THE GERMANIUM EXTRACTION FROM TECHNOGENIC RAW MATERIALS BY MICROBIOLOGICAL METHODS

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The purpose of this work is the study and comparative analysis of germanium extraction and related valuable components of the sublimates from the burning of domestic power coals (product 1) and germanium sulfide materials, which are a waste of lead-zinc production (product 2), by traditional chemical methods (distillation of germanium in the form of tetrachloride from raw and preliminary burning source) and by microbial bioleaching of sulfur-oxidizing bacteria.

The efficiency of germanium tetrachloride extraction from products 1 and 2 was 78.50 and 19.52%, respectively. Such difference in efficiency of extraction is caused by germanium confinement as concomitant trace component to the basic phases of carriers. In sublimates germanium is a part of the acid-soluble compounds easily accessible (this includes the soluble form GeO_2, germanates of alkali metals, bivalent metals, iron and aluminum, insignificant quantities of elementary germanium). The share of acid-nonsoluble compounds (tetragonal GeO_2 and silico-germanates) in the product accounts for 21.5% of germanium.

The proportion between acid-soluble and acid-nonsoluble (silico-germanates, solid solutions of GeO_2 in SiO_2) germanium forms is 19.52 and 80.48%, respectively, in product 2. In connection with this we performed a preliminary heat treatment of raw material for germanium transfer to easily opening phases (fulfilled enough and often used method in the germanium technology). Our experiments have shown that implementation of restorative firing (with addition of 30-40% carbon at 1150 ^{0}C) of sulfide product 2 considerably impacted on the extraction of germanium tetrachloride (91.76%) in comparison with its low extraction at straight distillation of hydrochloric acid (19.52%). The results are confirmed by a set of physical methods (infrared spectroscopy, electronic microphotograph, X-ray analysis).

We analyze the results of processing the same so-called hard phases material (product 2) with the help of microorganisms. The role of microorganisms which are present in initial germanium-containing raw materials and their influence on leaching metals processes has been studied and showed their high activity. In the sequel from products 1 and 2 strains of microorganisms as own microflora of raw materials were isolated. Their activity has been studied in comparison with typical and collection strains. All isolated strains of microorganisms leached metals from solid wastes approximately at 80–95%. The optimal parameters of bacteria's metals bioleaching process from wastes have been defined. Conversion kinetics from a solid phase in solution has been studied for such macroelements as iron, zinc and lead. It has been established that selected strains of bacteria are capable to extract from initial raw materials not only macrocomponents (iron, zinc, lead, manganese, aluminum, nickel), but also microimpurity of rare metals (gallium, germanium, zirconium). It is important that these metals were not extracted by traditional chemical methods (with application of aggressive conditions and heat) independently of the phase composition of the source.

The results have practical significance and can be the basis for developing a unified biotechnological method of technogenic waste processing with a purpose of their sterilization and detoxification with simultaneous obtaining concentrates of valuable metals.

Key words: Domestic Power Coals, Waste of Lead-Zinc Production, Germanium Tetrachloride Extraction, Microbial Bioleaching, Rare Metals, Sulfur-Oxidizing Bacteria