Contents

Introduction

The miniature manganese dioxide primary battery is designed to provide an economical power source for device applications that do not require the flat voltage discharge curve characteristic of silver oxide batteries. Device applications in which miniature manganese dioxide batteries can be used as substitutes include: calculators, some watches and a variety of small toys. The substitution of miniature manganese dioxide batteries for silver oxide batteries should only be made where recommended by the device manufacturer. General characteristics of the miniature manganese dioxide systems are:

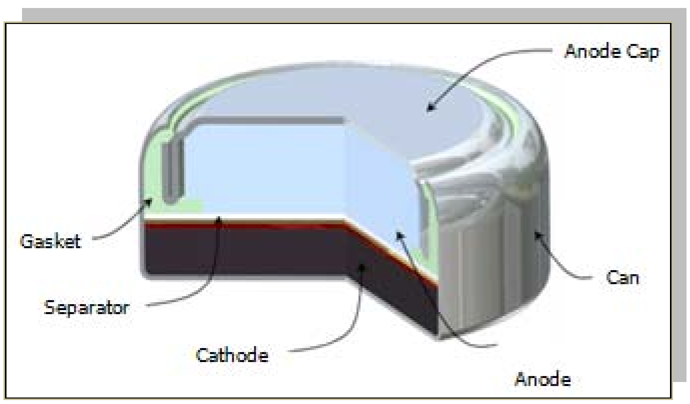
- Good low temperature characteristics
- Good resistance to shock, vibration, and acceleration
- Excellent service maintenance
- Sloping discharge curve

A76
Alkaline Miniature Battery

Battery Description

Construction:

Miniature manganese dioxide batteries are produced with flat circular cathodes and homogeneous gelled anodes. A cutaway of miniature manganese dioxide battery (fig. 1) is illustrated in the following diagram.



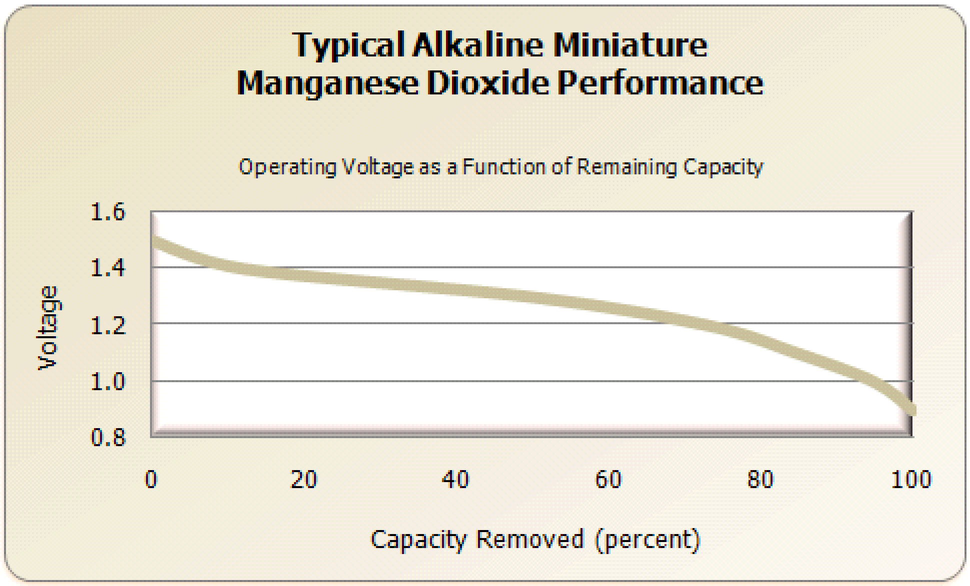
(fig. 1) Typical Alkaline Miniature Battery

Cathode: mixture of MnO_2 and conductor.
Anode: gelled mixture of amalgamated zinc powder and electrolyte.
Separator: specially selected materials prevent migration of any solid particles in the battery.
Exterior battery surfaces: nickel is used to resist corrosion and to insure good electrical contact.

Electrochemistry:
Miniature manganese dioxide batteries consist of a manganese dioxide cathode, a zinc anode of high surface area, and a highly alkaline electrolyte consisting of potassium hydroxide. The open circuit voltage of miniature manganese dioxide batteries is approximately 1.6 volts. The operating voltage at typical current drains varies with the depth of discharge of the battery as shown in the following graph. (fig. 2)

©2008 Energizer – Contents herein does not constitute a warranty of service, features or performance

Contents

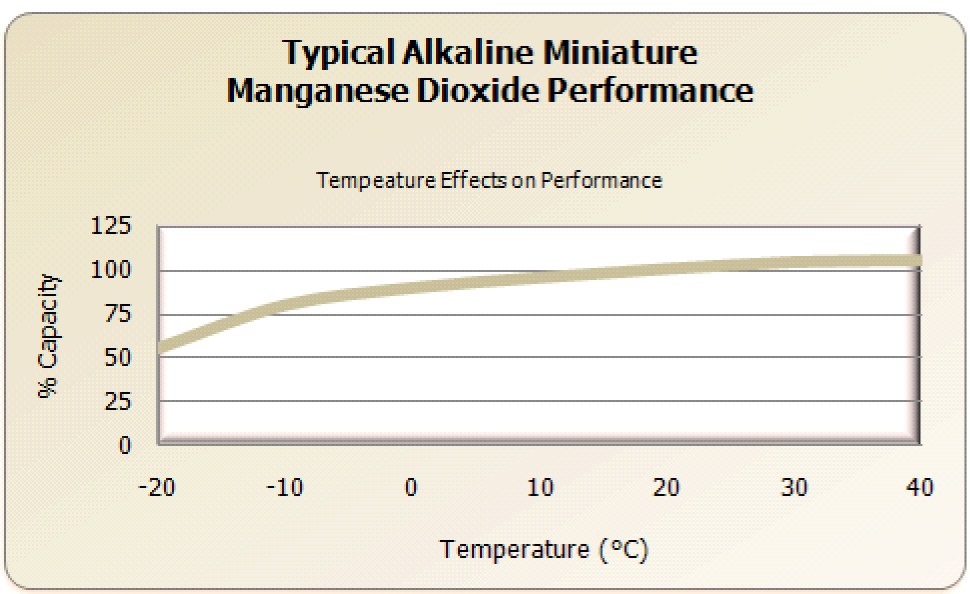


(fig. 2) Operating Voltage as a Function of Remaining Capacity

Miniature manganese dioxide batteries typically exhibit an expansion of the cathode on discharge which results in an overall increase in the battery's height. This increase in height is referred to as bulge. While miniature manganese dioxide batteries are designed to minimize bulging, they will typically bulge to a height greater than comparable silver oxide batteries during discharge.

Temperature Effects on Performance:

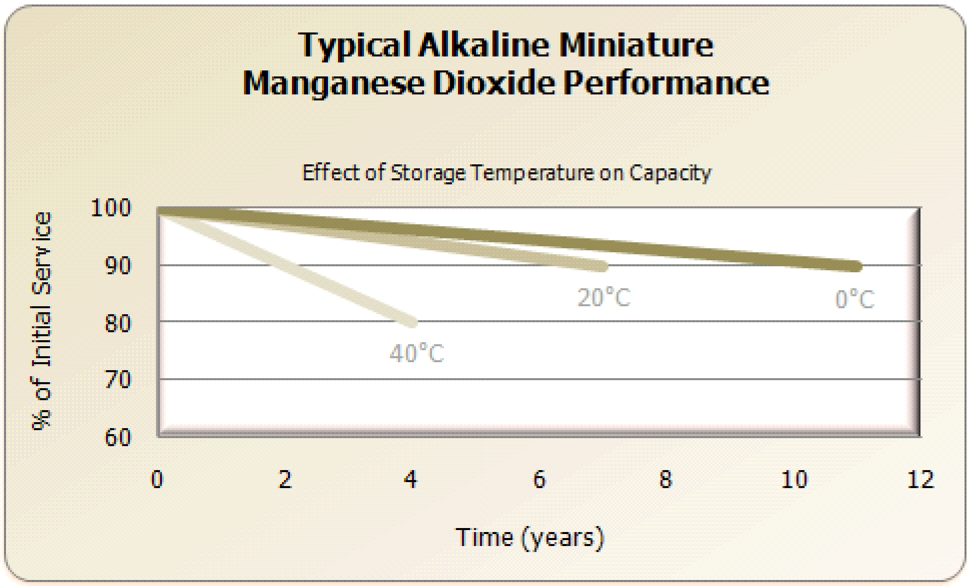
Typical temperature effects on miniature dioxide batteries are shown in the following graphs.



(fig. 3) Temperature Effects on Performance

©2008 Energizer – Contents herein does not constitute a warranty of service, features or performance

Contents



(fig. 4) Effect of Storage Temperature on Capacity

Applications:

Manufacturers who plan to recommend the use of miniature manganese dioxide batteries in their devices must accommodate their unique discharge curve shape in the design of their equipment.

Internal Resistance:

The internal resistance (Ri) of a battery is defined as the opposition to the flow of current within the battery. There are two basic components that impact the internal resistance of a battery; electronic resistance and ionic resistance. The electronic resistance plus the ionic resistance will be referred to as the total effective resistance.

The electronic resistance encompasses the resistivity of the actual materials such as metal covers and internal components; as well as, how well these materials make contact with each other. The effect of this portion of the total effective resistance occurs very quickly and can be seen within the first few milliseconds after a battery is place under load.

Ionic resistance is the resistance to current flow within the battery due to various electrochemical factors such as, electrolyte conductivity, ion mobility and electrode surface area. These polarization effects occur more slowly than electronic resistance with the contribution to total effective resistance typically starting a few milliseconds or more after a battery is placed under load.

The impact of electronic and ionic resistance can be observed using a dual pulse test. This test involves placing a battery on a low background drain allowing it to first stabilize and then pulsing it with a heavier load for approximately 100 milliseconds.

Using "Ohms Law" (Volts = Current x Resistance), the total effective resistance is subsequently calculated by dividing the change in voltage by the change in current.

©2008 Energizer – Contents herein does not constitute a warranty of service, features or performance

Contents

Disposal and Shipping:

Disposal:
Energizer® standard alkaline batteries are United States Resource Conservation and Recovery Act (RCRA) non-hazardous waste.

Waste standard alkaline batteries meet the United States Federal definition of a solid waste per 40 Code of Federal Regulations (CFR) 261.2. As such, the generator must make certain determinations relative to the waste material. Waste standard alkaline batteries do not fall under any of the specific United States Federal RCRA F, K, P or U lists.

This leads us to the RCRA characteristic waste criteria. Some Toxicity Characteristic Leaching Procedure (TCLP) listed materials may be present in minute quantities in the raw materials, but are well below the established regulatory maximum values. Waste carbon zinc and standard alkaline batteries are not RCRA toxic. Only the characteristics of ignitability, corrosivity and reactivity remain as possible classifications.

The batteries are solid, not liquid, which precludes their being a corrosive waste, since corrosive waste must be liquid by definition. As an inert solid, flash point is not an appropriate test for ignitability. *Energizer*® batteries are a safe consumer product and, under standard temperature and pressure conditions, will not cause fire through friction, absorption of moisture, or spontaneous chemical changes. The batteries contain no sulfides or cyanides, and they do not meet any other reactivity criteria.

United States Federal hazardous waste regulations are specific about relating waste determination to the waste as generated. As generated, scrap standard alkaline batteries are not a specifically listed waste stream and they do not meet the criteria for ignitable, corrosive, reactive or toxic wastes. Scrap standard alkaline batteries are not hazardous waste and they are not regulated by the United States Department of Transportation (DOT) as hazardous materials.

Other nations and some US states may regulate waste based on additional criteria or different test protocols. The status of scrap standard alkaline batteries should be confirmed in the nation or US state(s) where disposal occurs.

Shipping:
The transportation of *Energizer*® alkaline dry cell batteries produced and/or imported by *Energizer*® Battery Manufacturing, Inc. are not regulated as Dangerous Goods by the U.S. Department of Transportation (DOT), the International Air Transport Association (IATA), the International Maritime Dangerous Goods code (IMDG), or the International Civil Aviation Organization (ICAO).

The batteries and their packaging must be protected at all times from direct sun and any sources of moisture, such as rain or wet flooring. Shock and vibration shall be avoided by ensuring that boxes are placed and stacked gently, and properly secured from movement during transport. To lessen the exposure of the batteries to heat, metal shipping containers should be ventilated and kept away from heat sources such as ship's engines or direct sunlight. Stowage on ships must be below deck, while during other transport (road, rail, etc) and on/off loading, exposure to direct sunlight should be kept to a minimum.

Warnings:

Charging of Primary Batteries:
Charging of primary batteries may cause explosion or leakage which may result in bodily injury. IF ENERGIZER/EVEREADY PRIMARY BATTERIES ARE SUBJECTED TO ANY FORM OF RECHARGING, ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE NULL AND VOID.

Design and Safety Considerations
Click here for the Design and Safety Considerations Interactive on-line Catalog
There are many other conditions to avoid for the proper safe use of batteries. It is imperative to read the Design and Safety Overview document to assure that other safety considerations are not overlooked.

©2008 Energizer – Contents herein does not constitute a warranty of service, features or performance