PERCOLATION BIOLEACHING THE GOLD FROM ORES OF KAZAKHSTAN

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Percolation bioleaching the gold from ores of Kazakhstan
The work purpose - research of regularities and the technological scheme percolation bioleaching of gold extraction from ores of Kazakhstan. Heapleaching with thiosulphatic is only used in one location for the treatment of a refractory preg-robbing gold ore initially pre-treated with bio-oxidation. The chemistry of thiosulphatic leaching is complex. Further work is required to develop a better control ofthe system. A mild refractory gold ore containing pyrite and chalcopyrite was used in this study to investigate the use of thiosulphatic as an alternative heapleachingtechnology. Preliminary bottle rolls tests indicated that similar gold extraction was obtained with cyanide and thiosulphatic. In the column leach test, effects of thiosulphatic, copper and ammonia concentrations, and their ratio on both gold extraction and reagent consumption, were assessed. The range of reagent concentration were: 0.1 - 1.0M (NH4)(2)S2O3, 0.03 - 0.10M CuSO4*5H(2)O, 1.0 - 6.0M NH4OH. The solid-liquid ratio was in the range 0.83:1 to 5.1. Best results showed that 72% ofgold was extracted in 50 days with 0.3M (NH4)(2)S2O3, 0. of05M CuSO4*5H(2)O and 6M NH4OH or a combination of 1.0M (NH4)(2)S2O3, 0.03M CuSO4*5H(2)O and 3M NH4OH. The reagent consumption at solid/liquid ratio of 3.1 was 37 - 48.6 kg/t (NH4)(2)S2O3 and 0 - 0.62 kg/t CuSO4*5H(2)O. The results of thiosulphatic leaching were also compared with cyanide leaching [1].

The leaching of gold using alkaline amino acids-hydrogen peroxide solutions at low concentrations has been studied. The application of alkaline amino acid-hydrogen peroxide system may offer an alternative and environmentally benign process for gold leaching, particularly in the context of leaching low grade gold ores in an in-situ or in heap leach processes. In the presence of an oxidant or oxidants, it was found that amino acids can dissolve gold at alkaline condition at low and moderate temperature. Heating the leach solution between 40 and 60 degrees C was found to enhance the gold dissolution significantly in alkaline amino acid-peroxide solutions. It was also found that gold dissolution increases by increasing amino acid concentration, peroxide and pH. Amino acids acts synergistically to dissolve gold. Although glycine showed the highest gold dissolution as a single amino acid compared to histidine and alanine, histidine was found to enhance gold dissolution when used in equimolar amounts with glycine. The presence of Cu2+ ion enhances gold dissolution in the glycine-peroxide solutions. The process will propose an environmentally benign process for gold treatment in order to replace the use of cyanide in heap or in-situ leaching. In the presence of pyrite, the amount of gold leached was lower due to the peroxide consumption in sulphide oxidation. (C) 2014 Elsevier Ltd. All rights reserved [2].

Thebacterial oxidation of sulfide ores can be exploited in the mining industry to leach and extract heavy metals from metal sulfide deposits. Conventional methods for the extraction of precious metals from such complex sulfidic matrices are highly energy consuming and notorious for environmental pollution problems. Precious metals in the form of grains are very finely distributed and encapsulated in the sulfide matrices and direct cyanidation ofthe refractory sulfide ores usually gives unsatisfactory recoveryof such metals. Bio-oxidation ofagold-bearing pyrite concentrate has been considered as an alternative process for the pretreatment of such a refractory ores prior to cyanidation. In this research, a mixed cultures of "Thiobacillus ferrooxidans", "Thiobacillus thiooxidans", and "Leptospirillum ferrooxidans" strains of DSM culture collection were examined batchwise for their ability to oxidize iron portion ofgold-bearing pyrite

concentrate from "Mouteh" mine in Isfahan. Effects of initial levels (i.e. ratio ofthebacterial cell numbers in the inoculum) and ore adaptation of mixed cultures ofthe above named bacterial species on bioleaching; ofthe sulfidie pyrite have been studied. Time course of changes in iron concentration was determined. Iron dissolution during bioleaching could be used as an index for release ofgold, which has been intergrown in the sulfidic matrix. Mixed cultures of these strains of three bacterial species acted efficiently in leaching iron and the variables indicated above had positive influence onthe rate of iron dissolution. In order to characterize kinetics ofthe bio-oxidation in terms ofthe logistic equation, the data obtained were fitted to this equation. A linear regression was performed onthe data in their logarithmic form and logistic model parameters were calculated. The logistic equation was found to be a good fit to all ofthe data obtained in this study [3].

A quick, simple and reproducible method for the indirect determination of the population of the absorbed and suspended bacterias in the cultivation media is the Bradford's method. It has been used to evaluate the fraction of bacteria adhered to the mineral during the bioleaching process and the suspended fraction. It was observed that a significant fraction of the bacteria is adhered to the mineral surface. This proportion varies with the environmental conditions, mainly pH, the presence of ferric ions and the way to supply the mineral sulphide. It has also been observed that the fraction adhered to the solid shows a progressive loss of its oxidative activity. The results can help demonstrate that the sulphides leaching is due to the combination of the direct bacterial action on the sulphide mineral surface with the indirect leaching by the ferric ion produced by the bacteria into the solution [4].

The work purpose - research of regularities and the technological scheme of gold extraction from ores of Bakyrchik deposit, the East Kazakhstan region, by percolation bioleaching.

There are several some ways of leaching, in this experiment there was applied a percolation leaching by infiltration (percolation) of liquid reagent of solution through a motionless layer of solid material. The percolation way is imitation of a compact way of leaching. Generally percolation leaching is applied, for example, for processing gold-consisting porous structure with particles of 0,2-1,0 mm in special round sand of porous structure with particles of 0,2-1,0 mm in special round (height of 2-4 m, diameter of 12-14 m) and rectangular (length of 25 m, width of 15 m) tubs capacity on sand of 800 - 900 t; duration of full processing of one sand loading is 4-8 days. Percolation leaching is carried out by consecutive supply of solutions of cyanides alkaline alkaline-agrarian metals of the decreasing concentration from 0,1 – 0,2 to 0,03 – 0,05%.

In the administrative relation the Bakyrchik mining enterprise is located in the Zharminsky Area of East Kazakhstan region at distance of 90 km to the southwest from the regional center of Ust-Kamenogorsk. In close proximity to the enterprise on the southwest there is an Auezov working settlement , in 4 km to the West – the settlement of Shalobai (fig. 1). Transport system of the enterprise and settlements with the regional center and Semipalatinsk which is in 170 km to the northwest.

Gold leaching by solutions of cyanide of sodium was carried out in the following mode: at the 1 stage (to 20% of extraction of gold) concentration of cyanide of sodium is 0,6 g/dm3, density of an irrigation is 25 dm3/t of ore, without pauses in an irrigation; at the 2nd stage (20-40% of extraction of Au) concentration of NaCN is 0,4 g/dm3, density of an irrigation is 15 dm3/t of ore, a pause in an irrigation -1 day; at the 3rd stage (extraction of gold 40 %) concentration of NaCN is 0,2 g/dm3, density of an irrigation is 5 dm3/t of ore, a pause in an irrigation of 2 days. Stage-by-stage decrease in density of an irrigation allows to maintain concentration of gold in solution at higher level, in this case 2 mg/dm3, pH of initial solution of cyanide of sodium in all cases was equal to 10.

After each irrigation the whole solution was removed from a leaching cycle, i.e. the ore irrigation in each cycle was carried out by fresh alkaline solution of cyanide of sodium. The gold-consisting solution removed from a turn was analyzed on the content of gold, residual cyanide, alkaline, the content of iron and non-ferrous metals was periodically defined: cobalt, nickel, zinc, copper.

The general duration of leaching made 162 days, the maximum concentration of gold in solution is 5,63 mg/dm3. Extent of extraction of gold in solution for the entire period of leaching is 75,17%. In process of increase in duration of leaching, on each of three stages concentration of gold increased in solution in the beginning, and then evenly decreased.

It is revealed that cyanation of gold-arsenic concentrates of Bakyrchik deposits after bacterial leaching leads to gold extraction increase, and the best results are received when procedures of thiosulphatic and sulphatic leaching are preceded by A. ferrooxidans culture processing.

1. Yen, WT (Yen, WT)Development in percolation leaching with ammonium thiosulphatic for gold extraction of a mild refractory ore // EPD CONGRESS// 1999. Pages: 441-455.
2. Eksteen, JJ(Eksteen, J. J.) The leaching and adsorption of gold using low concentration amino acids and hydrogen peroxide: Effect of catalytic ions, sulphide minerals and amino acid type// MINERALS ENGINEERING// 2015. Volume: 70. Pages: 36-42
3. Cheng, DH (Cheng, Dong-Hui)Heap Bioleaching of Refractory Arsenic Gold Concentrates// ASIAN JOURNAL OF CHEMISTRY// 2013. Volume: 25. Issue: 5. Pages: 2839-2844
4. Nestor, D (Nestor, D). Mechanisms of bioleaching of a refractory mineral ofgold with Thiobacillus ferrooxidans// INTERNATIONAL JOURNAL OF MINERAL PROCESSING// 2001. Volume: 62. Issue: 1-4. Pages: 187-198

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