Electrochemical and Surface Studies of Zinc in Alkaline Solutions Containing Organic Corrosion Inhibitors

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The corrosion resistance of battery electrodes is an important characteristic controlling the battery reliability. This factor is especially important in alkaline batteries containing zinc electrodes as zinc corrodes in alkaline media with hydrogen depolarization, leading to hydrogen evolution. Hydrogen accumulation inside the battery in the gas phase can lead to increase in the pressure resulting in mounting damage, electrolyte leakage and deterioration of battery performance. In order to avoid these situations and to increase the corrosion resistance of the zinc metal in the alkaline media, zinc organic inhibitors are widely employed in alkaline batteries (1-4).

In the present work we studied the effect of different polymeric organic inhibitors on the electrochemical behavior of zinc in strong alkaline electrolytes. Electrochemical measurements were performed in a conventional electrochemical cell made of polypropylene. The cell was equipped with Luggin capillary and saturated calomel electrode, SCE, as a reference electrode. Platinum wire was used as a counter electrode. Experiments were conducted in 8.5M potassium hydroxide (KOH) containing 25 g/l zinc oxide and inhibitor additives (PEG and its derivatives and GAFAC). The concentrations of the inhibitors ranged between 400 and 4000 ppm. In addition to standard electrochemical measurements (E_{corr} transient, potentiodynamic cyclic polarization, and linear polarization), we employed weight loss measurements, FTIR spectroscopy, scanning electron microscopy, (HRSEM) and AFM.

The electrochemical measurements show that the tested inhibitors strongly decrease the rate of cathodic reaction. Sharp decrease in the observed cathodic currents was detected in the potential region of approx. 0.2 V bellow corrosion potential (Ecorr =-1.580 V_{SCE}). The effect of the inhibitors on the rate of anodic reaction (zinc dissolution) was practically negligible. Thus, both of the tested inhibitors can be classified as cathodic inhibitors.

The effect of the inhibitors on the zinc corrosion rate was detected with the use of linear polarization, weight loss tests and hydrogen evolution measurements. Sharp decrease in the zinc corrosion rate was found once PEG was added to the solution. The use of PEG in a concentration of 2,000 ppm was found to be an effective one (5).

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