Processing of Tungsten-Containing Tool Using Electrolytic Method

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Abstract. The regeneration processes of tungsten-cobalt alloy are studied. The electrochemical behaviour of tungsten and cobalt in tungsten-cobalt alloys in neutral salt solutions is investigated. The advantages of an electrochemical method for processing secondary raw materials by anodic dissolution are shown. It is established that tungsten and cobalt, entering the electrolyte, form insoluble oxides and hydroxides of impurity metals, which, due to poor solubility, quantitatively pass into the sludge. The technological regime of leaching of the oxide precipitate obtained by electrochemical oxidation of the alloy was determined: temperature is 90-95 °C; duration time is 2 hours; the concentration of nitric acid is 300-500 g/l; solid–liquid ratio is 1: 5. The advantage of this environmentally friendly method is the comparative simplicity of the process flow scheme, low capital and energy costs. The data obtained in these studies can be used for balance tests in large-scale laboratory, semi-experimental and experimental-industrial levels.

1. Introduction

As is known, the deficit of tungsten-containing alloys with the necessary structure and mechanical properties forces the operating enterprises of the Russian Federation to purchase hard-alloy raw materials for the production of cutting tools abroad, while 20-30% of all the required volume of carbide products can be produced on the basis of its own secondary raw materials mainly presented with worn tungsten-containing cutting tools [1,2].

Existing methods of recycling rare metals wastes are characterized by low productivity and the need for preliminary sorting of processed raw materials [3-12].

Electrochemical processing of tungsten-containing wastes of hard alloys is one of the most promising ways of extracting high-quality tungsten and cobalt [13-16]. However, when electrochemical methods are used, the choice of electrolyte solution plays a decisive role, to which serious demands are made:

• it must be effective and as inert as possible to the materials of the electrolysis cell and auxiliaries;
• be accessible, selective and stable over time;
• do not undergo electrochemical conversions with the formation of toxic substances;
• easy to regenerate.
Therefore, the problem of studying new compositions of electrolyte solutions, which allow anodic oxidation of tungsten-containing wastes of complex composition, is topical.

2. Literature route
Analysis of methods for processing tungsten-containing wastes of hard alloys i.e. hydro- and pyrometallurgical, chemical (chlorine, zinc), thermochemical, showed that in many cases they include a variety of technological operations accompanied by the costs of raw products, materials and sufficient losses of products and reagents. [13-6]. Thus, a new environmentally friendly technology for recycling solid carbide waste, described in the works of Austrian scientists, is based on selective leaching of ground waste with solutions of acetic acid, while the carbide constituents of the hard alloy remain in the leaching cake, and the cobalt binder goes into solution, which does not provide complex extraction of components and the desired purity of the product [6].

The purpose of this paper is to investigate the electrochemical behaviour of tungsten and cobalt in tungsten-cobalt alloys in aqueous neutral salt solutions.

3. Statement of the main material
Taking into account the above requirements, we have developed an economically and ecologically more effective electrochemical method for processing tungsten-containing waste of complex compositions in neutral salt solutions. We conducted a study of the effect of the electrolyte composition and process regimes on the electrochemical behaviour of tungsten and cobalt in tungsten-cobalt alloys.

Most of the research was carried out with the alloy of WC-8, %: WC-92; W – 86.36; C – 5.64; Co – 8.0, as well as with tungsten-containing waste of pseudoalloy W-Cu-Ni, obtained during the production and operation of high-temperature electrical contacts [7-8]. Anodic dissolution of the alloys was carried out at direct-current and room temperature (22 ± 0.2 °C). The concentration of neutral salt solutions varied within 1-5 mol/l.

During the experiments it was established that tungsten and cobalt, entering the electrolyte, form insoluble oxides and hydroxides of impurity metals, which, due to poor solubility, quantitatively pass into the sludge. X-ray diffraction data confirmed that the anode deposit obtained as a result of the electrochemical processing of the waste of hard alloys of the WC-8 grade consists of WO3, WO3, XH2O, and Co(OH)2 of blue and pink modifications [7].

From the sludge tungsten and cobalt are easily extracted by leaching. In this case, the circulating and regenerated solutions are again directed to the "head" of the electrolysis process, which ensures the low-waste and comprehensiveness of secondary raw materials used (Fig. 1). According to the results of laboratory studies, the technological regime of leaching of the oxide precipitate obtained by electrochemical oxidation of the alloy was determined: temperature is 90-95 °C; duration time is 2 hours; the concentration of nitric acid is 300-500 g / l; solid–liquid ratio is 1: 5.

A comparative analysis of the results of the work done on the electrochemical processing of WC-8 alloy shows that the current density and the composition of the solution used strongly influence the oxidation rate of the constituent metals waste. With a constant salt concentration in the solution of 200 g / l, the deposition process is more stable at an anode current density of DА, 4007000 A / m², while the current yield for the WC-8 alloy is 72.40 - 85.2%, and specific electricity consumption per 1 ton of recycled waste is increased from 6,737.9 to 11,696 kWh / t, depending on the type of solution. As for the current yield for the components of pseudoalloy, tungsten, copper and nickel, they increase from 93.40 to 119.34%. Thus, at an anode current density of 5000 A / m², an increase of the salt concentration in the solution from 1 to 5 mol / l contributes to an increase in the current yield for WC-8 to 75.64-82.4%, for pseudoalloy to 147, 95%. A noticeable excess of the current yield for copper, which determines the synchronous excess of the current yield for a pseudo alloy, is explained by the fact that this metal is oxidized not only by electrochemical, but also by a chemical mechanism [9].
Figure 1. Technological scheme of electrochemical processing of tungsten-containing waste.

4. Conclusions

Thus, the anodic dissolution of tungsten-containing waste in neutral salt solutions ensures their efficient processing with a high recovery of all the accompanying components. The advantage of this environmentally friendly method is the comparative simplicity of the process flow scheme, low capital and energy costs. The data obtained in these studies can be used for balance tests in large-scale laboratory, semi-experimental and experimental-industrial levels.

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