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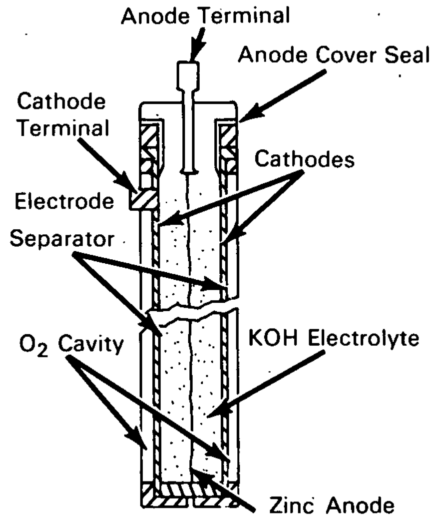
Zinc–Oxygen Primary Cell Yields High Energy Density



A zinc–oxygen primary cell has been developed to meet requirements for a reliable high-energy density battery for service as an auxiliary power source in space vehicle systems. The cell yields energy densities considerably in excess of conventional primary cells. For example, in a discharge time of 8 hours this cell yields an energy density of 120 watt-hours per pound of cell weight compared to 75 watt-hours per pound for a silver–zinc alkaline cell.

The zinc–oxygen cell (of square bi-cell construction to maximize zinc area per unit weight) incorporates two cathodes consisting of stable, efficient semi-permeable films. These film cathodes permit oxygen to pass through to the catalyst side to be reduced, yet retain the alkaline electrolyte (KOH) within the cell. The two cathodes, connected in parallel, are supported by a frame. The anode, made of porous zinc, is wrapped in separator material and inserted into the frame between the two cathodes. Intimate contact between the anode, separator, and cathode is achieved by proper cell support and stacking. The electrolyte, which provides a continuous ionic path, is used in an amount just sufficient to saturate the anode structure and separator material.

The oxidation–reduction reactions that occur in the cell during electrical power withdrawal may be represented as follows:

Anode: $Zn + 4OH^- \rightarrow ZnO_2^{2-} + 2H_2O + 2e^-$
Cathode: $1/2\ O_2 + H_2O + 2e^- \rightarrow 2OH^-$
Cell: $Zn + 1/2\ O_2 \rightarrow ZnO$

The zinc is oxidized at the anode, as electrons are released to the external circuit. These electrons pass through the external circuit to the cathode where they take part in the reduction of oxygen to hydroxyl ions. The net cell reaction results in oxidation of zinc and reduction of oxygen to form zinc oxide. Overall cell potential is 1.617 volts.

(continued overleaf)

Analytical studies were made to establish the optimum number of cells and stacking configurations in batteries required to yield the maximum energy density and overall system reliability. The results of these studies show that maximum energy densities occur when the batteries are designed to operate at current densities of 30 mA/cm^2. Maximum reliability and minimum battery weight would be achieved using a stacking configuration of 23 series-connected modules with 6 parallel-connected cells per module. A total of 138 series/parallel-connected cells will be required for a 28-volt, 400 A-hr battery system.

Note:

Inquiries concerning these cells may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B68-10218

Patent status:

No patent action is contemplated by NASA.

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