

DEVELOPMENT OF EXPERIMENTAL METHODS MANAGEMENT OF SULPHIDE OXIDATION IN STORAGE PLACES OF WASTE ORE DRESSING OEF

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Experimental geochemical technologies development of industrially important components re-extraction from dumps, tails of enrichment, inferior-grade ores and slagheaps, exactly in places of their warehousing and processing, where infrastructures of mining and ore-dressing are organized with minimal costs to transference is not advanced yet. Such dumps processing with accumulation directly in places of warehousing as the technologies of double-purpose directs on: 1) formation of complex technogenic deposits as means of renewal of a mineral resource; 2) protection of an environment. Production cycle of OEF is not accompanied by electrochemical processes of oxidation and reduction management, in the other words by ore elements mobilization and concentration in places of warehousing and organization of geochemical barriers in dump thickness with the purpose of ecological safe forming zones of the secondary enrichment, in the other words of the stimulation processes which are analogues of the natural ones in zones of oxidation and cementation of sulphidic deposits. In analogues practice of the focusing electrochemical processes with efficiency about 100% and with concentration factors (10^3 - 10^5) are advanced. But they usually have laboratory level of use and are developed in chemical technologies of ore dressing and fining with obvious impossibility to change only single links of large-capacity ore mining and smelting technologies. This limitation in use to the places of warehousing is absent and it's possible to combine known methods of geotechnologies (hydro-metallurgy, compact dissolution) here, in the other words of mobilization of ore substance with the localized accumulation on barriers. Our experiments show that technologically it's not simple to intensify reagent and electrochemical mass transfer of only target products, heavy metals, in dump thickness. It's enough to achieve concentration factors 10-20 for off-balance ores and wastes of ore dressing. On objects and in the conditions of laboratory modeling authors develop experimental methods management of migration in dumps and of the secondary ores accumulation with oxidation-reduction and adsorption-precipitation processes in concrete forms of minerals.

Sulphidic dumps and mud of the smelting are storing on the surface with oxygen access above subterranean waters level usually. They oxidize quickly in aerobic conditions, including bacterially. It's typical of these processes high sulfuric acidity of solutions (to pH=1.5-2.5) and high mobility of most of heavy metals in the sulfuric solution (except lead). When transporting of the tails by pipeline to tailing storage ponds in the usual ratio water/mud 7-12 primary difference is high watering anaerobic near neutral poral solutions with high subterranean water level and difficulty of oxygen accessing to deep layers. In that case most of heavy metals are contained in tails of enrichment in sulphidic forms with preservation even pyrite, chalcopyrite and arsenopyrite.

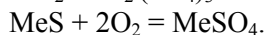
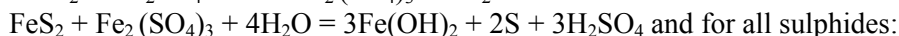
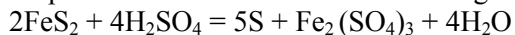
Intensification of oxidation is easily realized by reagent (with injecting oxidant – solution of 0.15M H_2SO_4 + 0.15M $Fe_2(SO_4)_3$) and electrochemically (by oxygen generation on carbon anodes) methods. The interception of mobile heavy metals forms and their concentration are realized by cathodes of cemented and charged electrodes that immersed in solution downstream (in drain or directly in slag-heap).

To apply to conditions of warehousing in tail storage pounds it looks in the following way. We hole a borehole system to the basis of a tail. Anodes are placed in boreholes and generate oxygen. Sulfuric solution is delivered, but the primary filtration is lateral one. Oxidation sulphides and conversion heavy metals in mobile condition take place. In the process of filtration of solution interact with carbonates and sulphides of mud and neutralizes. In drainage system the filtrate (pH=5-7) arrives with solute in it metals. Charged electrodes are put in drain; the cathodes intercept and concentrate heavy metals on the surface. Thereby metals are extracted from the solution. Partial interception and concentration metals are realized by cement and charged electrodes, that put directly in the tail.

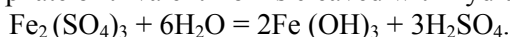
For detailed study of the processes of oxidation sulphides and concentration heavy metals in laboratory conditions a plant had been created. It models processes, which take place in a tail. The plant presents a plexiglass column of square cutest with transparent walls. It's filled by 2/3 by mud of Unal. Through the mud oxidant filtrates (solution of 0.15M H_2SO_4 + 0.15M $Fe_2(SO_4)_3$) at a rate 40-50 cm/day, that conforms to slow linear rate 1 cm/day. The carbon anodes, which generate oxygen, are introduced into basis of the column. Plastic container which is delivered outside the column and joined with it through a tube of a tried of filtrated solution is a prototype of the drain of a tail. Aluminum

cathode for interception and concentration heavy metals outflow is put into the container. It's closed a circuit with the anode, which generate oxygen. Partial interception and concentration metals are realized by cement and charged electrodes, which put in the middle of the column directly in the mud. At the same time additional factor of the thickening metals are electrolysis aqueous solution with hydrogen evolution and alkalization of catholyte. Accordingly, anolyte is acidified by basic electrochemical half-reaction: $2\text{OH}^- = \text{H}_2\text{O} + \text{O}^{2-}$ with active oxygen evolution.

Reagent sulphide oxidation is realized by the solution of sulfuric acid and sulfate trivalent iron. These processes are described the following reactions:



The second reaction is less probable in anode area provided continual oxygen generation, but reality of its local passing in cathode chamber into solution and into basic mud thickness is large. It's controlled and confirmed under thermodynamic modeling. By interaction sulfuric acid with carbonates and sulphides of the mud the filtrate is neutralized (from pH=1.2 to pH=5-6). At that the solution of sulphate of trivalent iron is cleaved with hydrate iron (III) and new portion of sulfuric acid formation:



A quarter of all sulfuric acid presents in pure form and 75% of it is secondary generated when FeSO_4 oxidize and $\text{Fe}_2(\text{SO}_4)_3$ cleave on mobile adsorption-precipitation barrier, which retains and concentrates ore components.

The filtrate is fed bottom up to avoid some undesirable after-effects: 1) to retain entrapped in pores air; 2) mixing and presence counter current over opposite direction of filtration and barbotage gassing on electrodes; 3) Strong roiling of particles of the mud. Such direction of filtration isn't at variance with natural conditions, where, as a rule, lateral filtration in the direction to drainage system is organized.

In operations by sulphide oxidation it's able to increase attenuated forms of zinc concentration from 0.001 mg/l to 10 g/l, and to increase lead, copper and cadmium concentration by 3-4 degrees (to tens mg/l). At that adsorption and cathode effect of concentration are also enough large and arrive at 70-80%.

At this stage methods of reagent and electrochemical management of processes of sulphide oxidation, as well as heavy metals migration and concentration from tails and ore mud theoretically proved and realized in the form of the experimental plant. As a result of experimental optimization of managed migration models for slag-heaps and tailing storage ponds with high subterranean waters level it's offered methods of complex man-caused deposits formation as means of renewal of a mineral resource and drop in ecological load on an environment in places of ore warehousing and processes. The final goal of the experimental part of our work is formation such technologies of dual purpose and of pilot level, which use available reagents of large-capacity chemical technologies, used in the practice of most of OEF and intensify processes on mobile geochemical barriers that are analogous oxidation and secondary ore-dressing in the zones of cementation sulphide deposits.

This study was supported by grant № 05-05-64166 of the Russian Foundation of Basic Research and grant № 02.434.11.4008 of Ministry of Education and Science.

References

1. *Perelman A.I.* Geochemistry. M.: Nauka, 1976.
2. *Savenko V.S.* Geochemical aspects of steady development // M.: Geos. 2003.

Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № 1(24) 2006

ISSN 1819 – 6586

Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2006

URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2006/informbul-1_2006/geoecol-3e.pdf

Published on July, 1, 2006

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