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Cementation of copper with metallic zinc in solution

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Abstract

A number of articles are devoted to the study of the cementation process, which has a significant industrial value, both in non-ferrous metallurgy and electroplating. Thus, the cementation cleaning of solutions from impurities with zinc dust is used in the hydrometallurgy of zinc in the preparation of solutions for the electrolysis of zinc.

Cleaning solutions by cementation (with powder of metal zinc or dust of zinc) is based on a principle similar to work of galvanic cells and electrochemical corrosion of technical metals containing impurities with low hydrogen overvoltage. In the general chemical reaction, oxidation (anodic process) and reduction (cathodic process) occur in different parts of the same metal particle, which are energetically more advantageous for this, which is possible due to the presence of a conductive medium. Therefore, the rate of displacement reaction of type $CuSO_4 + Zn \rightarrow Cu + ZnSO_4$ is determined by the rates of anode ($Zn \rightarrow Zn^{2+} + 2e$) and cathode ($Cu^{2+} + 2\ e \rightarrow Cu$) processes, which are dependent on their potential and other factors characterizing any electrochemical process.

For the study of recovery of copper zinc dust used the following reagents and substances. There are pentahydrate of copper sulphate $CuSO_4 \cdot 5H_2O$ brand chemically pure, zinc dust particle size is 0.063-0.2 mm with a content of metallic zinc is 95-99 %, solutions of coagulant, there are magnafloc 333 and 351, bestlock 6645 and 4034. We used in the experiments aqueous solutions of copper sulfate 0.025 mol/l and flocculants 2.5 g/l at dosages of zinc dust 2-4 g/l and 100-200 mg/l flocculants. Analysis of the copper content in the initial and final solutions was performed by spectrophotometric method with preliminary transfer of copper to the ammonia complex. The experiments were performed at different temperature ranges and mixing rates. At the first stage temperature were 24-50 ^{o}C and stirring speed were 40-50 rpm in apparatus with a magnetic stirrer and flow rate of flocculants was 100-200 mg/l. At the second stage temperature were 15-25 ^{o}C and stirring speed were 140-150 rpm and flow rate of flocculants were 50 mg/l. The duration of experience varied from 1 to 8 min. The degree of recovered from solutions of copper were 10-90%.

The purpose of this work was to search for models describe the process of copper recovery in aqueous solutions of finely dispersed zinc powder (dust of zinc) and to study the influence of high-molecular flocculants on this process.

It was shown that the change in the conditions of copper reduction by metallic zinc, namely a change in temperature and mixing rate leads to different models describing the kinetics of the process. The resulting difference of the description of experimental data is related to different speeds of the process were 0.0073 at the second stage, compared to 0.0022 g-EQ/l·min at the first stage for the cementation of copper with no additives, and still a big difference in the speed of the cementation of copper with the addition of flocculants.

While at both stages of the study it was shown that the addition of high-molecular substances inhibit the cementation process. This fact must be considered in industrial environments, where flocculants are used to improve the settling of pulps, and then the solutions purified from solid suspension are sent to the cementation purification from copper and other impurities.

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