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Energizer Silver Oxide (Zn/Ag_2O)
Application Manual

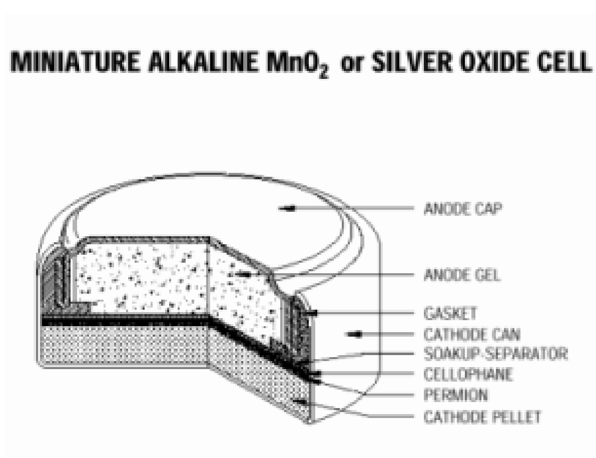
System Description:

The silver oxide/zinc alkaline primary battery is the predominate system of the miniature battery product line. It typically can be used in watches, calculators, photoelectric exposure devices, hearing aids, and electronic instruments. Its general characteristics include:

- Higher voltage than comparable mercury batteries
- Flatter discharge curve than alkaline manganese dioxide batteries
- Good low temperature characteristics
- Good resistance to shock, vibration, and acceleration
- Low and essentially constant internal resistance
- Excellent service maintenance; in excess of 90% after storage at 21°C(70°F) for five years
- Available in voltages ranging from 1.5 to 6.0 volts and a variety of sizes.

Battery Construction:

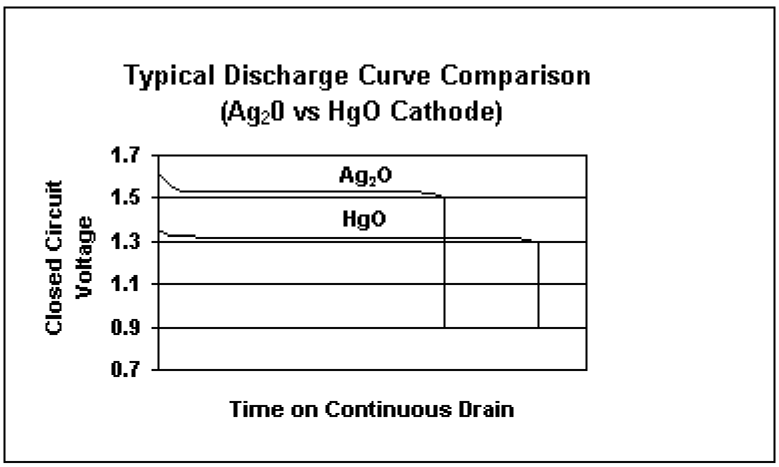
Silver oxide batteries are currently produced with flat circular cathodes and homogeneous gelled anodes. A cutaway of a silver oxide battery is illustrated in the following diagram:



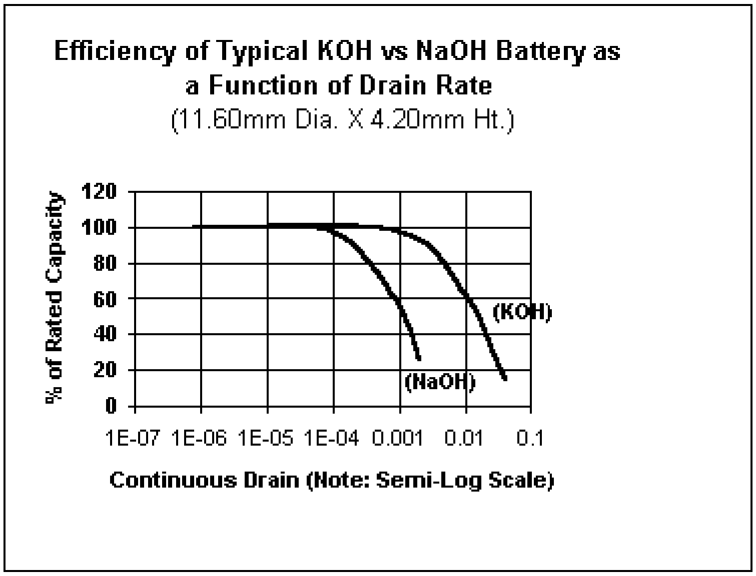
Cathodes are a mixture of Ag_2O and conductor.
Anodes are a gelled mixture of amalgamated zinc powder and electrolyte.
Separators of specially selected materials prevent migration of any solid particles in the battery.
Insulating and sealing gaskets are molded of nylon.
Exterior battery surfaces of nickel are used to resist corrosion and to insure good electrical contact.

Electro-Chemistry:

Silver oxide batteries contain a cathode of silver oxide with a low percentage of manganese dioxide and graphite, an anode of high surface area zinc, and a highly alkaline electrolyte consisting of either sodium hydroxide or potassium hydroxide. The open circuit voltage of silver oxide batteries is 1.6 volts. The operating voltage at typical current drains is 1.55 volts or more. Silver oxide batteries offer a higher flat operating voltage characteristic than mercuric oxide batteries as illustrated in the following diagram:



The type of electrolyte used with silver oxide batteries determines their rate or current carrying capability. Under heavy drains, potassium hydroxide (KOH) electrolyte offers less resistance to the current flow and allows the battery to operate at higher efficiency than a sodium hydroxide (NaOH) electrolyte. At low drains both electrolytes operate with equal efficiency. This relationship is shown in the following diagram:

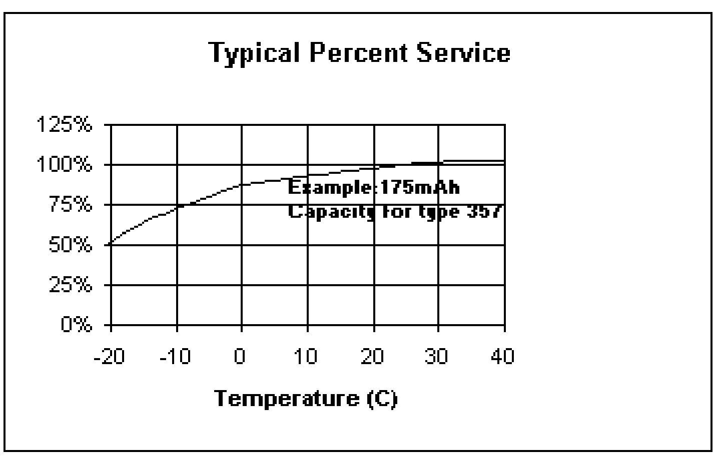


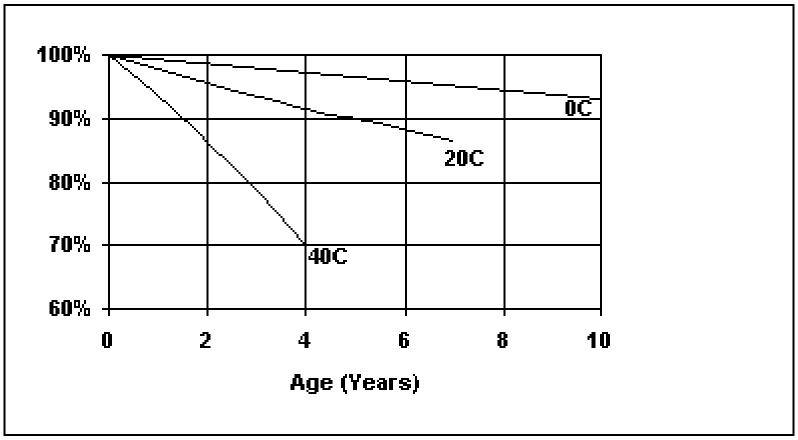
Silver oxide batteries containing a KOH electrolyte are more difficult to seal than those containing at NaOH electrolyte. As a result, NaOH batteries are typically more salt resistant than similar sized KOH batteries. Both batteries however, exhibit excellent long term salt resistance.

Temperature:

Silver oxide batteries have good performance characteristics at temperature extremes. They can be used up to 55°C(131°F). Silver oxide batteries utilizing KOH as an electrolyte will operate with less loss of efficiency at lower temperatures than comparable NaOH batteries. Batteries with KOH electrolyte will operate down to -28°C (-20°F) and NaOH batteries down to -10°C(14°F) with some service reduction in both types.

Typical temperature effects on miniature silver oxide batteries are shown in the following graphs:





Applications:

Eveready silver oxide batteries are specially designed to meet the varying power requirements of a wide variety of applications.

Watch and Calculator - Silver oxide watch batteries using a sodium hydroxide (NaOH) electrolyte system are primarily designed for low drain continuous use over long periods of time, typically up to five years. This is commonly found in analog watch applications.

Silver oxide watch batteries using a potassium hydroxide (KOH) electrolyte system are principally designed for continuous low drains with periodic high drain pulse demands for periods of approximately one to two years. This is typical of applications such as LCD watches with backlight, analog watches with alarms and calculators.

Hearing Aid and Electronic - Silver oxide hearing aid and electronic batteries are designed to produce greater volumetric energy density at higher continuous discharge rates than silver oxide watch or photographic batteries. Hearing aid and electronic batteries use potassium hydroxide electrolyte in combination with the separator system designed to match the required application.

Photographic - Silver oxide photo batteries are designed to provide constant voltage or periodic high drain pulses with or without a low drain background current.

Internal Resistance:

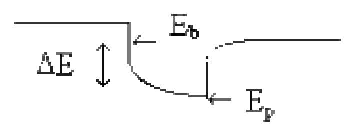
The internal resistance (R_j) of a battery is its opposition to the flow of current. In all cases, this resistance increases as the temperature of a battery decreases.

The internal resistance is typically measured as a reduction in closed circuit voltage when the applied load is increased. (voltage drop)

The R_j values obtained are subject to a number of variables and operator techniques. The effective R_j values shown on the individual data pages were calculated using the voltage drop method which projects the batteries' current carrying capability in actual device applications. This calculations involves placing a battery on a constant background load, allowing it to stabilize and then pulsing it with a heavier load for one second. The resulting voltage drop is then measured and expressed in terms of ohms as shown in the following example:

R_j = Internal Resistance

R_b = Resistance of Background Load
E_b = Background Voltage
R_p = Resistance of Pulse Load
E_p = Voltage at End of Pulse
DE = Voltage Change
D I = Current Change
I_b = Background Current
I_p = Current at End of Pulse



$$I_b = \frac{E_b}{R_b}$$

$$I_p = \frac{E_p}{R_p}$$

$$R_j = \frac{\Delta E}{\Delta I} = \frac{E_b - E_p}{I_p - I_b}$$

This reference manual contains general information on all Energizer/Eveready batteries within the Silver Oxide chemical system in production at the time of preparation of the manual. Since the characteristics of individual batteries are sometimes modified, persons and businesses that are considering the use of a particular battery should contact the nearest Energizer Sales Office for current information. None of the information in the manual constitutes a representation or warranty by Eveready Battery Company, Inc. concerning the specific performance or characteristics of any of the batteries or devices.