How to prolong the life of your expensive LiPo cells

I'm very enthusiastic about electric flight and I don't want people put off by their expensive LiPo cells only lasting a short number of cycles. I would like people to enjoy electric flight and continue to enjoy electric flight and here are my recommendations on how to get the most from your Lithium Polymer batteries.
Lithium Polymer cells often referred to as LiPo's or Li-Poly's, are a great advancement to increasing the performance and duration of electric flight. If used incorrectly LiPo cells will only give a short number of cycles and in the worst cases can result in a fire.
From talking to various companies, people in the know, reading a lot and from my personal experiences there are a few things you can do to get the maximum number of cycles from your Li-Po cells.
This isn't a list of what to do and what not to do with Lithium cells but a few tips to prolong the life of your cells. Please see my "Do's" and "Don'ts" for additional information.
In my experience cheap LiPo cells from the Far East are a poor investment. They do not use 'matched' cells. This can cause the cell with the lowest resistance to deliver the majority of the power and become deeply discharged compared to the rest of the cells within the pack. When charging a pack with un-matched cells, some cells will be undercharged and other will become overcharged causing the overcharged cell to fail (puff up) or even cause a fire. Unmatched cells will also cause the voltage to drop more under load (i.e. lower voltages under load = less power = less RPM= less performance).
Good cells from manufactures like FlightPower, Overlander, E-Tec and Kokam to name but a few, although cost more initially will easily out perform (hold a higher voltage under load) and outlast the cheaper cells and therefore cost you less in the long term. Good quality cells are also safer in operation then the cheaper Far East cells. As with most things in life, you get what you pay for.

Recommendations to get the most out of your LiPo cells.

- Purchase good quality battery packs. Cheap Far East cells are a bad investment with regards to life, performance and safety.
- Purchase a good quality charger designed specifically for charging Lithium Polymer cells. Make sure the charger has a display that will show what energy is put back into your packs in terms of "mAh" and one that shows the voltage of the cells being charged. This is essential to monitoring and therefore adapting your use and charging of your batteries.
- Purchase a digital voltmeter. These can be bought from eBay for as little as £5.00 and is an essential tool for checking your battery packs.
- Purchase a Watt meter. Again this is an essential tool to measure currents, voltages, Watts and some even have a tachometer built in as well. I recommend either the Hyperion E-Meter or the Tornado Watt Meter.
- Where ever possible always use a cell balancer when charging. A Cell balancer will keep the cells within a pack at the same voltage. This greatly helps the pack maintain it's peak performance and prolong it's life. A cell balancer will also give you the 1st indication that a single cell within a pack is failing. If one of the LED's on the balancer remains constantly on during the charge cycle this is an indication that one of the cells is failing. A failing cell can cause the other cells in the pack to become over charged, which can result in a fire.
- Aim to draw less then 60% of the maximum continuous rated current of your LiPo's.
  If you draw less then 60%, your cells will last even longer.
- Avoid putting back more then 80% of the cells capacity. If you consistently put less then 80% back you will increase the life of your cells. Start with short flights and time them. Make a note of how many "mAh" you put back and divide the number of "mAh" by the minutes to get an approximate "mAh" per minute figure. Use this mAh/minute figure to calculate the number of minutes you can fly without going over the 80% figure.
- Do not fly until the ESC cuts power to your motor as this will seriously shorten the life of your LiPo's.
- Charge at 80% of the capacity of the LiPo. e.g. a 1000mAh pack should be charged at 800mAh (0.8Ah) or less. (1000mAh x 0.8 = 800mAh)
- Do not fully charge your packs. Charge them to 4.15V per cell instead of 4.20V per cell.
  The new Thunder Power chargers have this as an option (95% of capacity).
- Do not charge your packs below 10ºC/50ºF and definitely not below 0ºC/32ºF.
- Do not charge hot cells. Warm cells are OK, cool cells are best. Let hot cells cool before charging.
- Lithium Polymer cells do not have a "memory" unlike Ni-Cad's and therefore they **SHOULD NOT** be cycled. Cycling will bring the voltage down to 3.00V per cell which will shorten the life of your battery.

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- **DO NOT "top up"** your cells before flight. Measure the voltage. If it is above 4.1V per cell then just fly as you would normally and then charge. LiPo's loose less then 1% of their capacity per month in storage. Apart from being unnecessary there is a chance of overcharging your cells which will damage them and possibly cause a fire.
- If you plan to store your LiPo cells for an extended period (over 1 month), discharge them as you would normally. Then charge them to only 3.80V per cell.
- If you discharge your LiPo's down to 3.30V per cell or less (no Load) you will damage them and shorten their life.
- If you deeply discharge LiPo's below 2.50V per cell you will severely damage them and therefore severely shorten their life and may even destroy them.

First Use

Some manufactures recommend that you 'Break In' your LiPo cells by using them 'gently' for short periods and allowing them to cool for 15 minutes between uses.
For example, if you expect to get 15 minutes flight as your standard flight time, (not exceeding your 80% of total capacity of course) then have 3 short flights of 5 minutes with 15 minutes between flights. Have gentle flights and avoid full throttle. It is recommended to do this for 5 or 6 charge cycles.

Example 1

3S2P 2,100mAh. Max continuous rating = 12C and a peak of 18C.

Charge as a 3S pack (11.10V nominal) and at 1,680mA (1.68A) or less. (2,100mAh x 0.8 = 1,680mA).
Stop charging when the voltage reaches 12.45V (3 x 4.15V)

Maximum discharge current is 12C. C is the cells capacity therefore
12C = 12 x 2,100 = 25,200mA which is also equal to 25.20 Amps

In this example you should try to achieve the following:-
Keep your current draw below 15.12 Amps.
12 x 2,100mA = 25,200mA 25,200mA x 0.60 = 15,120mA = 15.12A

Adjust your flight time to put no more then 1,680mAh back into your pack (2,100mAh x 0.8 = 1,680mAh).

Example 2

3S1P 3,700mAh. Max continuous rating = 20C and a peak of 30C.

Charge as a 3S pack (11.10V nominal) and at 2,960mA (2.96A) or less (3,700mAh x 0.8 = 2,960mA).
Stop charging when the voltage reaches 12.45V (3 x 4.15V)

Maximum discharge current is 20C. C is the cells capacity therefore
20C = 20 x 3,700 = 74,000mA which is also equal to 74.00 Amps

In this example you should try to achieve the following:-
Keep your current draw below 44.40 Amps.
20 x 3,700mA = 74,000mA 74,000mA x 0.60 = 44,400mA = 44.40A

Adjust your flight time to put no more then 2,960mAh back into your pack (3,700mAh x 0.8 = 2,960mAh).

In conclusion

If you draw the absolute maximum current from your cells and fly until your ESC cuts power to your motor and you charge your cells to 4.20V per cell at 1C then you may get as few as 30-50 cycles from your cells.

If on the other hand you do not stress your cells i.e. break them in gently, take 60% or less of the maximum continuous rated current and always put less then 80% of the pack's capacity back, charge at 0.8C and only charge your cells to 4.15V per cell you should get up to and maybe more then 300 cycles from your expensive, high power, low weight LiPo cells.

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October 2006 Rev3.