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Those Things We Call Batteries - Part Three

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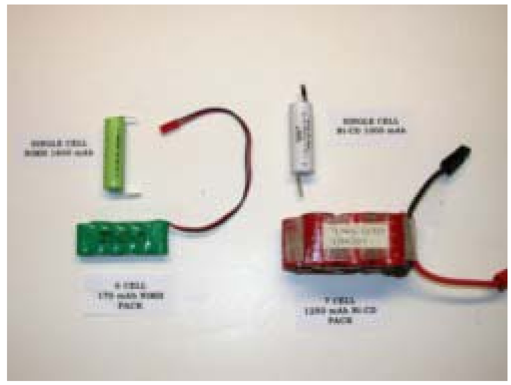

Lead Photo Photo 1

Sport Aviator Editor, Frank Granelli led off this technical information series on "Batteries" to teach the basics as they apply to our RC systems (both receiver/servos and transmitters). Frank explained both Ni-Cd (nickel cadmium) and Ni-MH (nickel metal-hydride) type batteries as are supplied with most modern day RC systems.

If you haven't as yet, I urge you to go back in this same Sport Aviator category (Flight-Tech ---- How to Articles) and read the Part-One and Part-Two articles. In a casual and easy to read format, Frank, describes such things as battery types, their characteristics, how to charge them, how to test them, how long you can fly on a charge, how to store them and what kind of battery life you should expect.

Photo 2

My job in this Part-Three will be two –fold:

1) To introduce you to Li-Poly (lithium polymer) and Li-Ion (lithium ion) batteries and let you know of possible a

2) Then I intend to go on to describe the truly wonderful advantages of using these lithium batteries to provide

Although Ni-Cd, Ni-MH, Li-Poly and Li-Ion are all rechargeable batteries, their characteristics (and internal chemistry) vary considerably. For the most part, Ni-Cd and Ni-MH batteries can be charged and used the same way, although the Ni-MH cells require a slightly lower fast charge current.

Photo 3

The popular AstroFlight 110 Deluxe peak detect charger can fast or slow charge both Ni-Cd and Ni-MH battery cells)

The lithium batteries are a totally different breed, with different characteristics, different charging techniques, different operational considerations and different storage requirements.

Photo 4

Three typical, dedicated Li-Poly chargers. The Peak Electronics Sirius lithium charge at the left, the AstroFlight 109 lithium charge in the middle and the FMA Direct CellPro 4S balanced charger at the right

If improperly charged or mishandled, lithium batteries can be quickly ruined and in some cases can even cause hazardous situations, like a meltdown or outright fire!

You might have had some concerns in the past identifying the difference between Ni-Cd and Ni-MH cells. They are usually cylindrical in shape and sometimes not very prominently marked. Li-Poly batteries are usually contained in flat, rectangular shaped aluminum pouches making them easy to distinguish from other type batteries. Li-Ion cells tend to look more like Ni-Cd and Ni-MH cells. So right away, that’s a flag raiser! Make sure you know what battery you have so that you can select the proper charger, charge current and the proper operating conditions.

Let’s proceed with some details on the new and very popular Li-Poly batteries. Later I’ll get back to Li-Ion batteries. Unlike the 1.2 volts nominal (per cell) for Ni-Cd and Ni-MH cells, the Li-Poly cell has a much higher nominal voltage of 3.7 volts per cell. It is said to be fully charged when the cell reaches 4.2 volts.

Photo 5

On the other end of the scale, Li-Poly batteries shouldn't be discharged below 2.5 volts per cell, but as a conservative recommendation, don't let it go below 3.0 volts per cell. If you let your Li-Poly battery goes below 2.5 volts per cell it will suffer irreversible damage. Keep this in mind when using Li-Poly batteries, never let them be charged above 4.2 volts and never discharged below 2.5 volts (3.0 volts better!).

Since Ni-Cd and Ni-MH cells have much lower voltage you can't substitute battery types using the same cell count. For example a six (6) cell Ni-Cd battery pack will have a nominal voltage of 7.2 volts (6 X 1.2V), while a two (2) cell Li-Poly battery pack will have 7.4 volts (2 X 3.7V).

Photo 6

One of the biggest advantages of going to Li-Poly batteries is the fact that they can offer more capacity, in a lower weight battery, that is physically much smaller in size. As an example, a 4 cell 600 mAh standard receiver size Ni-Cd pack might weigh 3.3 ounces, while a 2 cell 800 mAh Li-Poly battery might weight only 1.5 ounces. At first glance this appears to be half the weight with 25% more capacity. But then you must consider the voltage going to the receiver and servos. The 4-cell Ni-Cd pack will send about 5 volts to the receiver. The 2 cell Li-Poly would send 7.4 volts which is much too high for your receiver and servos. To cope with this higher voltage problem, you will need a regulator to reduce the 7.4 volts down to a useable 5 to 5.3 volts. These regulators, usually included as part of the on-off receiver switch system, are sold by MPI, Perfect Switch, FMA Direct and Batteries America to name a few.

Photo 7

What you have to decide is whether the weight savings (only 1.6 ounces!) justifies a different charging technique and an add-on voltage regulator? Also keep in mind that when charging Li-Poly batteries they must be removed from the aircraft and then attached to a dedicated Li-Poly charger. Li-Ion batteries, although based on the same lithium chemistry, are safer to charge since they have internal protection circuitry to protect against dangerous overcharging. Li-Ion batteries can be charged inside the aircraft but must otherwise still be treated the same as Li--Poly batteries when charging and discharging.

Photo 8

With Ni-Cd and Ni-MH cells you can charge the pack while it remains inside the aircraft's fuselage. Another offset to discuss is cost! A standard four cell Ni-Cd battery pack can be obtained for as little as $11.00. The 2 cell 800 mAh Li-Poly pack may cost $30.00 and the regulator another $20, bringing you up to $50.00 total.

I think you can see where this discussion is going. Using the newer Li-Poly batteries only buys you an advantage when you are talking about a very small aircraft, like maybe a 6 ounce parking lot flyer or even smaller. But once you get to about 10 ounce aircraft weights and more, the Ni-Cd and Ni-MH cells are a better deal for powering RC systems. The possible exception to this is that some very large model aircraft might benefit from Li-Poly power especially when using a large number of high-powered, high-resolution servos. Keep in mind that at this point we are still talking about fueled powered aircraft.

(*Ed. Note: Most competition pilots, Precision or Scale Aerobatics, use Lithium Ion* receiver *battery packs regulated to 5.3 volts. This saves about 4 ounces in weight while providing more energy to the servos. An 88 in. oz. output servo produces about 105 in. oz. of torque operating at 5.3 volts. Servos also center better at the higher voltage. The extra cost is not usually a factor since these aircraft already cost upwards of $4,000!)*

Photo 9

Taking this one step further, you decide to substitute Li-Poly batteries in your RC transmitter. Special Li-Poly battery packs are available that will fit directly into the same space used for an 8 cell Ni-Cd or Ni-MH pack in your RC transmitter. But this kind of battery substitution is even less likely than it is for the airborne (receiver/servo) power. To operate your transmitter you will need a three (3) cell Li-Poly pack that will supply 11.1 volts (3 X 3.7V). One of the typical packs I have in mind is rated at 1800 mAh and cost approx. $75.00. Yet, I can still go to Batteries America (http://www.batteriesamerica.com/) and buy an 8-cell Ni-MH battery pack, with a cable and connector, rated at 1650 mAh. That pack would cost me $34.95 or half the price of the Li-Poly equivalent. The Ni-MH pack could be charged while it remained inside the RC transmitter (using the external charging jack!). But the Li-Poly battery pack would have to be unplugged and removed from the transmitter every time to be recharged.

So in the case of the transmitter, and considering that weight is not a factor in this application, the Li-Poly battery offers you no real advantage.

After having said all of this should we give up on Li-Poly batteries? Should we stick with the original Ni-Cd and Ni-MH batteries that are supplied with RC systems? If we are talking strictly RC systems and you are using a fueled engine for power, I think it safe to say that sticking with Ni-Cd and Ni-MH batteries is the way to go, except for receiver/servo power in extremely small models, competition models and on the other end of the scale, extremely large models requiring a lot of extra control system power. The latter two aircraft will use standard (3.7 V/cell) lithium ion batteries for weight savings and safety reasons.

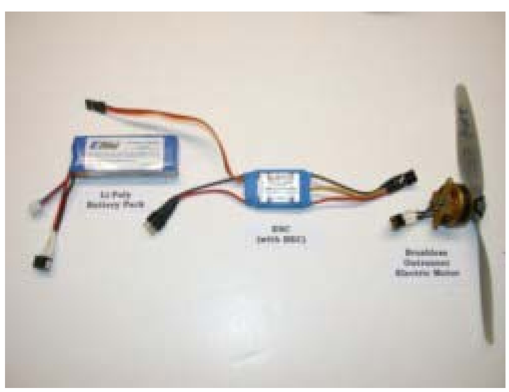

Photo 10

But this is not where this subject ends! In the world of electric powered flight, in the short time of five years, we are now seeing 95% usage of Li-Poly batteries and more recently Li-Ion batteries, to both power our electric motors and at the same time operate our RC systems (shared power as will be explained later!). Electric powered flight of model aircraft has benefited from new battery technology (lithium), new and more sophisticated electronic speed controllers (ESC's) and more efficient and less expensive brushless electric motors.

The subject of this article is still batteries, but I want you to realize that there are other key players in electric powered flight, like ESC's and motors, that make the new lithium batteries look so darn good!

Li-Poly battery packs will always be identified by the number of cells in the pack and by the capacity of each cell in that pack. A "2S" pack is one that has two cells connected in series (2S or 2 in series!). When you connect two of these cells in series you add the voltage. So the "2S" pack will have 2 X 3.7 volt/cell or an operating voltage of 7.4. The pack will also be marked for capacity, which is expressed as milliampere/hours or simply mAh.

Photo 12

As the capacity increases, so does the size of the cell. The battery pack's capacity in the above photo is 340 mAh. With higher capacities, the size of the pack made up from individual cells and the total weight of the pack will increase. The lowest capacity will be the smallest size battery, while the highest capacity will be the largest. Capacity will tell you how long the battery can supply power to run your motor and RC system. The higher the capacity, the longer the motor and RC system will operate.

A third, and very important, identification on Li-Poly battery packs is what we call "LOAD CAPABLE". This measures the battery pack's ability to deliver its electricity, its current flow, to the device the battery is powering; like an electric motor.

Photo 13

You will see figures like "10C", "15C" or "20C". The battery pack in the above photo has a 20C load capacity. This figure will tell you how big of a load you can apply to the battery (in amperes) and still obtain the rated capacity. This figure is not always accurate because some battery manufacturers tend to exaggerate to generate more sales (Ed. Note: *How shocking! I am sure this can never happen in our industry! All kidding aside, most manufacturers do their very best to correctly identify a battery pack's load capacity and label accordingly. But individual installations differ with different connectors, wire sizes and speed controllers sometimes limiting a pack's ability to transfer current efficiently.*) .

The formula for calculating LOAD CAPABILITY is MOTOR CURRENT (in amps) divided by CAPACITY OF BATTERY (in Ah or amp/hours) equals LOAD CAPABILITY.

$$\frac{\textbf{MOTOR CURRENT (amps, symbol “I”)}}{\textbf{BATTERY CAPACITY (amps/hours, symbol “C”)}} = \textbf{LOAD CAPABILITY (symbol “L”)}$$

Transforming this equation to find the battery capacity needed for a certain application, the formula becomes:

I = L x C then C = I / L

So, if you have a battery rated at 10C load capable and your electric motor draws a 15 amp current (load), substituting in the formula:

C = 15 amps / 10 then C = 1.5 amps

You will need a battery capacity of 1.5 Ah; which is the same as 1500 mAh, of a 10C battery in order to sustain a continuous 15 amp current flow. This is an important factor, because just capacity alone doesn't tell you what the battery can really supply.

Li-Poly battery cells can be as small as 30 mAh for micro and indoor RC applications. On the other end of the scale, you will see Li-Poly batteries with capacities over 5000 mAh (5.0 amp/hour).

Photo 14

As the model aircraft gets larger and heavier, it will need more battery voltage and more motor current to fly. That is what prompts the need for larger and larger batteries. Let's say you need a battery that can provide over 18 volts and with a total capacity of 6000 mAh (6.0 amp/hr). In this case, you would need two packs, each with five cells, to provide the 18.5 volts (5 X 3.7 V/cell).

Then, you take these two, five cell packs and connect them in parallel (plus to plus and minus to minus). When placing these packs in parallel, you add the capacity. So in this case two packs, each of 3000 mAh capacity, would then be double that or 6000 mAh (2 x 3000 mAh). After having done that, your "pack" will consist of a total of 10 cells (5 in each section) connected first in series (for the two individual packs, and then the two packs in parallel to achieve a total capacity of 6000 mAh.

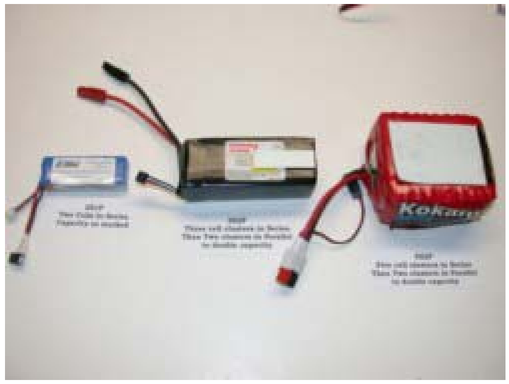

Photo 11

Keep in mind that connecting batteries in *parallel* when it came to Ni-Cd and Ni-MH cells was *not recommended*. But with Li-poly batteries, it is a perfectly acceptable technique. Now you should know what is meant by Li-Poly designations, “3S 1P”, “4S 2P” and “5S 2P”.

As we gathered experience using the new Li-Poly batteries, we learned of a very important characteristic that had to be addressed during the charging process. Li-Poly batteries, to provide the best possible capacity and load capability, must be balanced. By that we mean that each cell in a pack should be charged to the exact same voltage. Within the past two years most Li-Poly manufacturers have caught on to this need and have been providing battery packs that contain two sets of connectors. One connector is the main power output that goes to your ESC (electric motor speed controller).

Photo 15

The other connector is sometimes referred to as a “node” connector and has many pins (multipins) so that each battery cell within the pack can be separately accessed. This is the connector that you use to recharge your Li-Poly battery pack using a special charger intended for this purpose. Please note that not all node connectors are wired the same way. Make sure you use only the “balancing charger” designed for your make of batteries. Using the wrong charger connected to the node connector could result in an explosion or fire. Be careful here.

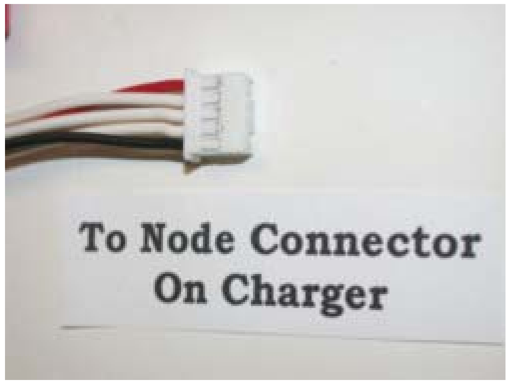

Photo 16

When using the proper balancing charger (the one made by the manufacturer of your batteries or one that can work multiple manufacturer's battery packs), your packs should always remain in balance, all will be at the same voltage (or close to it), after completing each charge. Keep in mind that many of the older or original Li-Poly battery packs dating back to about five years ago may not have this separate cell wiring. But safe to say that today (January 2007) just about every Li-Poly battery sold will have the separate cable and node connector.

Now that you know that the cells need to be balanced and that the batteries are supplied with separate cell wiring, how do you charge them? Various techniques have been and are being offered to help balance your Li-Poly battery cells while under charge. One of the better techniques to surface to date are the CellPro and BalancePro chargers as supplied by FMA Direct (http://www.fmadirect.com/category.htm?id=4). Both of these chargers contain separate circuitry so that each cell can be individually charged. You connect up the node connector from your battery pack to the FMA CellPro 4S charger

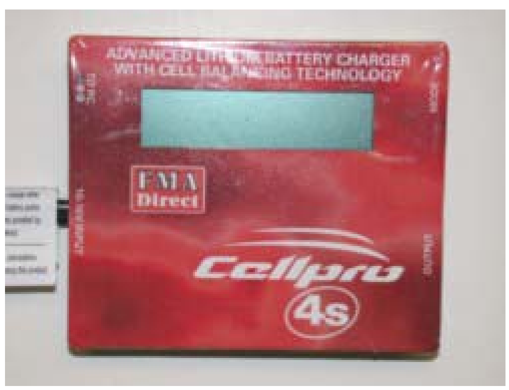

Photo 17

It will individually charge each cell, until each cell reaches the full charge potential of 4.20 volts. At that point, the particular cell cuts off and waits for the remaining cells to get to the same point. The CellPro charger also has an LCD screen that tells you the amount of charge in your pack (expressed as a percentage!), the voltage of each individual cell and the amount of charge that was put back into the pack (in total) during charging.

Photo 18

The CellPro is intended for the average to smaller size Li-Poly battery packs. The BalancePro is for the much larger batteries that require more voltage and charge current. I'm sure in the near future many other manufacturers will be developing and producing similar type chargers. I'm not picking favorites at this time. I'm only telling you what I use and feel comfortable with. (*Ed. Note: Each battery manufacturer now offers a balancing charging system for their batteries. If you are just starting out in electric powered flight, it might be the best idea to standardize your battery maker and use their balancing charger only. This works at least until you get more sophisticated at mixing various chargers and battery makes.)*

Photo 19

Note on this label that it states, "Never exceed 1C charge rate!"

The recommended maximum charge current for Li-Poly cells, at this time, is still a 1C. 1C means 1 times the capacity of the cell. So a cell rated at 1500 mAh, (1.5 amp/hour) would get charged at 1.5 amps. At that rate, it should reach full charge (or close to it) in about one hour. That is longer than the 20 minutes for Ni-Cd batteries and the 30 minutes for Ni-MH. But be advised as the charging techniques are being improved, the charge current for Li-Poly will slowly be increasing.

The fact that these cells have so much capacity for their size and weight allows the modeler to make several flights on a single charge before it becomes necessary to go back on the charger for the one-hour period. But please keep in mind that Li-Poly batteries should only be charged with chargers dedicated for that purpose or with chargers that have special adapters that permit proper charging. You don't ever want to use a peak detect charger, by itself, to charge a Li-Poly battery pack.

A final charge time note - If time allows, charge any Li-Poly at a 100 mAh (0.1 amps) rate. For all Li-Poly batteries, the slower the charge rate, the longer the battery pack will last.

Because of the new (to us!) battery chemistry, Li-Poly batteries should receive careful treatment in the interests of safety (personally and to your car or home). Charging a Li-Poly battery cell above the maximum 4.20 volts can lead to cell destruction or a possible fire!

Setting your charger to the wrong number of cells in a pack can also cause a melt down (fire!) or at best will result in an undercharged pack. It is most important that you not leave your battery unattended during the one-hour charge period. When you first turn on the charger, make sure, if it automatically sets the number of cells, that the charger made the right choice. If manually set, make sure that you select the right cell count and the correct charge current.

Photo 20

All Li-Poly battery packs should be charged outside the aircraft. In another words the pack should be removed from the airplane for charging purposes. When doing this, it is a good idea to sit the battery on a ceramic plate or some other heat resistant surface. Always keep a prescribed fire extinguisher and a 10 lb. bag of sand nearby when charging. The sand covers the battery cutting off the air (extinguishers will *not* put out a Li-Poly fire) while the extinguisher will put out anything else that the exploding battery had set on fire. If you are field charging, don’t charge the battery inside your vehicle. Always attach the charger to the car battery (with the hood open). Placing a small folding table next to the fender of your car and putting the battery on that table, is the best idea.

Photo 21

It’s a good idea to keep a sealed metal case, like this ammunition box with you when you travel to your flying field. If your battery appears to be getting hot or is swelling in size, place it immediately in this sealed container

As mentioned before, Li-Poly battery cells should not be discharged below 2.5 volts, and ideally not below 3.0 volts. To be on the conservative side. Modern electric motor speed controllers (ESC’s) have built-in circuitry that monitors the operating voltage and will burp or shut down your motor entirely when a preset minimum voltage is reached.

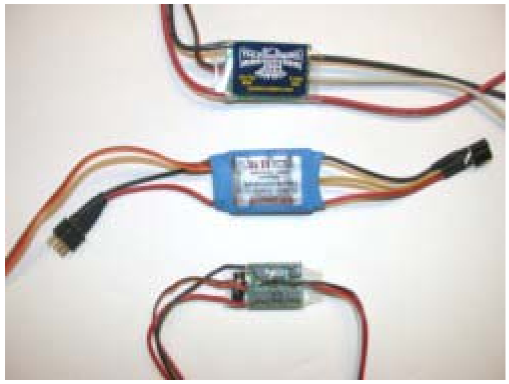

Photo 22

These are some typical and excellent modern ESC's. At the top is the Castle Creations Thunderbird brushless motor ESC. At the bottom is the tiny Castle Creations Phoenix-10 ESC. In the middle is the Jeti Advance ESC

If you have an older ESC that does not have this feature, you can still obtain add-on cut-off devices that will warn you when the voltage goes below the recommended minimum. If you take your battery down too low, it will quickly fail.

Photo 23

FMA Discharge Protection Module

One interesting point comes to mind with the concern that the Li-Poly cells (in a pack) always be balanced. You can start with all the cells at the same voltage. But if one of the cells has less capacity than the others, it might go below the minimum voltage, while the pack's total voltage is not low enough to trip the cut-off feature of the ESC. To cope with this problem, FMA Direct has come up with a device they call a DPM (Discharge Protection Module).

It goes on board your aircraft and, thanks to the node connector on your battery pack, it checks on individual cell voltages. When the first cell in your pack gets down to the recommended minimum, it burps or stops your motor. I've used this device and it works. But it adds more bulk, complication and weight to your aircraft equipment. My feeling is that just the proper balanced type charging (like with the CellPro charger) is good enough. The DPM is there if you feel you need it!

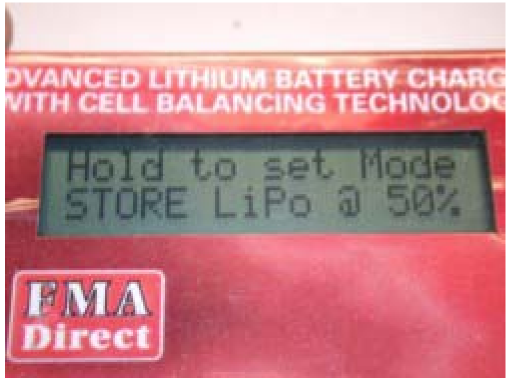

Photo 24

Here the CellPro 4S is in the STORE mode, which will charge Li-Poly battery, packs to only half capacity for storage purposes.

Storing Li-Poly batteries is once again an item that requires special, or at least different, considerations from other type batteries. Li-Poly batteries will last the longest long term if stored at half of the rated capacity. Generally if you recharge your Li-Poly batteries to about 3.8 volts, instead of 4.2 volts, you are at the right level for storage. Then, when you plan to use the battery pack, just recharge it to the full 4.20 volts per cell. The FMA CellPro charger now has a mode that will charge your Li-Poly battery pack to half capacity and then cut off. That is a neat feature!

Back earlier I eluded to the fact that thanks to modern electric motor speed controllers (ESC's) a built-in circuit, called a BEC (Battery Eliminator Circuit) allows you to use one battery pack to both operate your electric motor and your RC system. In other words the battery is shared between the two functions. For safety reasons, the ESC senses when the battery voltage is getting low and stops the motor, while there is still power remaining in the battery to continue to operate the RC system and fly the airplane in for a safe landing. In fact, some of the "smart" ESC's will give you one more chance for a short burst of power, after that first warning shutdown. This way, if you are short of your landing site, you may have enough power left to stretch it back for a landing.

The nice part of this shared battery concept, when using electric power, is that it really isn't necessary to discharge test or cycle the battery pack. In effect on every flight, you start with a fully charged battery, and at the end of the flight the battery may be close to being fully discharged. Then you charge up again. So this provides essentially your cycling of the battery.

Common sense will tell you that, after charging, if your airplane can't get off the ground, or it glides in right after being hand launched, that something is wrong with the battery. You may also notice while flying that each flight seems to be getting shorter and shorter, with the motor shutting down prematurely. Any situations like this means more than likely that you have one or more "weak" cells in your battery. (*Ed. Note: If this is a **new** airplane doing this with a new battery pack, it is likely that the speed controller is overheating. An overheated speed controller will also shut down the motor until it cools. If this happens to your new aircraft, increase the cooling air flow, and air exit area, to the speed controller.)*

If you substitute another battery pack, and the flight performance goes back to normal, that battery giving poor results should be a candidate for retirement. I never repair a battery pack. When I have a problem pack, regardless of the reason, it is simply retired and discarded (in a prescribed manner).

There is one more comment that is relevant when talking about and ESC with a BEC. Up until recently, the amount of power available from a BEC to operate an RC system was somewhat limited. The regulator circuit in the BEC could only handle battery voltages up to about 13 volts and could only supply current for the receiver and servos up to about 1 or 2 amps. If you required higher voltages and had a lot of high-powered servos in your RC system, you were forced to by pass the BEC and use a separate RC four-cell receiver/servo battery pack (like the ones supplied with the systems).

Photo 25

The new Jeti SPIN ESC is of the new variety that employs a switching circuit in the BEC function

Well, the good news is that some smart engineers have now gone to what is known as a “switching” circuit that provides for more efficient BEC operation. Some new ESC’s can now handle voltages as high as 40 volts and more with current levels upwards of 2-3 amps. More and more of these new type ESC’s are coming on the market every day. So the previous limitation on BEC’s is quickly going away and will be a real benefit to future electric powered aircraft enthusiasts. That means more and more electric powered aircraft will enjoy being powered by a single battery pack.

Now for the promised words on the “other” lithium battery, namely, lithium ion (or Li-Ion as we call them). Li-Ion cells have been used for quite a few years in the cell phone market and in digital cameras. Unlike Li-Poly cells with their somewhat expandable aluminum pouches, Li-Ion batteries have cylindrical sealed cases and look more like Ni-Cd and Ni-MH cells. Because of the sealed construction, early users found that during improper charging these cells might explode. To prevent that from happening, safety circuits were built right into the battery. If they were over charged or discharged too deeply, these safety circuits would open to protect the user and save the battery.

With our shared batteries in many electric powered aircraft, had we resorted to Li-Ion batteries it is possible that the built-in protection circuit might open, cutting off power to both the motor *and* the RC system. That would result obviously in a crash! For that reason Li-Poly batteries became the choice of the electric flyer.

Well, recently a group of engineers from MIT, started a new venture capital business in Watertown, MA known as A123 Systems Inc.

Photo 26

These engineers were able to develop a new Li-Ion type battery cell that has very high current capability, combined with very fast recharging time. They also are constructed in such a way as to eliminate the possibility of explosion or fire. These new A123 Li-Ion cells are now featured in a new line of DeWalt portable battery operated power tools. They are claimed to be capable of supplying up to 70 amps current and can be recharged in as little as 15 minutes. It also appears that the cost of a single cell may come down to approx. $10.00.

Although still based on lithium technology, these new A123 Li-Ion cells have a different characteristic voltage. They are fully charged when they reach 3.60 volts. Their nominal (average) voltage is 3.30 volts. At the present time there is only one size cell available. It is rated at 2300 mAh capacity. Each cell weighs approx. 3.0 ounces. The maximum load capability is claimed to be a very high 30C. My initial tests and use of these cells indicate that 17-20C-load capability is a better and more conservative rating for our electric powered flight applications. Charging current can be around a 4C rate or approx. 9 amps (4 X 2.3 = 9.2). At that rate a full charge can be obtained in 15 minutes, which is faster than both Ni-Cd and Ni-MH cells. My experience has indicated that even with that high charge current these cells barely get warm!

Photo 27

The CellPro 4S charger can now be set to charge A123 Li-Ion batteries. Note A123 on the LCD screen

But since the voltage at full charge is different than with Li-Poly batteries (4.2 volts Li-poly and 3.6 volts for Li-Ion), you won't be able to use a regular Li-Poly charger. That by itself might prove a problem, except for the fact that the engineers at FMA Direct have just come out with a new version of their CellPro 4S charger that is capable of charging **both** Li-Poly cells to 4.2 volts per cell and A123 Li-Ion cells to 3.6 volts per cell. All the other features of the CellPro will also work for A123 batteries.

The new A123 battery packs are now being shipped with node connectors that allow it to be plugged directly into the CellPro charger. As is the case with Li-Poly batteries, each cell in the A123 pack can also be charged separately and at the end of charge all cells will be in balance (at the same voltage). An excellent white paper titled, "Managing A123 Batteries" can be found at this FMA Direct exact website: http://www.fmadirect.com/support_docs/item_1229.pdf.

To give you an example of A123 battery application I recently replaced the 8 cell (9.6 volts), 1250 mAh Ni-Cd battery pack in my PLAYBOY SENIOR used in the E-NATS Class-B Old Timer competition. That pack weighs 13 ounces and the motor current is a very high 40 amps. In its place I substituted a 3-cell A123 Li-Ion pack with a nominal 9.9 volts (3 X 3.3 v/cell) rated at 2300 mAh and weighing only 9.0 ounces. At 40 amps the load capability is 17.4C. I was able to obtain at least four 1 minute motor runs at the 40-amp load level before recharging was necessary. So consider this, I obtained roughly the same voltage, got twice the capacity and the weight was 30% less.

Photo 28

Photo 29

(A closer view showing the older Ni-Cd battery at the left and the new A123 pack on the right

One of the interesting side facts to note is that the Li-Poly batteries are so light, that in many cases you won't have the weight up front to properly balance your airplane. In that instance, the heavier A123 cells will help achieve the proper balance. A123 Systems has indicated that new cells are on the horizon at various capacity levels and physical sizes. This is something you want to watch in the future.

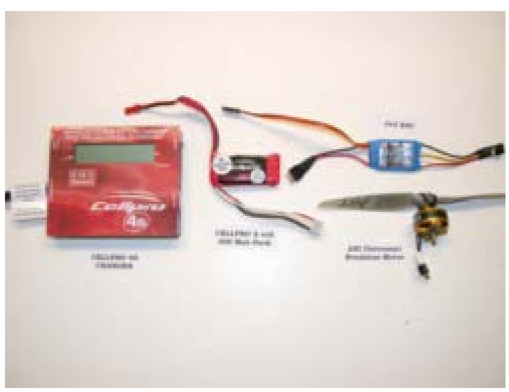

Photo 30

The key components now used in electric powered flight

So this is where we are right now after just five years using lithium type batteries. Their biggest advantages can be found in electric powered flight. Combine these new lithium batteries (the prices of which keeps coming down!), with progressively improved ESC's and brushless motor technology and one can only wonder what our hobby of flying RC model aircraft will be five years from now!

REFERENCE READING:

You really should read both the Part-One and Part-Two articles of this battery series, as well as this Part-Three. They all appear in one place in SPORT AVIATOR. Also appearing Sport Aviator's Pri-Fly Section is the "From The Ground Up" article about batteries: Battery Basics.

There is also some good information at Battery University: http://www.batteryuniversity.com/index.htm

Model Aviation's Battery columnist: Red Scholefield writes a bi-monthly column on all kinds of current battery products and questions. He can be reached at: red@rcbatteryclinic.com

Frequently Asked Questions (FAQ) monthly column by Bob Aberle appearing in Model Aviation. You can reach him at: baberle@optonline.net.