NEW GENERATION SUBMARINE BATTERY ELECTRODES USING A TIN-LEAD GRID ALLOY

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ABSTRACT

The life of lead-acid batteries is typically governed by corrosion of the positive grid. The grid experiences highly oxidising environments which, in turn, corrodes the grid material. However, the resulting corrosion layer is essential to create an electrically conductive bond between the grid and active material. Additionally, alloying elements are necessary to allow low-cost production techniques to be used. The selection of grid material is therefore a compromise between function, life and ease-of-manufacture. Tubular plate lead-acid batteries have historically used antimonial-lead alloys as the grid alloy. These alloys impart mechanical strength within a die-cast grid and provide a suitably conductive oxide within the corrosion layer. The use of tin in many lead alloy blends has resulted in a beneficial effect on the corrosion rate of these alloys. Tin-lead alloys are used in thin plate lead-acid batteries. However there is no published data on their use for grids of tubular plates in deep-cycling applications.

A simple binary, low-tin lead alloy has been tested and found to exhibit a significantly lower corrosion rate during periods of heavy cycling when compared to a traditional low-antimony based alloy. However, it was shown that under severe over-charge conditions, the tin-lead alloy corroded at a significantly faster rate than that of an antimonial alloy. The lead-tin alloy performed well as a positive grid material throughout 500 cycles. No indications of premature capacity loss were observed and the ability of the alloy to be recharged was excellent.

Electron microprobe analysis of sections of cycled positive plates showed the doping effect of tin within the corrosion layer of the grid material. This effect led to an increase in the conductivity of the layer, resulting in an increased ion-conductivity of the corrosion layer.

The corrosion layer of each alloy type was found to be fine, densely packed and uniformly structured under cycling conditions, but it became more porous during periods of severe over-charge. The tin-based alloy was shown to produce a thinner corrosion layer at completion of 500 cycles when compared to that of the antimonial alloy. Further, the corrosion layer of the tin based alloy was found to be less cracked than that of the antimonial based alloy.

Finally, this investigation could not identify any reasons why a tin-based grid alloy has not been identified for use in tubular plate deep-cycle batteries previously. The alloy was shown to perform well under both charge and discharge conditions and was not found to suffer premature capacity loss.

DECLARATION

I, Brenton Travis Swansson, certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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