NICAD Batteries

The average modeller buys a radio set expecting years of trouble free service with very little attention. The amazing thing
is they usually get it, until one day there is a severe dose of the twitches or total loss of control. Cries of interference or
(more likely) whose on my *@!? Frequency? are heard, especially if all appears well when tested on the bank. Even a battery
voltage check may not help as a no load check is not in itself much of a guide to nicad condition. There are therefore certain things modellers should know about nicads, and this article attempts to present them in an
understandable manner. The modeller needs no more complicated kit for this than a standard multimeter with a voltage
range of at least 10v dc and a current range of 500ma (100ma minimum). These are relatively cheap to buy.

Definitions

Nicad	Short for nickle cadmium, the materials used in the battery cell
Cell	One section of the battery
Battery	A number of cells, each of nominal 1.2v, wired in series to give the required voltage. Receiver batteries generally use 4 cells giving 4.8v and transmitter batteries 8 cells giving 9.6v
Capacity	The ability of the cell to store electrical energy. However, cells are like leaking buckets -a sound one holds its water for a long time, and unsound one leaks its contents over ever shorter periods
Cell rating	Given by a number followed by mah (milliamp hours). 500mah means 50ma for 10 hours, or 500ma f
C/10 rate	Charging and discharging rates are based on this, but more later

Nicad Cell facts
Typical cell life is around 500 to 1000 charge/discharge cycles so a five year life on 2 cycles/week is perfectly possible.
Overcharging at the standard rate does not appreciably affect the life of a cell, unlike lead/acid cells.
Charge retention for new cells, fully charged and stored at 20oC is 75% after 1 month, 50% after 3 months and 15% after
6 months. It is therefore advisable to fully charge your nicads just before you use them. Again unlike lead acid cells,
storing nicads fully discharged does no harm and new cells are supplied discharged. However, new and stored cells will
need several charge/discharge cycles to achieve maximum capacity.
Cells do not function well when cold and will show an apparent loss of capacity when cold, typically being 100% capacity
at 20oC but only 75% at 0oC. The apparent capacity is also affected by the rate of discharge, the higher the rate the lower
the capacity, typically if at 50ma the capacity is 500mah then at 90ma this falls to 475ma.

The capacity of a nicad is the total usable energy available in a fully charged cell. It is determined by discharging the cell

at a rate 1/10th its rated capacity, i.e. for a 500mah cell at 50ma, until a voltage of 1.0v per cell is achieved. The discharge
period should be 10 hours. NOTE discharging to lower than 1.0v per cell causes permanent damage to the cell. This discharge
rate is known as the C/10 rate.
Charging is usually done at a standard rate of c/10 + 50%, i.e. for a 500mah cell at 50ma for a period of 15 hours, to allow for
inefficiency in the charging process.

Cell failures
There are three categories, permanent, reversible and functional.
Permanent failures are usually open or short circuits in the cell, no voltage, dispose of cell safely and replace.
Reversible failures are usually seen as loss of capacity due to shallow discharges and can be improved by several
charge/discharge cycles down to the 1.0v per cell limit.
Functional failures are when the capacity becomes too small due to age/total usage where the cell should be replaced
and semi-retired to a less demanding application.

The Cell in use
In a model, nicads are used to power the receiver and several servos, switching units, speed controllers, etc. all of which consume
power, particularly servos when working and switches which have to be electrically held. Keeping all control linkages, rudder hinges,
etc. loose and free, using switch functions that need only be momentarily held, etc. all help to reduce this power consumption and
increase battery duration. Avoiding excessive use of the rudder also helps! Typical tests on Futaba gear gives:

Receiver plus 4 servos at rest	44 mA
As above, 1 servo running light	100 mA
As above, 1 servo running loaded	150 mA

For each case there is a volt drop of 0.1v for each running servo.

Charging
Nicads should be charged at the standard C/10 + 50% rate. Checks have shown some chargers fall short of the required 50ma rate,
a quoted example being a futaba charger which ran at 47ma at the start of the charging cycle of a 500mah battery, falling to 40ma by
the end of the cycle. Hence the additional 50% allowed on time!
Note the LED on the charger only proves the LED is working, it is not a guarantee the battery is charging! Keep the plug contacts clean
and check your charger periodically to ensure there is in fact a current flowing.
Do not fast charge your batteries if you can help it. Although modern cells can take the high currents involved without causing catastrophic
failure (i.e. exploding) it will still drastically shorten their life and reduce their reliability.

Loss of capacity
In cells in regular use loss of capacity happens gradually without being noticed. As cell age they still show a voltage of 1.2v, but their capacity

decreases with reduced running times. This is why a no load check is of limited use.

Checking capacity

Capacity is checked at the C/10 rate and ideally at 20oC. Fully charge the battery for 15 hours and then discharge it at the C/10 rate until
1.0v per cell is reached. This is achieved either using a variable resister set using the multimeter, or using a fixed resister whose value is
calculated using ohms law. An example of the calculation is for a receiver battery rated 500mah and 4.8v the resistance would be
4.8v/0.05a = 96 ohm (100 ohm is the nearest standard size). Similarly for a transmitter battery rated 9.6v, 500mah it would be 192 ohms
(nearest standard 200 ohms). The resisters should have a minimum ½ watt rating.
The battery must be discharged to the 1.0v per cell level AND NO FURTHER IF YOU WISH TO AVOID PERMANENT DAMAGE and the
time taken recorded. The capacity is then 100% if the time taken is 10 hours, 80% (i.e. 400mah) if 8 hours, 60% (i.e. 300 mAh) if 6 hours
and 50% (i.e. 250 mAh) if 5 hours.
We would recommend replacement when the capacity reaches 70% (in our example 350 mAh) as although in theory you can go on until
reaching 50% what is the point when you know you have a failing battery anyway. Although transmitters usually incorporate a battery condition
monitor, it is still sensible to check the capacity by this method. The receiver battery totally depends on this type of check. If you never check
your batteries then it is not a matter of will they fail, but when!

Cycling

Care needs to be taken when cycling batteries, particularly as some transmitters have internal components that can be damaged if to much
current is drawn. With this in mind do not use more than the c/4 rate (nominal 4 hour discharge rate) to discharge, and as an accurate capacity
check is not required, cycle down to 1.1v per cell only.
This means for a 9.6v transmitter battery a 76.8 Ohm (75 Ohm preferred size) resistor should be used, or for a 4.8v receiver battery a 38.4 Ohm
(39 Ohm preferred size) resistor, both minimum 1 watt rating. In fact you can use a 100 Ohm and a 50 Ohm safely.
This discharge can serve as a rough capacity check.

REMEBER IN ALL DISCHARGES IT IS VITAL NOT TO GO BELOW THE 1.0V PER CELL FIGURE AS BATTERY DAMAGE WILL RESULT