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Effect of Cationic Surfactant Addition on the Electro kinetics and Stability of Silica/Kaolinite Suspensions under Conditions Relevant to Copper Hydrometallurgy

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Abstract

It's a tricky situation when there are tiny particles present during hydrometallurgy process operation that result in crud. The majority of the time, silica and clay particles either float to the top or stay in suspension. Promoting the settling of the solids by adding surfactant could be a method for their removal. The evaluation of the composition and ideal dose of surfactant is however necessary for this approach in these complicated systems with a variety of particle types and sizes[1-15].In this study, we investigate the application of dynamic electrophoretic mobility for assessing CTAB adsorption on silica/kaolinite mixes at low pH and high ionic strength indirectly. with a particle concentration of more than 3%. The electroacoustic approach (ESA) demonstrates its suitability for predicting the impact of surfactant addition on silica and kaolinite individual particles as well as combinations of such particles. The findings concurred with estimates of sizes and sedimentation rates. Additionally, the evolution of aggregates and the construction of structures between particles as a result of the addition of CTAB are supported by images taken using a scanning electron microscope (SEM). This inquiry may help to resolve operational issues related to the production of crud in the hydrometallurgy process since the ultimate goal is to identify the appropriate doses of surfactant in which the specified suspensions flocculate and separate from the continuous.

Introduction

The production of mineral complexes as a result of interactions between particles in the mineral solid matrix, which are transferred by the leaching solution to the next step of solvent extraction, is one of the major challenges in the industrial process of beneficiating oxidized copper ore. The operational conditions of low pH and high ionic concentration result in these interactions, which naturally cause aggregation processes that finally lead to the development of crud during solvent extraction. Just to refresh your memory, crud is a layer of scattered particles that occurs at interfaces and is traditionally attributed to the presence of small solid particles at the contact between droplets of the dispersed phase and the surrounding continuous phase. Solid particles that behave both hydrophilically and hydrophobically have a specific propensity to produce crud. It is clear that high density particles don't pose issues because they quickly settle to the bottom of the separation vessel and are simple to remove from the copper solution. Smaller particles present a far more challenging situation since they will either float to the top or remain suspended, creating so-called "fish-eyes." The majority of the time, silica and clays make up the crud. The hydrometallurgy process' operating conditions low pH, high ionic strength, and particle concentration above 3 percent), which are most conducive to flocculation due to the decrease in electrostatic repulsive forces, are complicated by the instability of the colloids that make up the crud. To reduce the effects of the mineral dragged with the solvent extraction method of heap leaching, which is one of the primary causes of waste formation, is one of the metallurgical industry's major issues.

Subjective Heading

The inclusion of chemicals that can encourage the sedimentation of the sludge particles under certain circumstances is a potential solution. One possibility is the use of a cationic surfactant at low concentrations in a way that the stability is changed by a variety of surface phenomena related to I the nature of the structural groups in the solid, the molecular structure of the surfactant, and the properties of the aqueous phase. The addition of surfactants has a variety of consequences. First, the polar head can neutralize the electro kinetic charge density of the particles upon adsorption of the surfactant molecule, causing their flocculation. Only a charged, hydrophilic group in the molecule, the. Surfactants also increase the water repellency of aqueous media due to increased solid-liquid interfacial tension and increased particle-liquid contact, which in turn increases the likelihood for particles to flocculate. The effects indicated can be obtained with surfactant concentrations much lower than those of ions, and the impact is more effective the longer the surfactant chain, which is a benefit of using surfactants over inorganic ions of the same charge. If the surface coverage is low, bridging flocculation can also occur in this situation, allowing one molecule to join two particles such that uncovered patches can accept the chain end It is equally effective for shorter sequences

Discussion

Polymers, either ionic or nonionic, are frequently used to control the stability of concentrated slurries. The most effective way to monitor and interpret changes in the stability of such suspensions is based on electroacoustic tests that simultaneously determine particle size and zeta potential. This was demonstrated by in the instance of kaolinite and spectate suspensions. Although differences between polymers could be detected and linked to their various chemical functionalities, as demonstrated by zeta potential determinations, these authors discovered that polyethylene oxide or polyacrylamide-acrylate were

effective in flocculating and dewatering the clay suspensions. In the subject of mineral ore beneficiation by separation of, interfacial processes are also significant. Floating of froth. The effectiveness of the flotation collector adsorption in this traditional technology is governed by the electrical characteristics of the mineral/solution contact. Electroacoustics and direct adsorption measurements can also be used to determine these parameters, as demonstrated in the references.

The pressure wave produced by the application of an alternating electric field to the system has been detected and analysed using Electro kinetic Sonic Amplitude, or ESA, in the current work. As long as the particle density is different from that of medium, it is applicable to arbitrary particle content. In this article, we look at using electrokinetic techniques to evaluate the surfactant CTAB's indirect adsorption on mixes of silica and kaolinit the colloidal suspensions under investigation are made of silica and kaolinite particles distributed in an 80 mM solution of copper sulphate at pH 2 in order to simulate the conditions seen in the copper hydrometallurgical process. Materials included silica (Ludox TMA), natural kaolinite particles, copper sulphate, $CuSO_4\cdot 5H_2O$, sulfuric acid (ACS reagent, 95–98% purity), and the cationic surfactant hexadecyltrimethylammonium bromide (all from Merck & Co., USA) (CTAB). Using a Nova 2200e piece of equipment, the solids' surface area was measured (Quantachrome Instruments, Anton Paar, Austria). To determine the BET surface area, multipoint tests were carried out at 77 K using N2 adsorption (SBET). Kaolinite and silica yielded findings of 15 and 63.2 m2/g, respectively. Using a Milli-Q Academic system, water was deionized and filtered.

As previously mentioned, the electroacoustic technique known as ESA or Electrokinetic Sonic Amplitude was used to characterise the diffuse layer charge density of the suspended particles in solution, which is approximately represented by the electrokinetic charge density. When an alternating electric field (1 to 18 MHz frequency) is applied to the colloidal suspension, the relative movement between particles and media generates a pressure wave that I In example, in the case of surfactant adsorption on kaolinite, this technique has been frequently employed for the interfacial electrical characterisation of inorganic particles/solution.

For each frequency of the external field, the electroacoustic measurements give the dynamic mobility, ud (the alternating-field equivalent of classical electrophoretic mobility). Recall that the mobility is defined as the ratio of the applied electric field to the particle velocity, E where Km is the medium's conductivity, Kp and pare the particle's respective conductivity and permittivity, and is the volume fraction of solids. Remember that the electrical double layer's excess conductivity, or surface conductivity K, adds to the effective particle conductivity, which, for a spherical particle, is given by $Kp=K/2a$ even if the particles are intrinsically non-conducting (Delgado, 2002, Lyklema, 1995). When the field's frequency exceeds MWO, polarization is prevented, the dipole coefficient decreases, and the mobility increases. Simply said, dynamic mobility is the AC counterpart to DC electrophoretic mobility, although it offers far more information than the latter number, which only gives a single value where Km is the medium's conductivity, Kp and p are the particle's respective conductivity and permittivity, and is the volume fraction of solids. Remember that the electrical double layer's excess conductivity, or surface conductivity K, adds to the effective particle conductivity, which, for a spherical particle, is given by $Kp=K/2a$ even if the particles are intrinsically non-conducting When the field's frequency exceeds MWO, polarisation is prevented, the dipole coefficient decreases, and the mobility increases. Simply said, dynamic mobility is the AC

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Conclusion

Two steps of the electrokinetic characterization were completed. The Zetasizer NanoZS was used to quantify the DC electrophoretic mobility of diluted suspensions as a first approximation. Then, the AcoustoSizer IIc ESA equipment was used to evaluate dynamic mobility (Colloidal Dynamics, USA). Because the suspensions' ionic concentration is relatively high, background adjustment of the raw data was performed in each case to ensure accuracy.

As a function of CTAB concentration, electroacoustic measurements of 2.5 percent silica suspensions in 80 mM CuSO4 and pH 2 are plotted in Fig. 2. By modelling the particles as spheres, it was easy to match the ud() spectra (and in fact, the static electrophoretic data of Fig. 1) and derive the zeta potentials using well-tested dynamic mobility theorie. Table 1 presents the findings in detail. Our conclusions, which are mostly based on dynamic mobility, have credibility due to the clear agreement between the two types of evaluations.

Acknowledgement

Conflict of Interest

The authors declare that they are no conflict of interest.

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