

## Which battery chemistries are best suited for my application?

When selecting a suitable battery for a given task, four distinct battery characteristics must be considered: endurance, size, cost and maintenance requirements.

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## What are the advantages and disadvantages of the Ni-MH?

Some of the distinct advantages of today's Ni-MH are:

- 30% more capacity over a standard Ni-Cd.
- Less prone to memory than the Ni-Cd. Periodic exercise cycles need to be performed less often.
- Fewer toxic metals. The Ni-MH is currently labeled "environmentally friendly".

Unfortunately, the Ni-MH also exhibits some negative attributes and in some aspects lags behind the NiCd. For example:

- Number of cycles: The Ni-MH is rated for only 500 charge/discharge cycles. Shallow rather than deep discharge cycles are preferred. The battery's longevity is directly related to the depth of discharge.
- Fast charge: The Ni-MH generates considerably more heat during charge and requires a more complex algorithm for full-charge detection than the Ni-Cd if temperature sensing is not available. (Most [NiMH batteries](#) are equipped with internal temperature sensing to assist in full-charge detection). In addition, the Ni-MH cannot accept as fast a charge as the Ni-Cd; its charge time is typically double that of the Ni-Cd. The [trickle charge](#) must be controlled more carefully than on the Ni-Cd.
- Discharge current: The recommended discharge current of the Ni-MH is considerably less than that of the Ni-Cd. For applications demanding high power or a pulsed load, such as on GSM [digital cellular phones](#), portable transceivers and power tools, the more rugged Ni-Cd is the recommended choice.
- [Self-discharge](#): Both Ni-MH and Ni-Cd are affected by reasonably high self-discharge. The Ni-Cd loses about 10% of its capacity within the first 24 hours, after which the self-discharge settles to about 10% per month.

## How much can I discharge a battery?

The commonly used end-of-discharge voltage for the Ni-Cd and Ni-MH is one volt per cell. At that voltage level, most of the energy is spent and the voltage starts to drop rapidly. Discharging a battery further could damage the battery through cell reversal. Caution should be exercised when discharging a battery too deeply under heavy load.

Since the cells in a [battery pack](#) cannot be perfectly matched, a negative voltage potential (cell reversal) across a weak cell may occur if the discharge is allowed to continue below one volt per cell. A Ni-Cd can tolerate a limited amount of cell reversal. However, if a high current is drawn at the same time, the affected cell will likely develop an electrical short circuit.

### How often should I exercise and recondition my battery?

The effects of crystalline formation (memory) are most pronounced if a Ni-Cd battery is left in the charger for days, or is repeatedly recharged without a periodic full discharge. Since most applications do not use up all energy before recharging, a periodic discharge to one volt per cell (known as exercise) is essential for the Ni-Cd to prevent the buildup of crystalline formation on the cell plates. All Ni-Cd batteries that are in regular use or on standby mode (sitting in a charger for operational readiness) should be exercised once per month. Nothing else needs to be done between these monthly exercise cycles; the battery can be used with any desired user pattern without the concern of memory. The Ni-MH is also affected by memory but to a lesser degree--it only needs exercise once every three months.

For a closer look at batteries, we can take a look at

<http://www.batteryuniversity.com/>

The website includes articles suggesting the best battery choice for a given application, how to restore weak batteries and maintenance methods to prolong battery life. The highlights are:

- **Batteries in a Portable World** — A handbook on [rechargeable batteries](#) for non-engineers
- **Frequently asked questions about batteries** — Links to answers found in the 300-page book
- **New battery articles** — introducing new battery technologies and ways to prolong battery life.

[www.BatteryUniversity.com](http://www.BatteryUniversity.com) is an educational website that offers practical information for battery users. The material is condensed into easy-to-read essays of about 1000 words and covers most aspects of battery use. The essays are:

Part One

Facts about batteries

*Basics every battery user should know*

Battery chemistries  
Packaging and safety  
Charging — *How to charge — when to charge table*  
Discharging  
Internal resistance  
Intelligent battery  
Storing and recycling  
Summary table — *Do and don't battery table, quick answers*  
Prolonging battery life  
Battery applications  
Battery service  
Battery behavior  
Comparisons  
Things to come  
Sponsor  
Products  
Information

Part Two

*Getting the most from your batteries*

Part Three

*Battery University and the people behind it*

### From the Battery University website:

Battery University is an on-line resource that provides practical battery knowledge for engineers, educators, students and battery users alike. The papers address battery chemistries, best battery choices and ways to make your battery last longer.

The presentations are easy-to-read and are limited to about 1000 words. The material is based on the book *Batteries in a portable World - A handbook on rechargeable batteries for non-engineers*, and is written in condensed form. The 300-page book and a library of battery articles are available on [www.buchmann.ca](http://www.buchmann.ca). Battery service products are shown on [www.cadex.com](http://www.cadex.com).

Battery University is sponsored by Cadex Electronics Inc., a manufacturer of battery analyzers and chargers. The material is free of charge for the benefit of all battery users and cannot be used for profit.

Battery University is organized into three parts. **Part One** addresses the 'mechanics' of the battery and deals with chemistries, charging, discharging, storing and recycling. **Part Two** looks at the personalities of different battery systems and describes ways to get the most out of them. **Part Three** reveals who is behind Battery University and provides links to various products to service your batteries. I hope you will enjoy the reading.

Isidor Buchmann  
President  
Cadex Electronics Inc.

Some links from the Battery University website include:

## Links

### Battery Facts

[www.cadex.com](http://www.cadex.com) - Information on battery service products  
[www.buchmann.ca](http://www.buchmann.ca) - Battery articles and the book "Batteries in a Portable World"  
[www.batteries.frost.com](http://www.batteries.frost.com) - Statistical battery information  
[www.freedoniagroup.com](http://www.freedoniagroup.com) - Leading international business research company

### Organizations

[www.prba.org](http://www.prba.org) Portable Rechargeable Battery Association  
[www.rbrc.com](http://www.rbrc.com) Rechargeable Battery Recycling Corporation  
[www.sbs-forum.org](http://www.sbs-forum.org) Smart Battery System  
[www.acpi.info](http://www.acpi.info) Advanced Configuration & Power Interface  
[www.smbus.org](http://www.smbus.org) SMBus website  
[www.ul.com](http://www.ul.com) Underwriters Laboratories test lab

### Battery Services

[www.mobilepowersolutions.com/default.aspx](http://www.mobilepowersolutions.com/default.aspx) Mobile Power Battery Testing  
[www.prba.org](http://www.prba.org) Portable Rechargeable Battery Association  
[www.smbus.org](http://www.smbus.org) SMBus website  
[www.sbs-forum.org](http://www.sbs-forum.org) Smart Battery System  
[www.acpi.info](http://www.acpi.info) Advanced Configuration & Power Interface

### Government Organizations

[www.ul.com](http://www.ul.com) Underwriters Laboratories test lab  
[www.fcc.gov](http://www.fcc.gov) Federal Communications Commission  
[www.dot.gov](http://www.dot.gov) U.S. Department of Transportation  
[ec.europa.eu/index\\_en.htm](http://ec.europa.eu/index_en.htm) European Commission  
[www.iata.org](http://www.iata.org) IATA  
[www.iec.ch](http://www.iec.ch) International Electrotechnical Commission  
[www.rohs.eu](http://www.rohs.eu) RoHS  
[www.iso.org](http://www.iso.org) International Organization for Standardization  
[www.un.org](http://www.un.org) United Nations

### Manufacturers

[www.MoliEnergy.com](http://www.MoliEnergy.com) E-One Moli Energy, manufacturer of lithium-ion

[www.sanyo.com/batteries/](http://www.sanyo.com/batteries/) Sanyo Electric Co., Ltd.

[www.panasonic.com/batteries](http://www.panasonic.com/batteries)

[www.saftbatteries.com](http://www.saftbatteries.com) Saft Battery

[www.maxim-ic.com](http://www.maxim-ic.com) Maxim IC manufacturer

[www.benchmark.com](http://www.benchmark.com) Benchmark IC manufacturer

[www.linear.com](http://www.linear.com) - Linear Technology Corp.

### **Consultants**

[www.huret.com](http://www.huret.com) Huret Associates, battery consultants

[www.theroethlegroup.com](http://www.theroethlegroup.com) The Roethle Group, Inc.

### **Publishers**

[www.portabledesign.com](http://www.portabledesign.com) Portable Design

[www.BatteryPowerOnline.com](http://www.BatteryPowerOnline.com) Battery Power Products & Technology

[www.bestmag.co.uk](http://www.bestmag.co.uk) Batteries and Energy Storage Technology

### **Transportation**

[www.automobile-portal.com](http://www.automobile-portal.com)

[www.bicycle-power.com](http://www.bicycle-power.com)