

FLOTATION OF MANGANESE MINERALS AND QUARTZ BY SODIUM OLEATE AND WATER GLASS

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Abstract— In this paper, we present the results and a discussion of microflotation tests performed with manganese minerals (rhodonite and rhodochrosite) and quartz mineral, using sodium oleate as the collector. We also explore the influence of water glass (sodium silicate) as a depressant in the recovery of these minerals with sodium oleate. Potential zeta determinations were carried out with the three minerals conditioned with deionised water and with the previously mentioned reagents. It was found that, at a pH of 9, the recoveries of rhodonite and quartz were maximised, and for the rhodochrosite mineral, the maximum recovery was achieved at pH 11. The water glass at pH 9 was more efficient in depressing quartz than rhodonite, especially for smaller concentrations, whereas the flotation response of rhodochrosite was only slightly affected at both pH 9 and pH 11. The potential zeta curves indicate that the IEP of rhodonite (pH=2.8) is similar to values reported in the literature, whereas the IEP values of quartz (pH=2.2) and rhodochrosite (pH=10.8) differ slightly from those in the literature. The zeta potentials of rhodonite, quartz and rhodochrosite in the presence of sodium oleate and water glass become more negative in a basic medium. Finally, based on the experimental results with a collector of sodium oleate and a depressant of water glass, some inferences on the adsorption mechanisms of these reagents on rhodonite, quartz and rhodochrosite surfaces are made.

Keywords— Manganese, rhodochrosite, rhodonite, quartz, water glass.

I. INTRODUCTION

The State of Minas Gerais was the first to exploit manganese-oxide-rich ore in Brazil. Until the 1970s, Minas Gerais supplied the national metallurgy industry and was responsible for almost all exported Brazilian manganese ore products for foreign markets. Despite the exhaustion of manganese-rich deposits, Minas Gerais still has large manganese-poor deposits (queluzite and gondite). These ores have a complex mineralogy consisting of several manganese minerals, such as oxide, silicate and carbonate, that are associated with gangue minerals such as quartz and other silicates, sulphides, carbonates and other minerals.

Acevedo (1977) studied the possibility to concentrate, by flotation, the silicate-carbonate manganese-poor ore from the State of Minas Gerais. For the first step, microflotation tests in a Hallimond cell with pure

minerals (rhodonite, rhodochrosite) using sodium oleate and several depressants were performed. It was found that the pH values of maximum recovery for rhodonite were 9 and 10 at an oleate dosage of 5.0×10^{-4} M. The rhodochrosite recovery was constant and maximum (100%) for all pH values studied. It is likely that the reagent concentration used was very high. Furthermore, the floatability of rhodonite, preconditioned with water glass, decreased by 15% at pH 10. In the case of rhodochrosite, it was found that the water glass did not have any depressant effects on the floatability of this mineral. However, in bench tests carried out with manganese ore fraction sizes between 43 and 106 μm , no selectivity between the manganese and gangue minerals was observed.

Lima *et al.* (2008) performed bench flotation studies, at pH 11 by using sodium oleate as a collector and water glass as a depressant, of silicate-carbonate manganese tailings (Mn, SiO_2 , Al_2O_3 and Fe contents of 28.30, 28.10, 9.30 and 3.67%, respectively) from Morro da Mina Mine, located in Conselheiro Lafaiete, Minas Gerais, Brazil. They obtained a Mn recovery of 63%, and the contents of SiO_2 and Mn in the concentrate were 17 and 32%, respectively. Despite a reduction of 11% in the SiO_2 content in the concentrate as compared with the feed, the Mn content in the concentrate increased by only about 4%. What can be related with the high proportions of manganese silicate minerals such as spessartite, rhodonite and tephroite in their sample (Lima *et al.*, 2010).

Somasundaran (apud Fuerstenau *et al.*, 1985) used diagrams of species distributions for a sodium oleate concentration of 3×10^{-5} M and concluded that, at pH 7.8, the ionomolecular specimen ($\text{RCOOH}\cdot\text{ROO}^-$) activity is maximised and the ionic oleate (RCOO^-) and dimer (RCOO_2^{2-}) activities increase as the pH is increased up to pH 7.8. Above this pH value, both (RCOO^- and RCOO_2^{2-}) activities remain constant. For pH values lower than 7.8, neutral oleic acid begins to precipitate.

The dissociation of water glass (modulus 1) in water produces Na^+ , $\text{H}_2\text{SiO}_4^{2-}$. Furthermore, as a function of pH, the anion $\text{H}_2\text{SiO}_4^{2-}$ hydrolyses in two steps to H_3SiO_4^- and H_4SiO_4 (Grenburg and Sinclair; apud Misha, 1982). At pH values below 9, the predominant specimen in the solution is silicic acid [H_4SiO_4]. In this region, there is a smaller quantity of [$\text{SiO}(\text{OH})_3$], which is predominant at pH values between 9.5 and 12.5. At pH values greater than 6, the specimen [$\text{SiO}_2(\text{OH})_2^{2-}$] appears, which is then predominant above pH 13. The