Determination of copper dissolution activation energy in concentrated hydrogen peroxide

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Abstract. Determination of copper dissolution activation energy in concentrated hydrogen peroxide used as a decontaminant agent on aircraft has been carried out. This work was performed in conjunction with the determination of the effect of hydrogen peroxide used as a decontaminant agent on selected aircraft metallic materials. The main idea of this work was to simulate the worst possible condition, i.e. spillage of the liquid concentrate due to operator abuse or conditions where large-scale condensation of the peroxide takes place due to the failure of decontamination process control. Due to inherent properties of the chemical used as a decontaminant agent, it possibly could affect the airliner metallic materials during or after the decontamination process, particularly copper. Since copper is one of the important alloying elements in the aluminum alloys, this work was performed to get the idea how fast the process takes place and so to help understanding the subsequent corrosion process, if any, on the aircraft’s flightworthiness at least qualitatively and ideally quantitatively. The results showed that the rate of copper dissolution increased for the first 15 minutes of the reaction time with an activation energy of 19 kJ/mol, and then the fraction of copper dissolved became constant. This constant dissolution was expected to be due to the formation of copper hydroxide, which was observed to precipitate after the solution settled for some time. However, because the final consumption of hydrogen peroxide was not controlled, the exact reason for this constant dissolution cannot be determined at this time. The value of activation energy is within the range of activation energy found in the literature for other dissolution process. The low activation energy for dissolution of pure copper correlates with the observation of dissolution of copper from intermetallic particles in the aluminum alloys.

Introduction

The copper dissolution rate into hydrogen peroxide was determined after an initial study of the impact of decontamination on the properties of aircraft structural materials, in which some leaching of copper into hydrogen peroxide during the dip testing was observed. Dip testing is immersion of a specimen into liquid hydrogen peroxide for a certain time. This was done to simulate the worst possible condition, i.e. spillage of the liquid concentrate due to operator abuse or conditions where large-scale condensation of the peroxide takes place due to the failure of decontamination process control. This leaching was expected because of copper dissolution into hydrogen peroxide. Since copper is one of the important alloying elements in the aluminum alloys, this work was performed to get the idea how fast the process takes place and so to help understanding the subsequent corrosion process, if any, on the aircraft’s flightworthiness at least qualitatively and ideally quantitatively.

Copper is one of important alloying elements in aluminum alloys. In 2xxx aluminum alloys, copper is a major element alloying element with concentration of up to 4.9 wt.%. In 7xxx aluminum alloys, copper is one of the alloying elements with the concentration of up to 2.0 wt.%. Several investigators have investigated the dissolution of pure copper and its properties in several acidic solutions such as sulfuric acid [1,2], hydrochloric acid [3,4], and ethylene diamine tetra acetic acid/ethylene diamine (EDTA/EDA) base solutions [5]. Several others have investigated the copper dealloying and or nucleation and growth behaviors in aluminum alloys in the presence of sodium...