Comparison of Cycle Behavior of VRLA Cells in Positive- and Negative-Load Limiting Configurations

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This paper will discuss the performance characteristics in positive- and negative-load limiting configurations in valve-regulated lead-acid (VRLA) cells, which undergo continuous overcharge and deep-discharge cycles. The variation of the cell voltage, electrode potential, pressure and temperature provide much detailed information of the recombinant behavior of the cell and the deterioration of the electrode performance. The information is critical for the understanding of cycle life issues and the prediction of the cycle life performance of the cell.

Extending VRLA battery cycle life has been a continuous thrust in the industry for energy storage and stationary battery backup applications. For traction applications, the cycle life issues are even more crucial and complicated. Nonetheless, detailed information regarding the cycle life behaviors of the VRLA cells is scarce, often not available in the open literature. This work is intended to shed some lights on the cycle life issue and, particularly, investigates how overcharging affects the cycle performance of the cell and electrodes, most likely due to water loss. We use both positive- and negative-load limiting configurations in the study to compare the overcharging performance of the cell and electrodes, with the observation of water loss via gas collection.

The result from the positive-load limiting tests showed that the cell capacity increased in the first 50 cycles while the oxygen recombinant reaction became more active to stabilize the cell performance. Some capacity degradation occurred after reaching the maximum capacity near 50 cycles with gas evolution and venting. The capacity was stabilized over the next 200 cycles without any apparent loss, and the value remained higher than the rate capacity specified by the manufacturer. After 250 cycles, the capacity began to show another sign of degradation at a slow rate.

On the other hand, the test with a cell of negative-load limiting configuration showed that the cell experienced a more aggressive capacity loss from the beginning of the cycling than the one with positive-load limitation. The rate of degradation was however decreasing during cycling. The cell remained at 80-85% of the rate capacity after only about 15-20 cycles. The gassing and venting activity seemed to be more active than the cell with positive-load limitation.

The different load limiting cells allow us to distinguish how different electrode loading ratios affect the overcharging behavior and the cycle performance. The consequence to the cycle life from different loading limitations seemed quite unique and worth exploring further to identify the extent of the effects from each load limiting case and other intrinsic properties of the cell components.

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