Rechargeable Batteries at MTMBC

Introduction

Battery technology is a wide ranging and complex subject. It is fast moving and beyond my understanding, and that of the average modeller who just wants to connect up and go as quickly, or for as long as possible, depending on their particular interests. In this article I attempt to address the main aspects of battery usage for modellers at MTMBC without delving too deeply into the technicalities.

There are 3 main types of battery in general use at MTMBC and this article aims to describe the main characteristics of each and their suitability for the type of models common at the club. It will also look at some simple practices aimed at the handling, care and maintenance of each type.

Common sense precautions

Do read, understand and comply with the warnings and guidance provided with the battery.

Do not attempt to use a battery showing evidence of damage e.g. leaking, cracked casing, misshaped or swollen packaging.

Do not try and connect different cell types or capacities together.

Only use a charger that is designed for the type of battery you intend to charge and in the way described in the instructions. Only charge or discharge at Volts and Amps that are suitable for the particular battery or battery pack in question. If in doubt check any instructions that came with the battery or seek out a data sheet for it.

Do not allow the battery terminals or bare wires connected to them to touch each other during use, charging and discharging, transporting or storage. It is important to be aware that any electrically conductive material has the potential to 'short out' the battery terminals and cause a fire. e.g. metal tools, metal boxes, coins, wire and carbon fibre.

Nomenclature

Capacity

The capacity of batteries is usually expressed in terms of the current (Amps) that could be drawn over a period of 1 hour so a typical lead acid gel battery may be quoted as having a capacity of 3 Ah indicating that 3 amps can be drawn from it for 1 hour. If higher values of current are drawn the time will be diminished accordingly. NiMH and Lithium polymer batteries are normally specified in mAh which is 1/1000th of an Amp per hour. A 3Ah NiMH or lithium battery may well be specified as 3,000mAh which is the same capacity as 3Ah. A milliamp (mA) being a thousandth of an Amp.

Charge and Discharge rates

These are usually expresses in fractions of the batteries stated capacity (C). A 3Ah battery charging at 1C is been charged at 3 Amps. A 3Ah battery being discharged at 12 Amps is said to be discharging at 4C. i.e. 4 x the capacity.

Connection

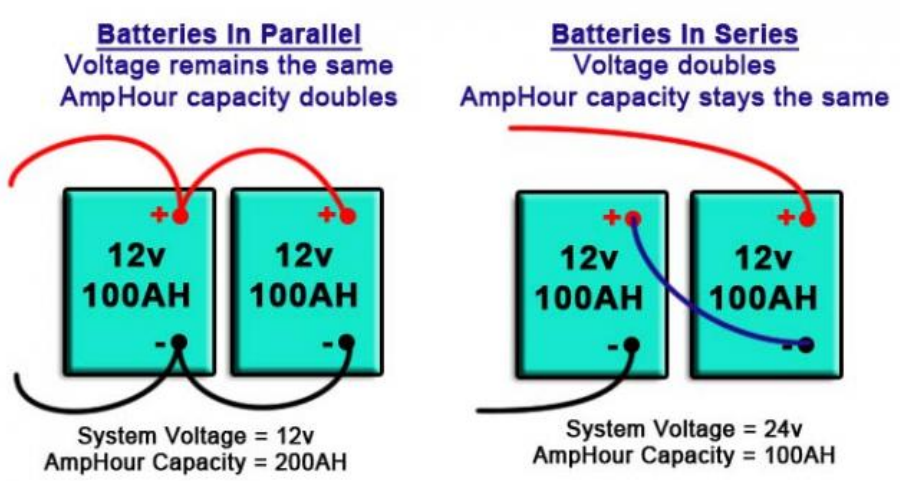
The arrival of Lithium Polymer batteries has heralded the more common use of conventions describing the way individual cells are connected together. Cells are most commonly connected in series (s) or parallel (p) or more rarely a combination of both. e.g. 6s2p would indicate 2 packs of 6 series connected cells connected in parallel.

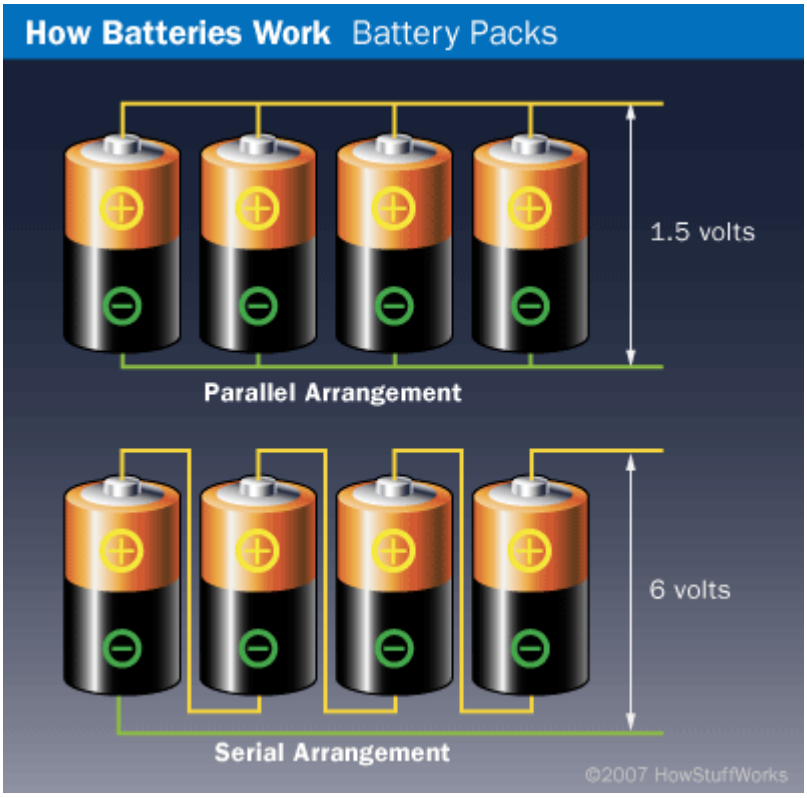
Cells connected in series have the positive connected to the negative of another cell. With two cells connected in this way and the load connected to the negative of the first cell and the positive of the second cell they form a battery pack. The voltage of such an arrangement is twice that of the single cell. Any number of cells can be connected in this way to achieve a desired voltage. e.g. 6s will give 6 x the single cell Voltage. Series connections are the most common and are relatively free of complications in use, charging or discharging.

Cells connected in parallel have the negatives connected together and the positives connected together. The pack Voltage will remain that of a single cell but the packs ability to supply current will be doubled. e.g. 2 x 1.2 Volt 3,000mAh NiMh cells connected in parallel will supply 6,000mAh at 1.2Volts.

Care should be taken when using parallel connection as difficulties can arise in use, charging or discharging if you don't have a good understanding of the subject.

Combinations of series and parallel connected cells of the same type can be employed to make up battery packs of any desired voltage and capacity but special care must be taken in use, charging or discharging. If you choose to go down this route make sure you have a good understanding of the subject and the hazards that can arise as a result of incorrect use.


Batteries In Parallel
Voltage remains the same
AmpHour capacity doubles
12v
100AH
12v
100AH
System Voltage = 12v
AmpHour Capacity = 200AH
Batteries In Series
Voltage doubles
AmpHour capacity stays the same
12v
100AH
12v
100AH
System Voltage = 24v
AmpHour Capacity = 100AH


How Batteries Work Battery Packs
1.5 volts
Parallel Arrangement
6 volts
Serial Arrangement
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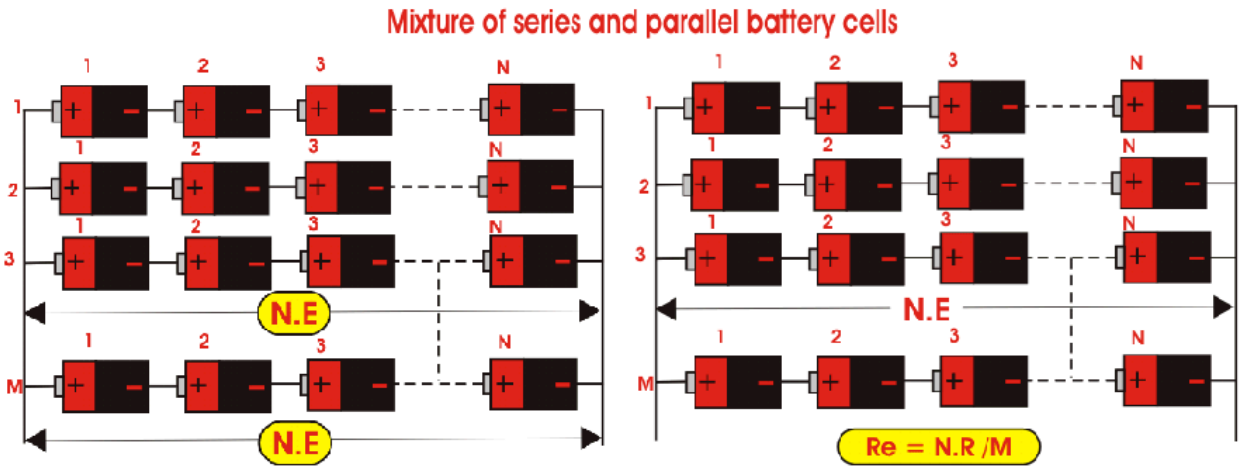

Mixture of series and parallel battery cells
N.E
N.E
N.E
Re = N.R /M

A cautionary note on specified and actual performance

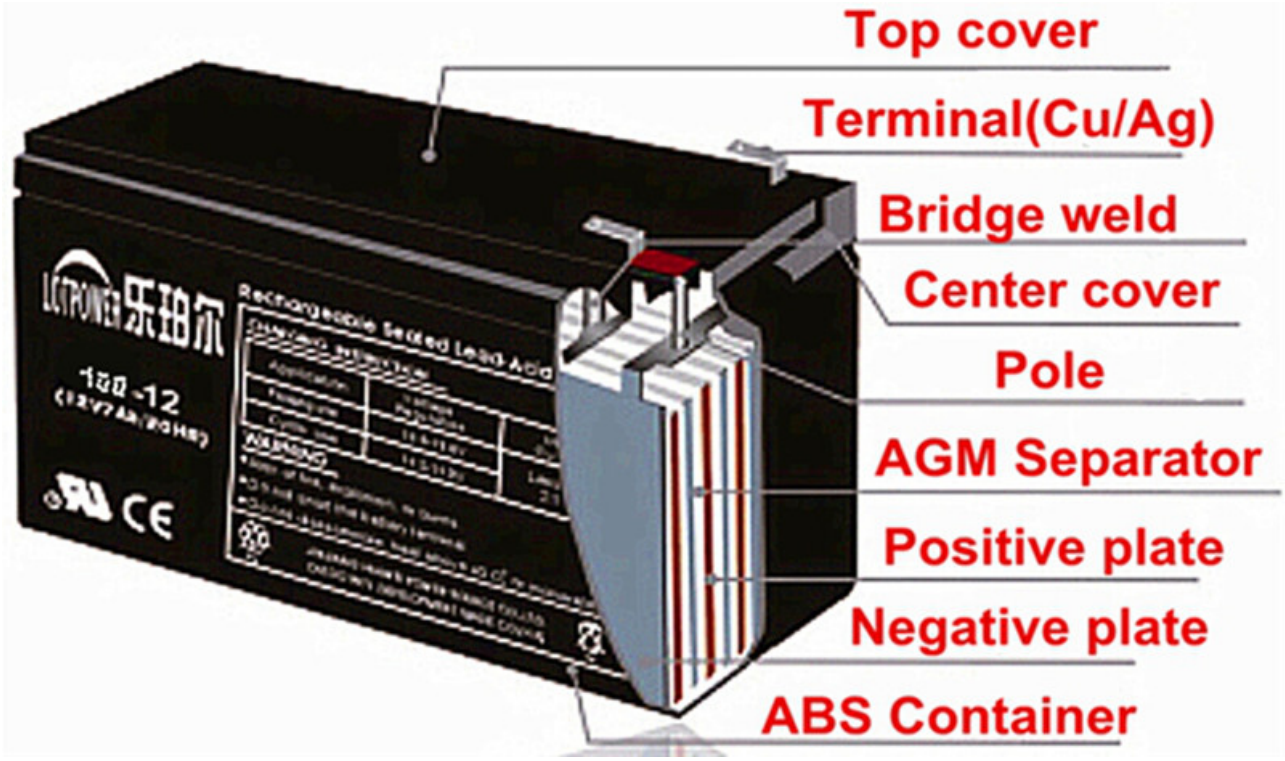
In general modellers want more bang for their buck and are looking for high performance from their batteries at reasonable prices. Manufacturers and retailers know this and advertise their wares accordingly. You may well find the performance of batteries in practice is different to that advertised. e.g. I don't seem to be able to get any more than about 65% of the stated capacity out of the 7Ahr Lead acid gel cells I bought for my tug.

It is worth checking out the data sheets for batteries before buying. Performance is usually claimed under very specific conditions of charge rate, discharge rate and probably temperature as well and often for a single cell. Put cells together in a pack, attach leads, connectors, labels, packaging and even shrink wrap, use them differently to specified, and you can find the performance or longevity is not what you expected. There is a constant push by manufacturers and retailers to increase the capacity of cells to the maximum possible. Experience has shown that this push reduces the reliability of the batteries with more failures and shortened service life being the down side. So don't always buy the latest, highest capacity cells, unless they have been proved.

Sealed Lead acid gel cells.

These batteries have a single cell nominal voltage of 2.0V. They are usually offered with 3 cells connected in series to give a more useable voltage of 6 Volts or 6 cells connected in series giving 12 volts.

Many of the batteries on the market offered for modelling applications are actually designed to provide back up power in the event of mains power failure to electrical and electronic devices like Security and Fire alarms. In that role they are continuously trickle charged so they are always ready in the event of being needed. Subsequently charge rates tend to be low and therefore slow.



Power to weight ratio

They are heavy and offer a poor power to weight ratio. Typically a 6Volt 3Ah battery weighs 0.7Kg which works out at 6V x 3.3A = 19.8W. 19.8W/0.7Kg is **28 Watts per Kg**.

Self discharge & storage

Holds a charge well but falls off if left for long periods uncharged.

Clean any deposits from the connectors and smear with a little vaseline. Keep in clean, cool, dry conditions above 5 degrees centigrade and keep fully charged. I have found if left without charging for long periods they deteriorate to the extent they become useless. Re-charging straight after use and then keeping the charge topped up once a month helps to prevent sulphating of the plates and keeps the battery in good condition.

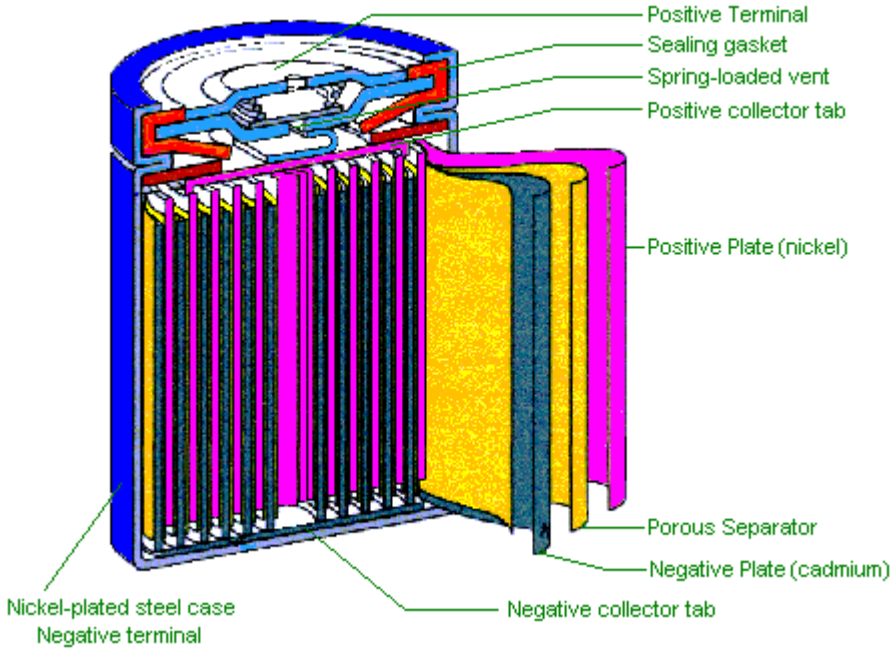
Model types

Suited to larger scale model boats, tugs and where weight is an advantage for ballast.

Nickel Metal Hydride

Generally NiMH cells fall into two main categories. Those used to drive the model which have high discharge and charge rates and are vented. They are fitted with an integrated pressure relief vent normally found in the positive connection button. And those used to power the control systems, and a myriad of other electrical devices, which have lower discharge and charge rates and are completely sealed. The sealed variety are sometimes used to power models where low charge and discharge rates only are required. Trying to fast charge or discharging fully sealed cells at high rates can lead to high temperature and pressure build up in the cell with the high probability of bursting the casing and destroying the cell completely so be sure you use the correct cells and correct charging/discharging procedures.

The high discharge batteries have a single cell nominal voltage of 1.2V. They are offered in a wide range of combinations but are commonly used as a 4s, 6s or 7s cell packs. Giving nominal voltages of 4.8, 7.2 and 8.4 respectively. Higher voltages packs are readily available typically offering 14.4 or 16.8.



Power to weight ratio

Much lighter than lead acid these versatile batteries are in widespread use for all different kinds of models. A better power to weight ratio typically works out at 7.2V x 3.3A = 23.7W. 23.7/0.4Kg is **59 Watts per Kg**.

Self discharge & storage

Starts to discharge quickly as soon as taken off charge and then looses charge more slowly. Allowing the cell voltage to drop below 0.9V per cell for long periods can shorten the service life of the cell so it's best to keep them charged.

There is lots of different advice about storage of NiMH but this works for me. Fully recharge straight after use and top up again every month or two. A slow charge rate is best as it helps to balance the cell voltages in the pack.

Clean any deposits from the connectors and smear them with a little vaseline. Store in clean, dry and cool conditions.

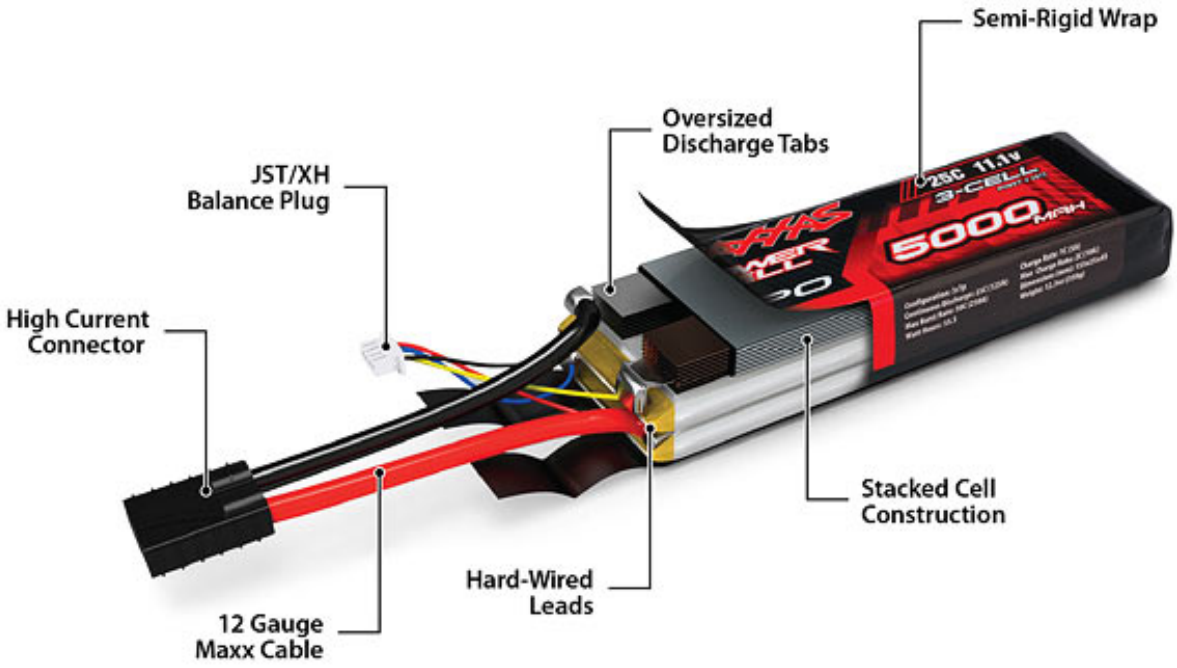
Model types

Suited to most model boats.

Lithium polymer

These batteries have a single cell nominal voltage of 3.7V. They are typically available in 2s 3s 4s and 6s cell packs giving nominal voltages of 7. 4, 11.1, 14.8 and 22.2.

When first introduced to the modelling world Lipo batteries had a lot of bad press because of their potential to cause fires if incorrectly treated. All battery types have the potential for explosion and starting fires if they are incorrectly treated but because of the chemicals used in Lithium Polymer batteries any fire is self sustaining so the potential for setting fire to surroundings and potential for personal injury is greater than most other types.



Modern manufacturing techniques and materials means current batteries are much safer and are not so likely to swell, burst, catch fire or explode unless badly abused. However the potential remains and this is recognised by the makers who include safety instructions and warnings when selling Lipos. Please read the instructions keep to the rules and all should be safe & well.

On a personal note in 8 years I have never had an 'incident' using lithium polymer batteries and have only witnessed 3 incidents where batteries in boats have swollen, ruptured, and generated lots of smoke. No fires or explosions.

To safely charge Lipo batteries the voltage each cell is charged to needs to be accurately controlled and so a special charger that balances the charging of each individual cell in the pack is essential. The batteries and chargers are fitted with balance connectors for this purpose. The voltage reached by the cells when discharging also needs to be controlled closely and so chargers/dischargers are designed to cope with this requirement. Electronic Speed Controllers also have facilities to close down the discharge of the batteries before a critical voltage, for the well being of the battery, is reached (usually 3.0V/cell minimum). Check your ESC has this facility and is correctly set for the number of cells in your pack.

It is advisable to charge or discharge Lipos on a non-combustable surface clear of any combustable material in a fire proof safe bag or box. Power to weight ratio

Much lighter than Lead acid or NiMh these batteries are in widespread use across a multitude of electrically powered models. Their low weight makes them particularly suited to electric flight and fast electric boats. Very good power to weight ratio that typically works out at 7.4V x 3.3A = 24.42W. 24.42/0.2Kg is **122 Watts per Kg.**

Self discharge & storage

A major advantage over other types of cells is that Lipos do not self discharge so a fully charged battery pack will remain fully charged for months and months. Also unlike other cell types the discharge capacity will be within a few tens of mAh of the charge capacity.

Because of the potential fire risk it is advisable to transport & store in a fire proof container. e.g. Fire proof bag or box. For long term storage manufacturers recommend a 50% charge. Store in clean and cold conditions above freezing.

Model types

All model boat types but particularly suited to Fast Electrics and small scale.

General notes on use and storage of batteries

Batteries rely on chemical reactions to provide the power. Most chemical reactions work better if they are warm and do not work so well when cold. This is true for NiMH and Lipo drive batteries we use in modelling at MTMBC. If you are striving for ultimate performance as we often are in Fast Electrics a warm battery pack will perform better than a cold one.

A note of caution is required here because heating or allowing batteries to get too hot can be dangerous so be sure you understand and know the limitations of your batteries.

Although higher temperatures help improve performance they are detrimental to the service life of the batteries. Storage at low temperatures helps to slow down chemical changes in the batteries that can shorten their service life. Keep your batteries clean, dry and cold for best results. I use a domestic fridge for my Lipo race packs at between 5-10 degrees centigrade, but anything below freezing could cause damage to the cells.

Type	Watts/Kg	Self discharge rate	Storage	Well suited for boats:-
Lead Acid Gel	28	moderate	Clean dry & cold	Large & medium scale & tugs
NiMH	59	high	Clean dry & cold	All
Lipo	122	very low	Clean & cold	Fast Electric, small & medium scale