

Parameters of electrically reducing zinc from sulfate solutions under mixing conditions

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Abstract

The aim of the work was to obtain data on the polarization of electrodes, velocity, and kinetic constants of electrically reducing zinc from neutral and acid solutions of zinc sulfate under mixing conditions.

Electrochemical investigations were carried out on two electrolytes: electrolyte 1: 0.25 M ZnSO₄ and electrolyte 2: 0.25 M ZnSO₄ + 18 g/l H₂SO₄. Lignosulfonate was dosed into the electrochemical cell in the amount of 10, 20, 40 and 80 mg/l and cationic flocculent K6645 in the amount of 25 mg/l. The physicochemical characteristics of these surfactants are indicated in the earlier studies. Potentiostatic, galvanostatic data and polarization curves in the dynamical regime were obtained at the potentiostat P-30J com. firm "Elins" using a three-electrode cell. In this case, the working electrode (cathode) was made of Z0A zinc with an area of 0.35 cm²; the auxiliary (anode) is made of platinum plate with an area of 0.20 cm², the reference electrode is silver chloride (AgCl/Ag). Electrodes were grinded before work, degreased with ethyl alcohol, washed with water. The auxiliary electrode was etched in a solution of nitric acid (1 : 2 = acid : water) for 5 seconds and intensively washed with distilled water. The measurements were carried out at room temperature without stirring and with vigorous stirring by a magnetic stirrer.

When calculating the total polarization capacitance in a dynamic mode, the rapid charge method for a neutral electrolyte showed its increase when cationic surfactant flocculent K6645 and anionic surfactant lignosulfonate were added to the electrolyte. With the addition of surfactants to the acid electrolyte, a single-valued result of the total polarization capacitance at different scanning speeds was not obtained. An increase in the sweep rate of the potential from 100 to 4000 mV/s reduced the total polarization capacitance from $111.1 \cdot 10^{-3}$ to $1.23 \cdot 10^{-3}$ F/cm².

It is shown that stirring the neutral electrolyte increases the polarization, and the acidic solution reduces. This fact indicates that during the discharge of cations from the acid electrolyte of zinc sulfate, the stage of migration of cations to the negative cathode, characteristic of a neutral electrolyte, is excluded to some extent, and the diffusion stage begins to dominate due to the presence of hydrogen cations having significantly greater mobility, than zinc cations. The addition of lignosulfonate also increases the polarization at all current density values, with or without stirring of the electrolyte.

The exchange currents and transport numbers for the neutral and acidic electrolyte are calculated, it is noted that an increase in transport numbers increases the reduced polarization of the cathode process. A decrease in the exchange currents was noted with an increase in the LST additive to the electrolyte in calculations based on the galvanostatic polarization curve at current densities of 10 to 20 mA/cm², close to the densities of industrial electrolysis.

It is shown that an increase in the current density with an increase in the duration of electrolysis at potentials minus 1150 and 1200 mV (Ag/AgCl) is associated with the onset of the discharge of the cation of hydrogen in parallel with the cathodic deposition of zinc. This was also evidenced by theoretical calculations.

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