

Battery Types: Which Batteries to Use?

Unfortunately there is no single battery technology available on the market today that can be considered as “The Solution” for all classes of portable battery operated devices.

There are a variety of batteries in use, each with its own advantages and disadvantages. There are two main categories of batteries: **(1) Primary Batteries**, sometimes also called single-use, or “throw-away” batteries because they have to be discarded after they run empty as they cannot be recharged for reuse; and

(2) Secondary Batteries, mostly called **rechargeable batteries** because they can be recharged for reuse.

Below is a short summary of each variety:

(1) Primary Batteries:

- **Carbon Zinc (aka. ‘Heavy Duty’)** -- The lowest cost primary cell (household) is the zinc-acidic manganese dioxide battery. They provide only very low power, but have a good shelf life and are well suited for clocks and remote controls.
- **Alkaline** -- The most commonly used primary cell (household) is the zinc-alkaline manganese dioxide battery. They provide more power-per-use than Carbon-zinc and secondary batteries and have an excellent shelf life.
- **Lithium Cells** -- Lithium batteries offer performance advantages well beyond the capabilities of conventional aqueous electrolyte battery systems. Their shelf-life can be well above 10-years and they will work at very low temperatures. Lithium batteries are mainly used in small formats (coins cells up to about AA size) because bigger sizes of lithium batteries are a safety concern in consumer applications. Bigger (i.e. ‘D’) sizes are only used in military applications.
- **Silver Oxide Cells** – These batteries have a very high energy density, but are very expensive due to the high cost of silver. Therefore, silver oxide cells are mainly used in button cell format for watches and calculators.
- **Zinc Air Cells** – These batteries have become the standard for hearing aid batteries. They have a very long run time, because they store only the anode material inside the cell and use the oxygen from the ambient air as cathode.

(2) Rechargeable Batteries:

- **Rechargeable Alkaline** -- Secondary alkaline batteries, the lowest cost rechargeable cells, have a long shelf life and are useful for moderate-power applications. Their cycle life is less than most other secondary batteries, but they are a great consumer’s choice as they combine the benefits of the popular alkaline cells with the added benefit of re-use after recharging. They have no toxic ingredients and can be disposed in regular landfills (local regulations permitting).
- **Nickel-Cadmium** -- Secondary Ni-Cd batteries are rugged and reliable. They exhibit a high-power capability, a wide operating temperature range, and a long cycle life, but have a low run time per charge. They have a self-discharge rate of approximately 30% per month. They contain about 15% toxic, carcinogenic cadmium and have to be recycled.
- **Nickel-Metal Hydride** -- Secondary NiMH batteries are an extension of the old fashioned NiCd batteries. NiMH batteries provide the same voltage as NiCd batteries, but offer at least 30% more capacity. They exhibit good high current capability, and have a long cycle life. The self-discharge rate is higher than NiCd at approximately 40% per month. NiMH cells contain no toxic cadmium, but they still contain a large amount of nickel oxides and also some cobalt, which are known human carcinogens and should be recycled.

- **Lithium Ion** -- Secondary Li-Ion batteries are the latest breakthrough in rechargeable batteries. They are at least 30% lighter in weight than NiMH batteries and provide at least 30% more capacity. They exhibit good high current capability, and have a long cycle life. The self-discharge rate is better than NiMH at approximately 20% per month. Overheating will damage the batteries and could cause a fire. Li-Ion cells contain no toxic cadmium, but they still contain either cobalt oxides or nickel oxides, which are known human carcinogens and should be recycled.
- **Lead-Acid** -- Secondary lead-acid batteries are the most popular rechargeable batteries worldwide. Both the battery product and the manufacturing process are proven, economical, and reliable. However, because they are heavy, Lead-Acid batteries are not being used in portable, consumer applications. Lead is a toxic, carcinogenic compound and should not enter the regular waste stream. Recycling of Lead-Acid batteries is the environmental success story of our time, approx. 93% of all battery lead is being recycled today in reused in the production of new Lead-Acid batteries.

Primary Alkaline Batteries are long lasting, single-use batteries. They will give good performance in all battery devices. Most standard alkaline batteries give you similar performance, regardless of brand.

Rechargeable Alkaline Batteries use a revolutionary type of battery technology that provides the long life of alkaline cells, but can be reused 25 times or more. Rechargeable batteries are ideal for many of your frequently used electronic devices. And because Rechargeable Alkaline Batteries give longer life per charge, hold their power in storage and are precharged when you buy them, they work far better than the old fashioned NiCd rechargeable batteries. Using rechargeable alkaline batteries instead of single-use, primary batteries will result in cost savings that can add up to hundreds of dollars.

Nickel Metal Hydride (NiMH) batteries meet the demanding power needs for today's high-tech devices, such as digital cameras, handheld TVs, two-way radios, and personal organizers. NiMH batteries can last three times longer than any alkaline in digital cameras. NiMH can be charged many hundred times resulting in cost savings that can add up to hundreds of dollars.

Heavy Duty batteries can be used in non-motor driven devices with low drain, such as radios, remote controls, smoke alarms and clocks. In devices like these, Heavy Duty batteries will give good performance at a minimal initial cost. However, over the lifetime of the application a rechargeable alkaline cell would provide a much better value and actually save you some money.

Most batteries can be stored for long periods of time. Heavy Duty batteries will retain more than 80 % of their power, even when stored at normal household temperatures for up to four years. Single use alkaline and rechargeable alkaline batteries can be stored for up to seven years retaining 80% of its power. NiMH batteries on the other hand have a fairly rapid self discharge losing about 40% of their rated capacity per month; hence, one pretty much has to recharge a NiMH battery before each use after prolonged periods of storage.

So What Batteries Work Best in Different Devices Today?

HEAVY DUTY BATTERIES are still very popular and have been around for many years because they are so cheap to purchase. Heavy Duty batteries work best in low drain devices such as AM/FM radios, flashlights, smoke alarms and remote controls. Over the lifetime of the device, rechargeable alkaline batteries will provide the better value and result actual in cost savings although the initial cost is higher.

ALKALINE BATTERIES, are the most popular battery used today. Alkaline will last 5 to 10 times longer than heavy duty batteries on higher current drains, making them more economical. They get their long life from unique construction and the purity of the materials used. Alkaline batteries are best suited for moderate to high drain devices such as portable CD players, electronic games, motorized toys, tape recorders and cassette players. Again, over the lifetime of the device, rechargeable alkaline batteries will provide the better value and result actual in cost savings although the initial cost is slightly higher.

RECHARGEABLE ALKALINE BATTERIES are specially designed for use 25 times or more when charged properly in a dedicated charger for rechargeable alkaline batteries. Rechargeable alkaline batteries come fully charged, have no memory problems, up to a seven-year shelf life and will last up to three times longer than a fully charged nickel cadmium rechargeable battery. They do not require to be fully drained before recharge and will actually last longer if frequently recharged. They will work in all applications where Heavy Duty Primary Batteries are being used and in all applications for Alkaline Primary Batteries with not too high drain rates.

RECHARGEABLE NiMH BATTERIES are an extension of the old fashioned NiCd batteries. These batteries offer capacities at least 30% higher per charge than NiCd batteries of the same size. NiMH batteries can be recharged without having to be fully drained and can be charged several hundred times. NiMH work best in high drain devices that chew through alkaline batteries quickly such as digital cameras, hand held TV's and remote controlled racing toy cars.

RECHARGEABLE Li-Ion BATTERIES are mainly used in Laptop computers and cellphones. They have a 3 times higher voltage on a per cell basis than NiMH batteries and are usually only sold as a 'system' (device w/ built-in charger), as they require a special type of charger. More recently, single Li-Ion cells with dedicated chargers are being offered for cameras that take Lithium cells.

RECHARGEABLE NiCd BATTERIES, should not be used due to the toxic cadmium, but are still in high demand for power tools due to their rugged design and performance. However, NiCd batteries have to be recycled to prevent toxic, carcinogenic cadmium entering the waste stream.

PRIMARY LITHIUM BATTERIES offer an outstanding shelf-life of above 10-years and they will work at very low temperatures. They are mainly used in imaging applications, i.e cameras.

What are the various types of batteries used for?

Battery types	Voltage (V)	Common usages
Primary		
Alkaline	1.5	CD/MD/MP3 players, toys, electronic games, cameras, flash lights, remote controls
Carbon zinc	1.5	Clocks, radios, smoke alarm
Lithium coin	3.0	Calculators, electronic organizers
Lithium photo	3.0 / 6.0	Cameras
Silver oxide (button cells)	1.55	Watches
Zinc air	1.4	Hearing aids
Rechargeable		
Rechargeable Alkaline	1.5	CD/MD/MP3 players, toys, electronic games, cameras, flash lights, remote controls, solar lighting
NiMH	1.2	Digital cameras, remote controlled racing toy cars
NiCd	1.2	Power Tools
Li-ion	3.6-3.7	Notebook computers, PDAs, mobile phones, camcorders, digital cameras
Lead Acid	12V	Car starter battery, lift trucks, golf carts, marine, standby power, UPS, solar lighting

How to strike a good balance between performance and cost when selecting batteries?

To be a smart consumer, you have to understand the power consumption requirement of your electronic device before deciding on which battery to go for.

Generally speaking, high power consumption electronic devices operate under high current condition and require a battery that can deliver runtime at this high current drain rates. Primary alkaline batteries have been redesigned to provide more performance at higher drain rates, but can still not match the performance of NiMH rechargeable batteries, which will provide up to three times longer run time in digital cameras. In addition, they can be recharged a few hundred times. Hence the cost per unit energy is much lower than alkaline batteries.

In case of moderate to low current consumption devices, rechargeable alkaline batteries are the best, economical choice. They provide plenty of run time, keep their charge when not in use, and can be recharged for reuse many times over. They can be purchased at a lower cost than NiMH rechargeable batteries and at a slightly higher cost than single-use alkaline batteries. Over the lifetime of the batteries,

rechargeable alkaline provide a much lower cost per unit energy than single-use alkaline or Heavy Duty batteries.

When cost per runtime is being considered, nobody should buy primary batteries unless no other option exists for the particular device that requires portable power.

Are Primary and Rechargeable Batteries interchangeable amongst each other?

Not all battery types are interchangeable. However, in the consumer, household small format battery category, the following types of the same format can in most cases be interchanged: Heavy Duty, Alkaline, Rechargeable Alkaline and NiMH batteries. Although primary and rechargeable alkaline batteries are rated at a nominal voltage of 1.5 volts, as they begin discharging, their voltage continuously drops. Over the course of discharge, the average voltage of alkaline batteries is in fact about 1.2 volts, very close to NiMH batteries. The main difference is that alkaline batteries start at 1.5 volts and gradually drop to less than 1.0 volt, while NiMH batteries stay at about 1.2 volts for most of the service time.

However, NiMH batteries make only practical sense in very high drain devices such as digital cameras as their self discharge rate is too high for applications that require power of long periods of time. For those slow discharges, a battery type with a very low self discharge rate is required. Rechargeable Alkaline will fit the bill there.

Remember, what ever battery type you use, NEVER mix battery types for use at the same time and never mix old and new batteries. Keep batteries in sets for best performance.

What are the advantages of using Rechargeable Batteries?

Performance – Since rechargeable batteries can be recharged many times over, the cumulative total service life exceeds that of primary batteries by a wide margin.

Savings – Recharging rechargeable batteries many hundred times is giving the consumer tremendous savings in the long run.

Environmentally friendly – Since the cumulative service is so much longer than primary batteries, only a fraction of the solid waste is generated and a solid waste reduction of 90% and more is possible. If the battery contains no toxins, such as rechargeable alkalines, they can be even disposed of in regular landfills. Other rechargeables, which do contain toxins such as NiMH should be recycled. Most stores nowadays do take old rechargeables back.

How should batteries be stored?

Remember, batteries are like any other chemical system. Heat will accelerate the chemical reaction and shorten cell life. Therefore, the greatest threat to a battery's useful life and shelf life is heat. So, avoid storing batteries or battery-operated devices in extremely warm places; store them in a cool, dry place.