useful components by classification using a new vibratory impact screen [5] developed at the N.S. Polyakov Institute of Geotechnical Mechanics of the National Academy of Sciences, which allows for efficient dewatering of the oversize product simultaneously with separation by size. By selecting the design and operating parameters, the vibratory impact screen can be configured for efficient separation by size for both dry materials and for classification with dewatering of wet raw materials from the accumulator. Tests of the new vibratory impact screen in the processing of coal sludge showed fairly high screening performance: for dry sludge, the extraction of high-ash class less than 0.02 mm from the undersize product was 75-80%, for wet sludge from the accumulator – 65-70%, while the moisture content of the oversize material was reduced from 45% to 6-8%.

Thus, the conducted research on processing dry and wet sludge from storage tanks showed the prospects and possibility of their processing using a new vibratory impact screen. At the same time, the processing process is economically feasible, technologically possible and socially conditioned. Waste processing allows to stop their shipment to the storage tank and to obtain marketable products. All components are of industrial and commercial interest. In addition, waste processing will reduce material costs for their maintenance, free up the land areas occupied by them, receive additional profit from the sale of waste processing products and improve the environment.

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