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Role of pH on the adsorption of xanthate and dithiophosphinate onto galena

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ABSTRACT

In the concentrators of a Mexican mining company has been observed that the pH of the flotation has a significant effect on the galena recovery: the increase of pH from 7.5 to 9.5 in the Pb/Cu flotation circuit, resulted in a decrease of about 10% of lead recovery. In the present investigation, experimental models and techniques were developed to study the effect of pH on xanthate and di-isobutyl dithiophosphinate adsorption onto galena. The results obtained by UV / Vis spectroscopy showed that once galena surface has been slightly oxidised by the dissolved oxygen of the aqueous suspension, adsorption of both surfactants increases significantly, being adversely affected by the increase of pH from 5.5 to 9.5. Microflotation measurements performed for both surfactants support these findings. Thermodynamic simulation of the system suggests that the observed behaviour is due to the nature of the solid species formed on the galena surface at the particular pH: lead sulfate ($PbSO_4$) under neutral and slightly acid conditions, and the basic sulfate ($2PbO{\cdot}PbSO_4$) under neutral and slightly alkaline conditions, as well as to their respective solubility. Infrared spectrometry confirmed the occurrence of sulfate onto galena particles, with a higher concentration for the acid pre-conditioning compared to the alkaline pre-conditioning.

RÉSUMÉ

On a observé dans les concentrateurs d'une société minière mexicaine, que le pH de la flottation avait un effet important sur la récupération de la galène: l'augmentation du pH de 7.5 à 9.5 dans le circuit de flottation de Pb/Cu, avait pour résultat une diminution d'environ 10% de la récupération de plomb. Au cours de la présente étude, on a développé des modèles et techniques expérimentaux pour étudier l'effet du pH sur l'adsorption du xanthate et du di-isobutyl dithiophosphinate sur la galène. Les résultats obtenus par spectroscopie UV/Vis ont montré qu'une fois la surface de la galène légèrement oxydée par l'oxygène dissous de la suspension aqueuse, l'adsorption des deux surfactants augmente de manière significative, étant affectée négativement par l'augmentation du pH de 5.5 à 9.5. Des mesures de microflottation effectuées pour les deux surfactants confirment ces résultats. La simulation thermodynamique du système suggère que le comportement observé est dû à la nature des espèces solides formées à la surface de la galène au pH particulier: sulfate de plomb ($PbSO_4$) dans des conditions neutres et légèrement acides, et le sulfate basique ($2PbO{\cdot}PbSO_4$) dans des conditions neutres et légèrement alcalines, ainsi que dans leur solubilité respective. La spectrométrie infrarouge a confirmé la présence de sulfate sur les particules de galène, avec une concentration plus élevée pour le conditionnement préliminaire acide que pour le conditionnement préliminaire alcalin.

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1. Introduction

Concentration of lead, copper, and zinc from their complex ores is conventionally performed by sequential flotation circuits. Galena (PbS) and copper minerals (chalcopyrite, $CuFes_2$; bornite, Cu_5FeS_4; etc.) are initially floated, leaving sphalerite (ZnS), iron sulfides (pyrite, FeS_2; pyrrhotite, Fe_7S_8) and non-sulfide gangue (nsg) in the tails. This separation is possible since galena shows natural affinity for the commonly used collectors [1–3]. In contrast, sphalerite is naturally hydrophilic and has little or no affinity for such collectors [4–7]. In the Pb/Cu flotation circuit, a mixture of collectors isopropyl dithiocarbonate (C_3H_7-O-CS_2^-, isopropyl xanthate) and di-isobutyl dithiophosphinate ((C_4H_8-O-)$_2PS_2^-$, Aerophine 3418A), is commonly used. Dithiophosphinate is known to be highly selective for lead and copper minerals [8,9]. Flotation is conducted under neutral and slightly alkaline conditions with the aim of minimising flotation of iron sulfide gangue (i.e. pyrite and pyrrhotite).

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