

Choosing the Right Rechargeable Battery

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There are many things to consider when choosing the right rechargeable battery for your design—the battery technology mated to the discharge rate of your device, for the length of time required, battery size and weight, interchangeability, temperature extremes, recharge rates, and appropriate battery disposal for each country marketed—all have to be considered early in the design cycle. Different recharging management techniques, specific to the

chemistry of each battery type, must be selected so the batteries are not overheated during charging. Balancing cells in a pack ensure longer battery life. Appropriate testing of different vendors’ “battery recipes” is a good idea to ensure the best battery selection. See the **Battery Technology Comparison** chart below, to compare operating temperatures, environmental concerns, and relative performance comparisons that help address these characteristics.

Battery Technology Comparison								
Battery Type	Ni-Cd	Ni-MH	Lead Acid Sealed	Li-ion	Li-ion cobalt	Li-ion manganese	Li-ion phosphate	Li-polymer
Nominal Cell Voltage (V)	1.25	1.25	2	3.6 to 3.7	3.6 to 3.7	3.6 nominal, 3.8 average	3.3	3.7
Charge Discharge Efficiency (%)	70-90	66	85-95	99.9				99.8
Cycle Life to 80% Initial Capacity	~1,500	300-500	200-300	300-500	300-500	Better than 300-500	<1,000 lab conditions	
Number of Charge Cycles	2,000	500-1,000	1,000	~1,200	1,000	1,000	1,000	>1,000
Self Discharge Rate (percent per month)	10-20	30	5	5-10	<10	<10	<10	5
Fast Charge Time (hours)	~1	2-4	8-16		1.5-3	1 or less	1 or less	
Overcharge Tolerance	Moderate	Low	High	Low, can not tolerate trickle charge	Low, can not tolerate trickle charge	Low, can not tolerate trickle charge	Low, can not tolerate trickle charge	Low, can not tolerate trickle charge
Operating Temperature (°C)	-40 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-30 to +85
Maintenance Required (frequency)	30-60 days	60-90 days	3-6 months	24-36 months	Not stated	Not stated	Not stated	24-36 months
Safety	Thermally stable, fuse recommended	Thermally stable, fuse recommended	Thermally stable	Protection circuit mandatory; stable to 150°C	Protection circuit mandatory; stable to 150°C	Protection circuit recommended; stable to 250°C	Protection circuit recommended; stable to 250°C	Protection circuit recommended; stable to 250°C (not confirmed)
Toxicity	Highly toxic, harmful to environment	Relatively low toxicity, should be recycled	Toxic leads and acids harmful to environment	Low toxicity, can be disposed of in low quantities	Low toxicity, can be disposed of in low quantities	Low toxicity, can be disposed of in low quantities	Low toxicity, can be disposed of in low quantities	
Advantages/Disadvantages	Cadmium is extremely toxic. This type of battery exhibits discharge/charge “memory effect” and premature failures due to non-use.	Advantageous for high current drain applications. Ni-MH cells deliver near-constant voltage until almost completely discharged. Voltage-sensitive devices won’t perform well due to lower voltage of Ni-MH batteries.		Li-ion batteries have higher energy density than nickel-metal hydride. Drawback of Li-ion battery is life span and time required to get a fully charged battery is also reduced in proportion to the capacity. Older batteries will not last as long as a new battery due solely to age.				Balancing cells significantly improves battery efficiency and avoids capacity/energy (C/E) mismatch. SOC (state-of-charge) is common and limits the pack capacity to the weakest cell. Li-poly cells do not require metal cases, which makes the batteries light and shapeable. Rate of self-discharge is much lower than nickel-cadmium and nickel metal hydride cells.
Electrochemistry	Nickel oxide hydroxide and metallic cadmium as electrodes.	The most common electrode is AB ₅ , where A is a rare earth mixture of lanthanum, cerium, neodymium, praseodymium, and B is nickel, cobalt, manganese, and/or aluminum. Some higher-capacity batteries use negative material electrodes based on AB ₂ compounds, where A is titanium and/or vanadium, and B is zirconium or nickel, modified with chromium, cobalt, iron, and/or manganese.		The anode of a conventional Li-ion cell is made from carbon, the cathode is a metal oxide, and the electrolyte is a lithium salt in an organic solvent.				Anode: Li or carbon-Li intercalation compound; Separator: conducting polymer electrolyte; Cathode: LiCoO ₂ or LiMnO ₄

Batteries and Beyond

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