Zinc-Manganese Dioxide Battery Development and Commercialization at Urban Electric Power

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Development of Energy Dense 1st electron Zn-MnO₂ Batteries

- Figure 1 (a) Cycle life comparison of UEP baseline anode and improved anode cycling at 20% of anode active material utilizations (164 mAh/g-Zn).
- Figure 1 (b) Cycle life comparison of UEP baseline cathode and improved cathode cycling at 40% of cathode active material utilizations (123 mAh/g-MnO₂).
- Figure 1 (c) Cycle life comparison of UEP electrodes with different current collector materials.

1. Developed improved Zn anodes with 20% utilization >600 cycles
2. Developed improved MnO₂ cathode with 40% utilization with a cycle life > 250 cycles.
3. Cheaper current collectors like CRS and Ni plated CRS mesh have been developed to reduce the cost of the battery and showed good stability throughout cycling.
4. Electrodes manufactured on the manufacturing floor repeat lab-made electrodes.

Development of Non-Spillable Gelled Zn-MnO₂ Batteries

1. A non-spillable and low-maintenance Zn-MnO₂ battery that meets DOT requirements for safe transportability is developed by applying a poly(acrylate-KOH-H₂O) hydrogel electrolyte.
2. An in-situ polymerization method to incorporate the hydrogels in the cells is reported that enhances contact with the electrode and reduces corrosion.
3. The hydrogel reduces zincate migration, formation of stray Zn particles and manganese dissolution to increase the utilization of the electrode materials.
4. The hydrogel also enhances the safety by reducing dendrite formation that often leads to short circuits.

Development of Zinc-ion blocking Graphene Oxide Separators

1. We demonstrate for the first-time of graphene oxide/polyvinyl alcohol (GO/PVA) composite membrane as a zincate ([Zn(OH)]²⁺) blocking separator in alkaline Zn-MnO₂ batteries to prevent zinc poisoning for MnO₂ electrochemical redox reaction.
2. Near full utilization of the MnO₂ electrode’s 2-electron capacity (~617 mAh/g-MnO₂) is demonstrated in a primary cell.
3. An enhanced cycle life is reported in rechargeable Zn-MnO₂ cells accessing the 2nd electron capacity of MnO₂.

Development of High Voltage Zn-MnO₂ Batteries

- Figure 1 (a) Cycle life comparison of UEP electrodes with different current collector materials.
- Figure 1 (b) Cycle life comparison of UEP baseline anode and improved anode cycling at 20% of anode active material utilizations (164 mAh/g-Zn).
- Figure 1 (c) Cycle life comparison of UEP baseline cathode and improved cathode cycling at 40% of cathode active material utilizations (123 mAh/g-MnO₂).
- Figure 1 (c) Cycle life comparison of UEP electrodes with different current collector materials.