A Batteries a Battery or is it..?

Having grown up with Lead Acid batteries (SLA) and NiCad's I was personally a bit apprehensive using Lipo's, so I never delved into the world of electric power, preferring gas, however, after speaking with the guys at RCBoatBitz I am now a true convert, not only too LiPo's but battery power.

So I will share some of what I have learnt, you too maybe converted to the power of Lipos'..

Lithium Polymer batteries (henceforth referred to as "LiPo" batteries), are a newer type of battery now used in many consumer electronics devices. They have been gaining in popularity in the radio control industry over the last few years, and are now the most popular choice for anyone looking for long run times and high power.

LiPo batteries offer a wide array of benefits. But each user must decide if the benefits outweigh the drawbacks. For more and more people, they do. ***In my personal opinion***, there is nothing to fear from LiPo batteries, so long as you follow the rules and treat the batteries with the respect they deserve.

Let's first lets look at the differences between LiPo batteries and their Nickel-Cadmium and Nickel-Metal Hydride counterparts.

LiPo Versus NiMH/ NiCd

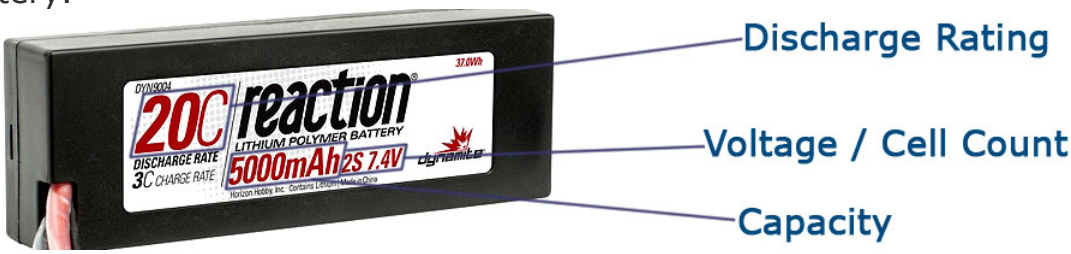
LiPo batteries offer three main advantages over the common Nickel-Metal Hydride (NiMH) or Nickel Cadmium (NiCd) batteries:

- LiPo batteries are much lighter weight, and can be made in almost any size or shape.
- LiPo batteries offer much higher capacities, allowing them to hold much more power.
- LiPo batteries offer much higher discharge rates, meaning they pack more punch.

But, just as a coin has two sides, there are some drawbacks to LiPo batteries as well.

- LiPo batteries have a shorter life span than NiMH/NiCd batteries. LiPos average only 300–400 cycles.
- The sensitive chemistry of the batteries can lead to fire if the battery gets punctured and vents into the air.
- LiPo batteries need special care in the way they are charged, discharged, and stored. The required equipment can be expensive

The way we define any battery is through a ratings system. This allows us to compare the properties of a battery and help us determine which battery pack is suitable for the need at hand. There are three main ratings that you need to be aware of on a LiPo battery.



So what does it all mean? Let's break it down and explain each one.

Voltage / Cell Count

A LiPo cell has a nominal voltage of 3.7V. For the 7.4V battery above, that means that there are two cells in series (which means the voltage gets added together). This is sometimes why you will hear people talk about a "2S" battery pack - it means that there are **2** cells in **S**eries. So a two-cell (2S) pack is 7.4V, a three-cell (3S) pack is 11.1V, and so on.

The voltage of a battery pack is essentially going to determine how fast your vehicle is going to go. Voltage directly influences the RPM of the electric motor (brushless motors are rated by kV, which means 'RPM per Volt'). So if you have a brushless motor with a rating of 3,500kV, that motor will spin 3,500 RPM for every volt you apply to it. On a 2S LiPo battery, that motor will spin around 25,900 RPM. On a 3S, it will spin a whopping 38,850 RPM. So the more voltage you have, the faster you're going to go.

Capacity

The capacity of a battery is basically a measure of how much power the battery can hold. Think of it as the size of your fuel tank. The unit of measure here is milliamp hours (mAh). This is saying how much drain can be put on the battery to discharge it in one hour. Since we usually discuss the drain of a motor system in amps (A), here is the conversion:

1000mAh = 1 Amp (1A)

I said that the capacity of the battery is like the fuel tank - which means the capacity determines how long you can run before you have to recharge. The higher the number, the longer the run time.

But there is a downside to large capacities as well. The bigger the capacity, the bigger the physical size and weight of the battery. Another consideration is heat build up in the motor and speed control over such a long run. Unless periodically checked, you can

easily burn up a motor if it isn't given enough time to cool down, and most people don't stop during a run to check their motor temps. Keep that in mind when picking up a battery with a large capacity.

Discharge Rating ("C" Rating)

Voltage and Capacity had a direct impact on certain aspects of the vehicle, whether it's speed or run time. This makes them easy to understand. The Discharge Rating (I'll be referring to it as the C Rating from now on) is a bit harder to understand, and this has lead to it being the most over-hyped and misunderstood aspects of LiPo batteries.

The C Rating is simply a measure of how fast the battery can be discharged safely and without harming the battery. One of the things that makes it complicated is that it's not a stand-alone number; it requires you to also know the capacity of the battery to ultimately figure out the safe amp draw (the "C" in C Rating actually stands for **C**apacity). Once you know the capacity, it's pretty much a plug-and-play math problem. Using the above battery, here's the way you find out the maximum safe continuous amp draw:

20C = 20 x Capacity (in Amps)

Calculating the C-Rating of our example battery: 20 x 5 = 100A

The resulting number is the maximum sustained load you can safely put on the battery. Going higher than that will result in, at best, the degradation of the battery at a faster than normal pace. At worst, it could burst into flames. So our example battery can handle a maximum continuous load of 100A.

Most batteries today have two C Ratings: a Continuous Rating (which we've been discussing), and a Burst Rating. The Burst rating works the same way, except it is only applicable in 10-second bursts, not continuously. For example, the Burst Rating would come into play when accelerating a vehicle, but not when at a steady speed on a straight-away. The Burst Rating is almost always higher than the Continuous Rating. Batteries are usually compared using the Continuous Rating, not the Burst Rating.

Our example battery has a Burst Rating of 30C. That means it can handle a load of 150A, but only for 10 seconds or less.

Care & Treatment

LiPo batteries offer plenty of power and runtime for us radio control enthusiasts. But that power and runtime comes at a price. LiPo batteries are capable of catching fire if not used properly - they are much more delicate than the older NiMH/NiCd batteries. The problem comes from the chemistry of the battery itself.

Lithium-Polymer batteries contain, quite obviously, lithium. Lithium is an alkali metal, meaning it reacts with water and combusts. Lithium also combusts when reacting with oxygen, but only when heated. The process of using the battery, in the sometimes extreme

ways that we do in the R/C world, causes there to be excess atoms of Oxygen and excess atoms of Lithium on either end (be it the cathode or anode) of the battery. This can and does cause Lithium Oxide (Li_2O) to build up on the anode or cathode. Lithium Oxide is basically corrosion, albeit of the lithium kind; not iron oxide, which is otherwise known as "rust". The Li_2O causes the internal resistance of the battery to increase. Internal resistance is best described as the measure of opposition that a circuit presents to the passage of current. The practical result of higher internal resistance is that the battery will heat up more during use.

Most manufacturers have taken to putting a Low Voltage Cutoff (LVC) on their speed controls. The LVC detects the voltage of the battery, and divides that voltage by the cell count of the battery. So it would see a fully charged 2S LiPo as 8.4V, or 4.2V per cell.
This is where the advantage of balancing comes in. Because the speed control does not read off the balance tap, it cannot know the exact voltages of each cell within the battery. The speed control can only assume that the cells of the battery are all equal. This is important because, as I mentioned above, discharging a LiPo cell lower than 3.0V causes a usually permanent degradation of the cell's ability to absorb and retain a charge.

A LiPo cell should NEVER be discharged below 3.0V

The LVC works to cut-off the motor of the vehicle (or in some cases, pulse the motor) to alert you to a nearly-depleted battery pack. It uses the total voltage of the battery as its reference. Most LVCs cut-off around 3.2V per cell. For our two-cell example battery, that would be 6.4V. But if the battery isn't balanced, it's possible for the total voltage to be above the cutoff threshold, yet still have a cell below the 3.0V danger zone. One cell could be 3.9V, while the other could be a 2.8V. That's a total of 6.7V, which means the cut-off would not engage. The vehicle would continue to operate, allowing you to further degrade the battery. That's why balancing is so important.
So when running your LiPo, make sure you have the Low Voltage Cutoff enabled, set up correctly, and for the sake of all that is Holy, don't continue to run it after the LVC has kicked in! It may be a slight nuisance, but it's worth enduring so that your LiPo batteries remain in good health.

Proper Care & Treatment: Storage

In the old days, we used to run our boats, cars or airplanes until the batteries died, then just set the batteries on the shelf at home, waiting for the next time we could use them. We just stored them

dead. But you should not do that with LiPo batteries. Nor should LiPo batteries be stored at full charge, either. For the longest life of the batteries, LiPos should be stored at room temperature at 3.8V per cell. Most modern computerized chargers have a LiPo Storage function that will either charge the batteries up to that voltage, or discharge them down to that voltage, whichever is necessary.

Proper LiPo Storage Voltage = 3.8V per cell

It’s recommend that LiPo batteries are charged or discharged by a charger set with storage mode after every run. This isn't necessary per se, but it does build up good habits. If you do it every time, you don't have to worry about whether or not you remembered to put it in storage. *Lithium-Polymer batteries can be damaged by sitting fully charged for as little as a week*. This doesn't mean they *will* get damaged every time you leave them for over a week. It just means they can. So don't forget to put your LiPos at storage voltage when you're done using them.

They should also be stored in a fireproof container of some sort. As I mentioned above, most people tend toward leaving their LiPos in a LiPo bag, as they are portable and protect your workshop from catching fire should the LiPo combust. I have also heard of people use empty ammo boxes, fireproof safes, and ceramic flower pots. Whatever you have (or can buy) that will prevent any fire from spreading will be worth it in the unlikely event that anything untoward should happen.

I feel the need to reiterate: the most common problem people have with LiPo batteries is a direct result of *improper storage*. When a LiPo battery sits for a long period of time (and not at proper storage voltage), it tends to discharge itself. If it drops below 3.0V per cell, the vast majority of LiPo chargers *will not charge it*. Sometimes, batteries with this problem can be rehabilitated, but just as often,

they are a lost cause. So again: if you take a 'laissez-faire' approach to the storage of your LiPo batteries, it's entirely likely that you will be purchasing new batteries sooner than you think.

For quality batteries, service and advice contact the guys at RCBoatBitz.com.au remember to mention your from St George Model Boat Club to get your member discount.