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Prospects for the Extraction of Non-Ferrous Metals from Cell Phones

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***Abstract*—The article defines the significance of the extraction and use of non-ferrous metals from cell phones and other equipment, which has advantages over the extraction of non-ferrous metals from ores from an economic and environmental point of view. It is noted that alternative methods of extraction of non-ferrous metals and new technologies are being considered. One of such innovative directions for the extraction of non-ferrous metals may be the project "metals from telephones and other electrical equipment". However, a large number of phones used, a quick change of models, determines the promising possibilities for the extraction and processing of non-ferrous metals from them. The author analyzes sales and turnover of cell phones in Russia and in the world. Analysis has shown the economic efficiency of such processing is substantial, and the cost of secondary precious metals is much lower than when extracting the same metals from ore. A comparative analysis of the content of precious metals in electronic equipment from different countries was also carried out.**

Keywords—non-ferrous metals, benefits, prospects, economic efficiency, ecology, telephones

I. Introduction

This article identifies the importance of mining and processing non-ferrous metals. It should be noted that non-ferrous metallurgy is one of the industries that is characterized by a fundamental variety of industries, methods, processes with different types of mineral raw materials.

The tasks of the work are as follows:

- show and explain the prospects and possibilities of extracting non-ferrous metals from old electronic devices, including cell phones

Article problems:

- to identify and substantiate problems: industrial, natural, environmental, associated with the extraction of non-ferrous metals

Content:

- to determine possible directions of extraction and extraction of non-ferrous metals;
- to analyze data on the production and use of mobile phones in the Russian Federation and in the world;
- to substantiate the positive prospects for the implementation of the project for the disposal of non-ferrous metals from waste of electronic equipment, including cell phones [9].

II. Methodology

Research methods:

- analytical methods for processing information and building integrated solutions for further consideration of the project and its implementation;
- an abstraction method for studying the economic and environmental prospects of implementing a project for the extraction of non-ferrous metals and the processing of unnecessary equipment;
- a method for constructing economic hypotheses to identify the expected benefits of extracting non-ferrous metals from electronic equipment;
- comparison method for the purpose of comparing the available metal elements in different techniques.

III. Results and Discussion

Recently, it has become more and more economically profitable to use secondary raw materials in order to extract useful materials for their further use. In particular, waste from the electrical industry, radio and household appliances are sources of valuable metals. There are enough resources for e-waste mining today. Secondary production of gold, silver, platinoid groups falls under the rule of economic expediency: the income from their sale must exceed the amount of expenses. The content of gold, platinum, silver and palladium in waste is significantly higher than in ore. The share of secondary precious metals in the total volume of their production is currently about 40% and continues to grow.

Many rare metals, which were practically not used for a long time, are now widely used in the world. They have spawned completely new areas of modern industry, science and technology, such as solar power, ultra-high-speed magnetic levitation, infrared optics, optoelectronics, lasers and the latest generation of computers.

Recycling metals has both environmental and economic benefits. Particular attention is paid to the problems of depletion of natural resources and the environment, since non-ferrous metallurgy is a complex and difficult process from the point of view of organizing waste-free production, as well as the release of a large amount of toxic substances. In the production of non-ferrous metals, a lot of water is consumed - 1200 million m3 per year, and water resources are also polluted: salt solutions; mud water; secondary pollution caused by atmospheric precipitation. Production wastes pollute the soil in the surrounding areas [2].

It is important to note that the depletion of non-ferrous metal deposits on land creates incentives to seek new ways to find and extract them. When analyzing the latest developments and prospects for the extraction of non-ferrous metals by non-standard methods and methods: microorganisms for the extraction of metals from poor ores and man-made waste, the development of deep-sea deposits, etc. With the discovery of new microorganisms, it becomes possible to use them in the development of low-grade complex ores, in the extraction of valuable metals from electronic waste (e - waste), in the bioremediation of soils and waste waters. In the future, two to three decades, bacteria will begin to extract metals on asteroids and other planets, and microbe engineers will learn to carry out end-to-end reassembly of electronic components.

Consideration is given to startups for the extraction of metals on the Moon and asteroids and the possibility of processing them in space orbital factories; extraction of non-ferrous metals from industrial solutions and waste water.

The source of secondary precious metals is multicomponent scrap: military-technical equipment, computers and electrical equipment, scrap and waste from the electronic and electrical industries, machine-building industries, and the automotive industry. Electronic waste is making the most significant contribution, as electronic products become obsolete quickly and goes to recycling. A considerable amount of gold is contained in SIM cards. They cover the contact area, from one SIM card you can get up to half a gram of gold. Most of all gold is found in processors: on connectors - up to 3 mg; on the body in contacts -2-3 mg; in the FCPGA package - up to 12 mg; processor memory slot -1 mg. Also high gold content in the keyboard, cooler and computer power supply. Most of this metal is found in old computers: Intel; Pentium PRO.

Recycling of cell phones is very promising. Smartphones are pocket stores for precious metals and rare items. A typical smartphone contains about 0.034 grams of gold, 0.34 grams of silver, 0.015 grams of palladium, and less than one thousandth of a gram of platinum. It also contains the less valuable, but still important, aluminum (25 grams) and copper (15 grams). Most of all, a mobile phone contains copper - about 8.5 g, but in some devices its number can reach 15 g. It also contains about 3 g of cobalt [6,14].

Smartphones also contain a number of rare earth elements - elements that are actually abundant in the earth's crust, but which are extremely difficult to mine and extract: yttrium, lanthanum, terbium, neodymium, gadolinium and praseodymium.

In addition, plastic, glass, batteries go to waste - the list of materials that can be reused is quite long.

If you know the composition of an ordinary smartphone, then you can make interesting calculations. The sum of all the previously listed valuable elements in the device is approximately 18 grams.

If we assume that each household has two unused smartphones, taking into account the number of all households - about 49 million - we get a pretty impressive amount.

It turns out that in Russia there are about 100 million unused mobile phones, and the resources contained in them are worth almost 4 billion rubles!

Therefore, unused or defective electronic equipment should be returned to a professional recycling company to recycle expensive materials and protect the environment.

Today, there are more than two billion people in the world with smartphones, and this number is constantly growing. In addition, the concentration of some of these elements, such as gold and silver, in a mobile phone is much higher than their concentration in an equivalent mass of ore. One ton of iPhone will produce 300 times more gold than one ton of gold ore, and 6.5 times more silver than one ton of silver ore.

Two billion users update their smartphones every 11 months on average, old ones end up in a drawer, forgotten or thrown away. So far, only 10% is recycled, recovered and reused. At a time when the consumption of certain resources exceeds all conceivable and inconceivable quantities, it makes sense, both from an economic and an environmental point of view, to extract valuable substances from waste electronic devices.

One phone is not much, but a million cell phones can extract 16 tons of copper, 350 kilograms of silver, 34 kilograms of gold and 15 kilograms of palladium.

The challenge is simple: how to safely and economically extract these valuable materials. In countries such as China, where low-paid workers and children dismantle electronics, large quantities of electronic waste, including cell phones, are taken away or disposed of. The Chinese city of Guiyu has earned the dubious honor of being the largest electronic dump in the world. Residents of the city face serious health problems due to pollution of soil, rivers and air with mercury, arsenic, chromium and lead.

Electronic waste that is returned to the country of origin is also a problem. In Australia, for example, e-waste continues to be recycled in industrial smelters, which are expensive and harmful to the environment.

The old "mobile phone", which many have at home, contains:

* Au-0.024 g;

* Ag-0.25 mcg;

* Pd-0.009 g;

* TA (tantalum) - 0.4 g.

And that is not counting other metals (copper, tin, etc.). Precious metals are embedded in boards and all current-carrying contacts of cell phones [9].

From 40 mobile phones that have lost their practical interest, as much gold is extracted as from 1 ton of gold-bearing ore.

Let us make a comparison for other electronic devices.

Let us compare the content of the precious metal in the Soviet TV sets "Horizon", "Vityaz", etc. For imported equipment, it should be noted that the equipment of the Japanese company "Funaj" and the Chinese, Taiwanese or Korean assembly contains only 0.1474 g of gold and 2.4859 g of silver.

We recommend that you familiarize yourself with the data on the content of precious metals in some computers and televisions. Weight is also indicated in grams per device.

TABLE I. WEIGHT ELEMENTS OF NON-FERROUS METALS IN ELECTRICAL ENGINEERING.

Model	Au (gold)	Ag (silver)	Pt (platinum)	Pd (palladium)
Elbrus-1-KB	2668	7737.4	259	639
Electronics-60	17.93353	29.85809	6.46067	5.86536
Personal computer	10.972	5.84	0.082	0.267
Knight	0.3412	7.4606	0.622	0.3199
Horizon-Ts355 (Ts355D)	0.68	3.7443	0.43	0.318

Thus, it has been determined that the processing of waste to extract gold, silver, platinum and palladium is a priority area in modern metallurgy, and the cost of secondary precious metals is an order of magnitude cheaper than when extracting the same metals from ore. Electronic scrap makes the most significant contribution, since electronic products quickly become obsolete and go for recycling or simply lie in the closets and bedside tables of the country's population. The analysis of the sales and turnover rate of cell phones in Russia and in the world showed that the economic efficiency of such processing has been determined.

IV. CONCLUSION

From the presented material it becomes clear that the content of gold and other precious metals in products of the period of developed socialism is many times higher than in refrigerators, telephones and other devices produced in our time.

However, there is a weighty "but": over the past 12 years of the last century and a slightly longer period of the new century, the hunters for devices produced in the USSR have thoroughly destroyed the raw material base - it is becoming more and more difficult to look for the source material to obtain it.

In general, the problem is solvable - you can always switch to modern equipment or foreign equipment. more units must be disposed of to obtain the same amount of "degraded" VDM as when disposing of Soviet units.

The presence of various highly toxic materials and heavy metals makes landfills or incineration unacceptable methods of disposal of such waste. Therefore, optimal disposal of e-waste is recycling [8].

Prospects for the development of non-ferrous metallurgy in Russia are associated with meeting the demand for non-ferrous metals in the domestic market in the entire spectrum required for the implementation of major investment projects, development strategies for economic sectors and regions; with the strengthening of Russia's positions in the world market of non-ferrous metals, the CIS market and the Customs Union; increasing the competitiveness of non-ferrous metal products in the domestic and foreign markets, reducing their resource and energy intensity, reducing imports by protecting domestic exporters in these markets; rational use of the raw material base: innovative improvement and creation of new types of equipment and technologies for the production of non-ferrous metals.

One of such innovative directions for the extraction of non-ferrous metals may be the project "metals from telephones and other electrical equipment."

REFERENCES

[1] https: //www.nkj.ru/archive/articles/9396/ (Science and life, RARE METALS - THE FUTURE OF NEW TECHNOLOGY)

[2] Ministry of Industry and Trade, access mode: http://www.minpromtorg.gov.ru

[3] Metallurgical industry of Russia, industry portal, access mode: http://rusmet.ru

[4] A.P. Gulyaev, Metallurgy, M.: Metallurgy, 1986.

[5] Yu.V. Baimakov, Metallurgy of rare metals, Moscow: Lights, 2012, 166 p.

[6] https: //www.elibrary.ru/item.asp?id=36315797

[7] https://habr.com/ru/company/pc-administrator/blog/306396/

[8] E.Y. Sidorova, Y. Kostyukhin, and V. Shtanskiy, “Creation of Conditions for the Development of Production of Science-Intensive Products Based on the Potential of Russian Applied Scientific Organizations”, Smart Innovation, Systems and Technologies, 2019.

[9] E. Sidorova, “The main factors and conditions determining the feasibility of production of high-tech products based on the potential of applied research organizations”, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 2019.

[10] A.A. Yurievich, Y.Y. Kostyukhin, O.O. Skryabin, I.V. Androsova, A.V. Zhaglovskaya, “National innovation system as a model of economic development”, International Journal of Advanced Biotechnology And Research, no. 3, 2017, pp. 2075-2082.

[11] E. Sidorova, “Modern strategic decisions in the field of waste as a basis of development of circular economy and greening of industrial production”, International Multidisciplinary Scientific Geo Conference Surveying Geology and Mining Ecology Management, SGEM, 2019.

[12] N. Vikhrova, “Implementation of the resource saving concept by involving in the recycling of the titanium sheet at the metallurgical front”, 18th International multidisciplinary scientific GEO conference SGEM 2018, Albena, Bulgaria, 2018.

[13] L.A. Kostygova, E.Yu. Sidorova, N.O.Vikhrova, “Modern clusters and assessment of their innovative development”, Entrepreneurship and Sustainability Issues, 2019, pp. 603-614.

[14] Y. Kostyukhin, “Conceptual provisions for sustainable development of socio-economic systems (on the example of an industrial enterprise)”, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM (2019).

[15] Y. Kostyukhin, “Enhancement of labor efficiency in coal mining industry”, Gornyi Zhurnal, 2016.