



Effect of hydrochloric acid on the transport properties of tin through ion-exchange membranes

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ABSTRACT

This work presents a study of the transport properties of two ion-exchange membranes present in an electrochemical reactor used to process the wasted and rinse baths of the electroless plating of polymers industry. The influence of the hydrochloric acid on the transport properties of tin through both cation- and anion-exchange membranes has been evaluated by chronopotentiometry. The shape of the chrono-potentiograms depends on the specie under consideration, Sn(II) or Sn(IV), the hydrochloric acid concentration and the type of membrane. In the case of the study of Sn(II) transfer through the cation-exchange membrane (CEM), the contribution of the water splitting is evident for every HCl concentration by the increase of the membrane potential drop (E_m) after a short-time plateau observed in the chronopotentiograms, and by the appearance of a Sn(OH)₂ precipitate located at the anodic solution-membrane interface. The transport of Sn(IV) through the CEM is a complex phenomenon due to their high charge density leading to an important hydration shell, to their low mobility and, to their trend to form hydroxyl complexes and insoluble salts. Low HCl concentrations and high applied currents leads to the formation of a Sn(IV) specie, probably the Sn(OH)₆²⁻ monomer, which can polymerise and remain adhered to the membrane surface. This specie is re-dissolved when the HCl concentration is increased. In the case of Sn(II) transfer through the anion-exchange membrane (AEM), if the applied current is high and the HCl concentration is low, the OH⁻ produced due to water splitting are forced to cross the membrane when the chloride concentration in solution is depleted. For higher HCl concentration, the development of the gravitational convention phenomenon is coupled with the water splitting at those high applied currents. The presence of Sn(IV) at low HCl concentration in the over-limiting region produces a diffusion-relaxation region characteristic of the bipolar membranes. The formation of a Sn(IV) gelatinous specie adhered to the anodic side of the AEM could explain the formation of the bipolar structure in the membrane. At lower pH values the formation of this Sn(IV) gelatinous specie is avoided, and the OH⁻ ions from the water splitting are responsible for the peak of E_m observed in the chronopotentiograms.

Keywords: Anion-exchange membrane; Cation-exchange membrane; Chronopotentiometry; Hydrochloric acid; Sn(II); Sn(IV); Water splitting

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