

Memory Accumulation

In recent years, you often hear people say things like "Nickel Cadmium Batteries and Nickel-Metal Hydride Batteries are hard to use because they get memory accumulation" or "when a battery starts to accumulate memory, it's time to replace it." The term "memory accumulation" arose when nickel cadmium batteries started to be used in Camcorders (portable video recorders) 10 years ago, and since then, the term has become something with which most people are familiar. However, since many users don't seem to understand what it really is, we will try to explain it.

1. What is memory accumulation?

- Memory accumulation is the name given to the phenomenon when a battery remembers how much it is discharged, resulting in a temporarily voltage drop. The secondary batteries that are said to be vulnerable to memory accumulation are Nickel Cadmium Batteries and Nickel-Metal Hydride Batteries.

2. What causes memory accumulation?

- It's caused by repeatedly using a battery without running the power supply down completely.

3. Why is it a problem?

- Memory accumulation is often caused by the way the equipment using the batteries is designed. If a battery accumulates memory, the battery's operating time can become extremely short. When batteries are used with equipment that is designed for nickel cadmium/Nickel-Metal Hydride Batteries, or with equipment not affected by voltage drops, memory accumulation is not a problem.

4. Does memory accumulation mean a battery's life is over?

- No. You can still use it.
- A voltage drop due to memory accumulation is just like a voltage drop due to the changes in the ambient temperature or discharge current -- it's only temporary.

5. Memory accumulation has very little effect on equipment using nickel cadmium/Nickel-Metal Hydride Batteries.

- Since most of our battery Applied Products are designed to be resistant to battery voltage drops, you never need to worry about memory accumulation. If equipment is at all affected by memory accumulation, Sanyo offers a special battery charger function called "refresh" that eliminates the problem.

Note: "Memory Accumulation" is not an academically defined term. In this section, we explain the condition using the generally accepted term "memory accumulation."

Memory Accumulation

1. Symptoms

If a nickel cadmium battery is recharged (or discharged) from a point when its charge is only partially used, the voltage level at that point will become slightly lower.

If a battery's charge is repeatedly used (discharged) down to the same point (only partially used with power still remaining), the voltage in that area will remain at a low level.

When a battery remembers the point that it stopped discharging, it's called "memory accumulation." This effect lasts only for a short time, and the battery will recover after being completely discharged.

Nickel Cadmium Batteries are not always discharged completely, so memory accumulation sometimes occurs without users really realizing it's happening.

2. Cause

Although scientists have various hypotheses, the cause of memory accumulation has yet to be identified. The following are some possible causes:

- * Formation of a higher order nickel active material such as β -NiOOH.
- * Accumulation of undischARGEABLE active materials during cycling.
- * Formation of an alloy of the cadmium (Cd) and nickel (Ni) used in the electrode (Ni₅Cd₂₁).

Problems

When the minimum operating voltage of equipment powered by a Nickel Cadmium Battery is set at a high level, memory accumulation will occur even if the equipment is operated right until it stops. As a result, voltage drops more quickly and operating time becomes shorter.

The degree of a battery's voltage drop depends on the discharge current, minimum operating voltage, battery type, and ambient temperature.

Battery operation time drops to a certain level and stabilizes at that level.

4. Conditions

Although the conditions in which memory accumulation occurs depend on discharge current and ambient temperature, consider 1.1V or larger/cell for 1C discharging and 1.15V or larger/cell for 2C discharging as a guideline for when to stop discharging. Also, be sure to prevent poor wiring and battery contact as it leads to battery voltage drops as well.

The minimum operating voltage of equipment should be less than the guideline given above.

We recommend approximately 1.0V/cell. When equipment using less than 1.0V/cell is employed, battery operation time is not affected even if memory accumulation occurs.

The following are examples of shortened operation times caused by memory accumulation.

1. Number of cell in battery pack is reduced up to minimum number that the machine can drive, because of making light, compact, low cost.
2. For word processors, a certain amount of capacity is reserved so that there is enough power to save data before shutting down.
3. For equipment with a residual capacity alarm (a battery voltage indicator), if the battery is replaced right after an alarm, the time between alarms becomes shorter. (Whether the actual operating time is shortened or not depends on the equipment's minimum operating voltage.)

5. Equipment that requires caution

[Equipment that requires caution]

* Equipment having a high-level minimum operating voltage. (See Section 4.)

Through the use of integrated circuits, this equipment shuts down when the operating voltage decreases to a certain level.

* Equipment with a residual capacity alarm dependent on battery voltage (excluding those using discharge capacity addition systems.)

e.g. Camcorders, personal computers, word processors, cellular phones, etc.

[Equipment that does not require caution]

* Equipment whose minimum operating voltage is not set at a high level.

* Equipment without a residual capacity alarm dependent on battery voltage.

e.g. Power tools, electric toys, lighting equipment, etc.

6. Corrective measures regarding equipment

1. Design equipment so that it can operate to a voltage level (approximately 1.0V/cell) at which it is not affected even if memory accumulation occurs.
2. If the measure in section 6-1 is impossible, attach a refresh device* to the battery charger.

(* a device that separately discharges power not sufficiently discharged during equipment operation). * It depends on the equipment's minimum operating voltage and load current, but if the equipment's load current on standby decreases greater than when in operation, keep the equipment on standby until it shuts down to eliminate battery's residual capacity.

* The above action should be taken only when you are sure the battery operating time has become shorter.

The electric discharge cut voltage and memory effect

