

The Anode Process in Cobalt Electrowinning

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Industrial cobalt electrowinning is performed in sulphate or chloride based aqueous solutions /1/. The main anode reactions are oxygen and chlorine evolution respectively. Along with the gas formation, divalent cobalt ions are oxidized in both solutions, forming a cobalt(III) oxyhydroxide anode scale (CoOOH) by hydrolytic precipitation.

In sulphate media, which is most widely used, alloyed lead is the predominant anode material. When using lead anodes, CoOOH deposition is advantageous, since the cobalt layer acts as a collector for lead corrosion particles, which will otherwise contaminate the cobalt product. Cobalt also shows a depolarizing effect on the oxygen evolution reaction on lead /2/. This fact, in combination with increased lead anode stability, is why the addition of some cobalt sulphate to the electrolyte has become common practice in copper electrowinning /3/.

Dimensionally stable anodes (DSA), made of titanium coated with noble metal oxides, are currently used exclusively in cobalt chloride electrolytes. The anodes are bagged to collect the toxic chlorine gas produced /4/ (Fig. 1). As opposed to lead anodes, CoOOH deposition on DSA is detrimental, because the electrocatalytically active noble metals will then be less accessible to the chloride ions (Fig. 2). Accelerated corrosion rates of the catalytic coating due to the anode scaling have also been observed. If the DSA's are not cleaned regularly, CoOOH may grow through the bags resulting in chlorine formation outside the tanks, reducing the cobalt current efficiency, or end up in the tankhouse atmosphere giving an unacceptable working environment.

Experiments were carried out in order to study the cobalt electrowinning process from aqueous solutions, with emphasis on the anode reactions, and in particular the CoOOH formation. In most of the electrowinning tests DSA-type anodes and industrial cobalt chloride solutions were employed. The system was examined by electrochemical techniques, scanning electron microscopy and X-ray diffraction analysis.

The anodic CoOOH deposition reaction was found to be highly dependent on several electrowinning key parameters, e.g. solution pH (Fig. 3). No CoOOH was detected at low pH values. At intermediate pH CoOOH was observed solely on the anode surface, but as the pH was further increased, CoOOH precipitated on the anode as well as in the bulk of the cobalt chloride solution.

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2. O. Forsén, J. Aromaa, *Possibilities to Lower Energy Use in Electrowinning by Modification of Lead Anodes*, Aqueous Electrochemical Technology: Progress in Theory and Practice, D.B. Dreisinger, ed., The Minerals, Metals & Materials Society, 1997, pp. 333-346.
3. T. Robinson et al., *Copper Electrowinning – 2003 World Tankhouse Operating Data*, Copper 2003-Cobre 2003, Copper Electrorefining and Electrowinning, J.E. Dutrizac, C.G. Clement, eds., vol. V, CIM, 2003, pp. 421-472.
4. F. Grøntoft, *Electrowinning Metal from Chloride Solution*, U.S. Pat. 4,155,821, 1979.

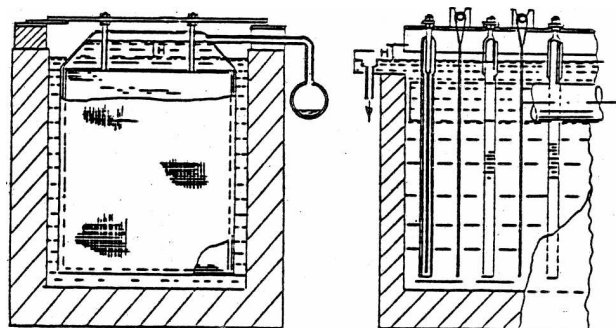


Fig. 1. Falconbridge electrowinning cell

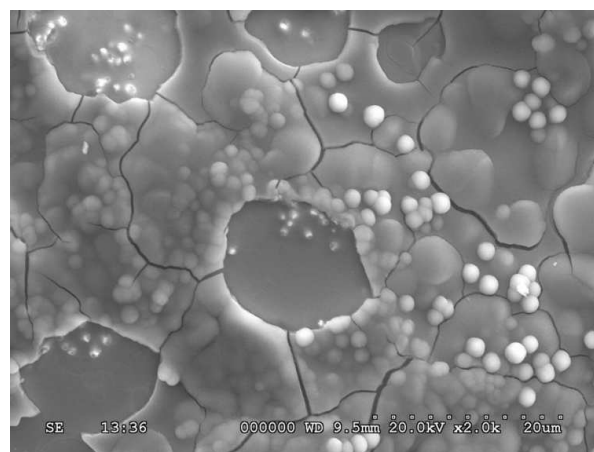


Fig. 2. SEM micrograph of CoOOH deposits on DSA

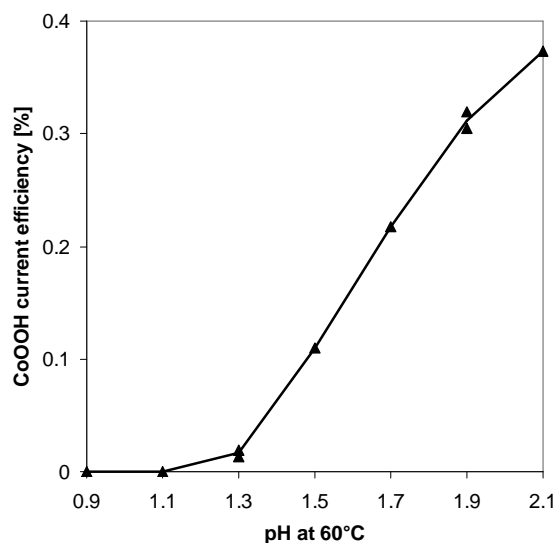


Fig. 3. CoOOH current efficiencies at varying pH