Improving Gold Flotation Selectivity by Using New Collecting Agents

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Abstract—As a result of the present research into the effect of xanthogenate and new collecting agents on flotation properties of gold, the authors defined selective characteristics of a nitrogen-containing agent (MTKh) and phosphorus-containing agent (DIPh) relative to gold. The article describes testing the new collecting agents on gravity tailings of the quartz–sulfide–gold ore.

Key words: Gold coating on pyrite, xanthogenate, nitrogen-containing agent MTKh, di-isobutyl dithiophosphinate (DIPh), monomineral flotation, adsorption, electrode potential, ore flotation.

INTRODUCTION

Gold placers have been ranked as major gold resources in Russia for a great while, but their deterioration in due course time fostered the ever-increasing involvement of gold-bearing ore deposits into gold production. The gold-bearing ore, ground down to 60–70% of −0.074 mm size fraction, is mainly processed by flotation to yield final concentrates of a higher gold concentration and dump tailings. Gold is easily floated with xanthogenate as a collecting agent with a high gold recovery into a concentrate. However, xanthogenate is distinguished for poor selectivity to noble metals. The gold concentrates produced by using this collector are characterized with a low grade at a high yield. This peculiarity leads to higher costs of the flotation concentrate regrinding before cyanidation and the cyanidation process itself, as well as higher costs of off-gas purification in the oxidizing roasting of high-arsenic concentrates. So the selective extraction of gold-bearing minerals is of actual value in improving a gold concentrate grade. Lately the research work is mainly focused on the search for higher selective collectors and investigation into a mechanism for their action [1]. Gold is prone to form complexes with oxygen-carrying ligands, ammonium, and amines, sulfur-containing ligands, including chelate groups [2]. The nitrogen-containing agent MTKh and phosphorus-containing agent DIPh were selected to study their flotation characteristics relative to gold in the present studies. Agent MTKh is synthesized from a cheap raw material, available in Russia. Agent DIPh behaves as an effective and selective collector to platinum-group metals in flotation of sulfide copper–nickel ores [3]. DIPh is produced by US Cytec Industries Inc. as Aerophine 3418A in the form of 50% aqueous solution with stabilizing additives which can influence the research complex-formation results. So in the present studies the researchers used specifically synthesized white crystalline substance sodium di-isobutyl dithiophosphate (DIPh) (C₈H₁₈PS₂Na m.m. 232.15). DIPh was also selected to float gold-bearing products in the tests.

1. RESEARCH MATERIALS TO STUDY FLOTATION CHARACTERISTICS OF GOLD METAL AND ADSORPTION OF COLLECTING AGENTS ONTO GOLD

The material to study flotation characteristics of gold metal in the presence of the test collecting agents was prepared according to the procedure for deoxidizing adsorption of gold from gold-hydrochloric-acid solution onto a sulfide-mineral carrier, namely, pyrite from Kalanguisky (Eastern Transbaikalia) and Kurgashinskansky (Uzbekistan) deposits in the present case. Mineral particles

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–0.16+0.04 mm in size were treated with gold-hydrochloric-acid solution (GHCA) and the pyrite specimens with gold content about 1700 g/t at their surface were obtained (Fig. 1).

Configurations of gold metal deposits on Kalanguisky (Fig. 1a) and Kurgashinsky (Fig. 1b) pyrite specimens were identified by scanning electronic microscope LEO 1420VP. The spectrum of a pyrite area with a gold extract in Fig. 1c is detected by X-ray energy-dispersive microanalyzer INCA350*.

Selectivity of the test agents was verified by comparative flotation in the presence of natural pyrite specimens and pyrite specimen with gold, artificially plated onto its surface. It is known that the treatment of sulfide minerals with chlorhydric acid appreciably alters their flotation properties. In view of this, the pyrite specimens of both deposits were treated with chlorhydric acid of the concentration, identical to concentration of gold-hydrochloric acid solution in the comparative flotation.

To study adsorption characteristics of collecting agents, the test material was prepared according to the above procedure, but the size of material ranged within –0.04 + 0.01 mm. From the chemical analysis data the gold content on this pyrite size fraction, treated with GHCA, was more than 2000 g/t.

2. MONOMINERAL FLOTATION WITH COLLECTING AGENTS

The prepared pyrite specimens from two deposits were floated by using the test agents in the lime medium at pH 9.0. As a velocity of the organic agents-noble metals complex formation was known to higher in the presence of deoxidants [2], the addition of sodium hyposulfite amounted to 40 mg/l in this flotation stage. Figure 2 demonstrates the results of the test pyrite specimen flotation by using xanthogenate. It is obvious that floatability of pyrites with gold-free surface is different. Kalanguisky pyrite is floated with xanthogenate more actively as compared to Kurgashinkansky pyrite. However, after the surfaces of both pyrite specimens were coated with gold, their floatability with xanthogenate was practically the same. Thus, it is reasonable to conclude that the flotation characteristics are essentially affected by gold artificially deposited onto pyrite surface.

Fig. 1. Configuration of gold metal coating at pyrite particles: (a) Kalanguisky pyrite; (b) Kurgashinsky pyrite; (c) X-ray spectrum of pyrite areas covered with gold.