Study of the morphology and elemental composition of electroerosive materials, obtained from waste based on W-Ni-Fe alloy in lighting kerosene

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Abstract. This article presents a study of the morphology and elemental composition of electroerosive materials based on W-Ni-Fe alloy, obtained in lighting kerosene. It has been shown that part of carbon is present in the resulting electro-erosion materials. The main elements in the resulting EED materials are W, Ni and C.

1. Introduction
Tungsten-based alloys are very important in modern technology. An analysis of research in the field of tungsten-containing alloys shows that most of them are related to the issue of saving tungsten. This issue is very relevant in connection with the deficit, high cost and continuous expansion of the scope of tungsten. Tungsten saving is closely related to the collection of hard alloy waste and its processing [1-5].

In the domestic and foreign industries, several methods of processing tungsten-containing alloys are currently used, which are mostly characterized by large tonnage, energy consumption, large production areas, low productivity, and environmental problems. One of the promising methods for producing powder from virtually any conductive material, including an alloy of the W-Ni-Fe brand [1-6], which is distinguished by relatively low energy costs and environmental cleanliness of the process, is the method of electroerosive dispersion (EED).

Carrying out the planned measures will allow to solve the problem of waste disposal and their further use and thereby reduce the cost of production of the final product.

The aim of the work was to study the morphology and elemental composition of electroerosive alloy materials based on W-Ni-Fe, obtained in lighting kerosene.

2. Materials and Methods
To obtain powder from waste alloys based on W-Ni-Fe, an EED device, developed by the authors, was used [7]. Waste was loaded into a reactor filled with a working liquid - lighting kerosene, the process was carried out with the following electrical parameters: capacitance of discharge capacitors 65.5 μF, voltage 150 V, pulse repetition rate 100 Hz.

The method of scanning electron microscopy was used to study the microstructure of the obtained electroerosive materials. Using an EDAX energy-dispersive X-ray analyzer built into the Quanta 200 3D scanning electron microscope (Figure 1), we obtained the characteristic X-ray spectra at various points on the surface of the sample. X-ray microanalysis is understood to mean the determination of
the elemental composition of micro-objects from the characteristic x-ray radiation excited in them [8-15]

![Figure 1. Quanta 200 3D electron-ion scanning microscope.](image)

Analysis of the elements distribution can be performed in a qualitative, semi-quantitative and quantitative form. Qualitative analysis determines the type of elements that make up the sample area under investigation. If the sample has several phases (sections), the chemical composition of which is unknown, then a qualitative analysis of each phase is performed. Qualitative analysis is usually used to determine the nature of the elements distribution over a thin section. After a qualitative analysis, a quantitative analysis is often carried out at selected points; according to the data obtained, the software allows you to determine the type of phase based on its chemical composition. Semi-quantitative analysis is implemented if it is necessary to determine the distribution of elements along lines (linear analysis). Linear analysis is performed by the step scanning method, i.e. by conducting sequential analysis at individual points. Thus, the concentration of elements is quantified with a given accuracy [16–20].

3. Results
The results of the morphology and elemental composition study of electroerosive materials based on W-Ni-Fe alloy, obtained in lighting kerosene, are shown in Figures 2, 3, and 4 and in table 1.
Figure 2. Morphology of electroerosive materials based on W-Ni-Fe obtained in illuminating kerosene (with a magnification of the microscope 500 times).

Points 1 and 2 in Figure 2 correspond to the spectra of characteristic x-ray radiation in Figures 3 and 4. In the spectrum, each chemical element corresponds to a peak of a certain height.

Figure 3. Elemental composition over the surface of the sample at point 1.
Figure 4. Elemental composition over the surface of the sample at point 2.

Table 1. The results of the elemental composition study of electroerosive materials based on W-Ni-Fe alloy, obtained in lighting kerosene

| Point | The content of element, % |
|-------|---------------------------|
|       | C  | O  | Ni  | Cu  | W  |
| 1     | 15,9 | 3,0 | 5,6 | 3,3 | 72,1 |
| 2     | 30,15 | 7,46 | 9,46 | 8,93 | 42,65 |

It was found that when dispersing waste based on W-Ni-Fe alloy in lighting kerosene, part of the carbon is present in the resulting electro-erosion materials. The main elements in the resulting EED materials are W, Ni and C.

4. Conclusions
On the basis of experimental studies aimed at studying the morphology and elemental composition of electro-erosion materials based on W-Ni-Fe alloy, obtained in lighting kerosene, it was found that part of carbon is present in the obtained electro-erosion materials. The main elements in the resulting EED materials are W, Ni and C.

The study will determine the most relevant area of application of the obtained samples and improve the quality of scientific and technological developments.

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