Nickel Metal Hydride Batteries

A **nickel–metal hydride battery**, abbreviated **NiMH** or **Ni-MH**, is a type of rechargeable battery. It is very similar to the nickel–cadmium cell (Ni-Cd). Ni-MH use positive electrodes of nickel oxyhydroxide (NiOOH), like the Ni-Cd, but the negative electrodes use a hydrogen-absorbing alloy instead of cadmium. A Ni-MH battery can have two to three times the capacity of an equivalent size Ni-Cd, and their energy density approaches that of a lithium-ion cell. Because Ni-MH batteries have about twice the energy density of Ni-Cd batteries and a similar operating voltage as that of Ni-Cd batteries, they have become a mainstay in rechargeable batteries.

Ni-MH batteries have replaced Ni-Cd for many roles, notably small rechargeable batteries. Ni-MH batteries are very common for AA batteries, which have nominal charge capacities ranging from 1100 mAh to 2800 mAh at 1.2 V, measured at the rate that discharges the cell in five hours. Ni-MH batteries normally operate at 1.2 V per cell, somewhat lower than conventional 1.5 V cells, but will operate most devices designed for that voltage. Same with a Ni-Cd battery, there voltage is the same. Most applications are designed to recognize this.

The first consumer grade NiMH cells for smaller applications appeared on the market in 1989, the culmination of over two decades of research and development.

Some advantages to Ni-MH batteries are:

- Ni-MH cells and chargers are readily available in most sizes. Common sizes being the AAA's and AA's.
- Can be charged on a charger that does both Ni-Cd and Ni-MH. Have very similar charging rates. Most chargers now a day are designed to recognize the various chemistries of each battery.
- Ni-MH cells are not expensive, and the voltage and performance is similar to primary alkaline cells in those sizes; they can be substituted for most purposes. Although alkaline cells are rated at 1.5 volts and Ni-MH cells at 1.2 volts, during discharge the alkaline voltage eventually drops below that of Ni-MH. This is particularly true for high drain applications, where the voltage of even a fresh alkaline battery can be lower than a Ni-MH battery while under a load. Furthermore, Ni-MH batteries offer a flatter discharge curve, particularly at higher current draw
- NiMH cells are often used in digital cameras and other high drain devices, where over the duration of single charge use they outperform primary (such as alkaline) batteries. Applications that require frequent replacement of the battery, such as toys or video game controllers, also benefit from use of rechargeable batteries. With the development of low

self-discharge Ni-MHs many occasional-use and very low-power applications are now candidates for Ni-MH cells

However there are some disadvantages to Ni-MH batteries:

- Certain devices that were designed to operate using primary alkaline chemistry (or zinc–carbon/chloride) cells will not function when one uses Ni-MH cells as substitutes. However, this is rare, as most devices compensate for the voltage drop of an alkaline as it discharges down to about 1 volt. Low internal resistance allows Ni-MH cells to deliver a near-constant voltage until they are almost completely discharged. This will cause a battery level indicator to overstate the remaining charge if it was designed to read only the voltage curve of alkaline cells. The voltage of alkaline cells decreases steadily during most of the discharge cycle.
- Unlike a Ni-Cd battery which is known for the “memory effect” these batteries can develop a slight memory if not properly discharged and charged.
- Ni-MH batteries fail in two predominant modes that are somewhat interrelated. The metal hydride material used for the negative electrode undergoes gradual corrosion in a strong alkaline environment. This corrosion results in less negative active material for hydrogen storage and also consumes water from the electrolyte.

Inside a Ni-MH Battery Pack or Cell

Nickel-metal hydride batteries consist of a positive plate containing nickel hydroxide as its principal active material, a negative plate mainly composed of hydrogen absorbing alloys, a separator made of fine fibers, an alkaline electrolyte, a metal case and a sealing plate provided with a self-resealing safety vent. Their basic structure is identical to that of Ni-Cd batteries. With cylindrical nickel-metal hydride batteries, the positive and negative plates are separated by the separator, wound into a coil, inserted into the case, and sealed by the sealing plate through an electrically insulated gasket. With prismatic nickel-metal hydride batteries, the positive and negative plates are sandwiched together in layers with separators between them, inserted into the case, and sealed by the sealing plate.

The negative electrode reaction occurring in a NiMH cell is:

$$H_2O + M + e^- \rightleftharpoons OH^- + MH$$

The charge reaction is read left-to-right and the discharge reaction is read right-to-left.

On the positive electrode, nickel oxyhydroxide, NiO(OH), is formed:

$$Ni(OH)_2 + OH^- \rightleftharpoons NiO(OH) + H_2O + e^-$$

Nickel-Metal Hydride Cells

Being as Ni-MH and Ni-Cd set ups are similar, the only that changes is the fact it uses nickel hydroxide and not a cadmium base. Cell set up is pretty much the same.