

## LiPo Battery DO and DON'Ts





LoveAir RC

Presented by Dave Sharpe



#### Lithium polymer battery – LiPo or Li-Po Background:

- <u>2 Main Types of LiPo's Cells</u> Lithium ion polymer and lithium ion
  - The main difference between them is the physical phase of the electrolyte
  - LiPo cells use dry solid, gel-like electrolytes
  - Li-ion cells use liquid electrolytes
- Four main components: positive electrode, negative electrode, separator and electrolyte (all within a case or pouch)
- Significant Benefits:
  - Provide higher specific energy than other lithium (salt) and non-lithium battery types (NiCad, NiMH, ...)
  - Good for applications where weight is a critical feature
  - Allows for a very compact design, and flexibility in shape
  - Low self discharge rate of ~5%/month

#### LiPo Battery Parameters/Definitions

- <u>Cell Configuration</u> how many cells are in series (S) and parallel (P)
  - More in Series increases voltage
  - More in Parallel increases max current & pack capacity
- <u>Battery Capacity</u> Milli Amp Hours (mAh)
- <u>Discharge Rate</u> (C) maximum current the pack can safely provide without damage
  - mAH X "C" rating
- <u>Nominal Battery Voltage</u> cell quantity times cell voltage
  - Standard cells 3.7 volts/cell
  - HV Cells 4.35 volts/cell
- <u>Watt Hours (WH</u>) battery capacity (mAh X volts)



Watt Hrs



#### Do - Have a Class - ABC Fire Extinguisher near by Don't - Never charge batteries unattended

- If a battery "cooks-off", you'll need to act quickly. A typical fire will double I size every 30 seconds!
- LiPo fires are considered Class B (flammable liquid) fires
- https://www.youtube.com/watch?v=seooNSZSFDs





#### Do - Use a Charger Specifically made for LiPo batteries Don't - Never exceed the manufacturer's Charge Rate and never charge above 4.2 volts per cell

- Manufacturer's will always specify a maximum charge rate
  - Typically 1 to 5 C if in doubt, use 1C
  - <u>NEVER over-charge LiPo Batteries (current or voltage)</u>
- Excessive charge rate can damage to battery shortening life, cause over-heating, swelling, case/enclosure failure could result in fire
- Excessive voltage (>4.2v/cell) will cause a fire!
- Always use the battery-charger balancing leads
- I do not recommend parallel charging unless you <u>really</u> know what you are doing!

There are many excellent chargers on the market

- Costs range from ~\$60 to ~\$300
- Many are designed to charge several different battery types NiCad, NiMH, LiPo, LiFe, Lead-Acid, ...
- Charge 1 to 4 batteries at a time
- Newer ones have auto-detect features (Spektrum SMART)



#### Do - Use a "Battery Box" made for LiPo batteries Don't - Charge batteries without an Enclosure

- The enclosure needs to be capable of containing flame but allow for venting large volumes of hot, sooty, expanding gasses
- A Bat Safe (best) or properly modified Ammo Box (pretty good – remove any seals!) are suitable for containing/venting a LiPo fire
- Boxes and LiPo Bags can be easily "over-loaded" with too much battery capacity (Amp Hours – AH), reducing their effectiveness
- \* LiPo bags are better than nothing, but marginal at best for preventing the spread of a fire





#### Bat Safe

- Available in 4 sizes (2 useful, 2 large)
  - Mini ~ \$40
  - Bat Safe ~\$70
- Contains heat, flames, and filters soot
- Cools hot gases as it vents
- Has fire-resistant grommet for charging and cell leads
- Bat Safe can store & charge 2X 6S, 5000mah or equivalent 222WH
- <u>https://www.bat-safe.com/</u>



#### Do - Regularly monitor your flight times and remaining battery capacity

- Battery capacity (AH) will gradually decrease over time increasing the possibility of over-discharge
- Maximum discharge of the pack will occur under load when the airplane is flying
  - If you have a telemetry radio use the monitoring/reporting function to determine the lowest discharge level of the pack under load

## Don't - Discharge batteries below 3.2 volts per cell, or below 20% rated capacity

- There is lots of competing information about minimum discharge level. From 2.8 to 3.2 volts – I suggest 3.2v to maintain good battery life (same for HV batteries)
- Cell voltages below manufactures stated minimum may cause permanent damage
- Discharging below 20% capacity will reduce battery life
- Check cell voltages with a volt-meter under load \$15 to \$50:
  - 2 cell 6.4 volts min
  - 3 cell 9.6 volts min
  - 4 cell 12.8 volts min
  - 5 cell 16.0 volts min





#### <u>Do - Monitor battery packs for swelling and other damage</u> <u>Don't - Don't fly with a battery that excessive exhibits swelling</u>

- Excessive swelling can indicate a pack that has internal damage due to normal use or excessive discharge ( voltage and/or current)
- Check battery pack pre/post flight for excessive swelling (they will get a little puffy due to temperature increase from use – this is normal)
- Check the pack temperature post flight excessive heat can damage packs and reduce life





<u>Do - Use the Storage Charge function on you charger or a</u> <u>Battery Tender to obtain the Proper Storage Charge</u> <u>Don't - Store Batteries at Full Charge or Discharged condition</u>

- Storing at full charge will reduce life (charge/discharge cycles) and encourages swelling
- All modern chargers have a storage charge function use it!

#### OR

- VIFLY StoreSafe Smart LiPo Discharger XT30 or XT60 from https://www.getfpv.com/
- Typical store charge is 3.8 Volts per cell, or ~50% to 60% capacity





#### Don't - Transport Batteries without an Enclosure Do - Use a Bat Safe, Ammo box, or Bag

- Place Battery Enclosure in a safe, secure position that can be easily accessed in a hurry if necessary and safely remove it if necessary
- ALWAYS have a fire extinguisher in your vehicle that can be reached quickly and easily in case a fire should start

#### Do - Safely discharge damaged batteries prior to transporting or discarding them Don't - Place batteries that have been in a crash into your vehicle or trailer

- Damaged batteries can suddenly swell and burst without much warning – even if they appear to be ok after a crash
- Never intentionally puncture the battery as it may cause a fire or explosion
- Use a Bat Safe, Ammo box, or Bag if you have to transport damaged (hopefully discharged) batteries
- **Better yet!** place damaged batteries into the battery bucket at the flight field (coming very soon)
- <u>Don't EVER Short the battery leads fire could result!</u>

#### Do - Safely discharging damaged or "used-up" batteries

- Use a passive device (resistor, light bulbs, LiPo Killer, ...) to safely discharge damaged batteries to Zero Volts
- Resistor Method:
  - 1 Ohm, 200 Watt resistor X2 (Amazon for under \$15)
  - 1 Ohm, 500 Watt resistor (Amazon for ~\$30)
  - Place in <u>Series</u> if required to reduce the discharge current
  - Power (W) = I (Current) X E (Voltage) don't exceed resistor rated wattage!
- LiPo Killer Method: LiPo Killer Device <u>https://www.getfpv.com/lipo-killer-0v-battery-discharger.html</u>
- Light Bulb Method: 12 Volt automotive bulb(s) 1156 type
- Placing batteries in a bucket of salt water it works, but is slow and messy (also - lithium is reactive in water, so if the battery enclosure has been compromised, don't do it!)







#### <u>Do - Store batteries between 68 and 77 degrees F</u> <u>Don't – Subject batteries to temperatures below 14 degrees F, or</u> <u>above 140 degrees F</u>

- Damage can occur if packs are exposed to temps below 14 degrees F
- LiPo batteries loose capacity (AH) as they get colder reducing flight time, increasing the possibility of over-discharge
- Avoid storing LiPo batteries in extreme temperatures (> 140 F). High temperatures can lead to capacity loss and even thermal runaway (fire or explosion)

Do - Dispose Fully Discharged batteries at an approved recycling center Don't - Dispose of LiPo batteries with other household waste or household recycling items

- Use a passive load or discharger to fully deplete the battery
- Some places for disposal are :
  - The Mac Shack 157 N. College Ave
  - Batteries Plus 1107 W. Drake Rd (there is a per-pound charge)
  - Fort Collins Timberline Recycling Center 1903 Timberline Rd
  - City of Loveland Recycling Center 400 N Wilson Ave
  - Larimer County Household Hazardous Waste Facility 5887 S. Taft Road
  - Home Depot, Lowes (?)

# Cycle (condition) new batteries to obtain the highest capacity (AH)

- Lots of opinions, but not a lot of manufacturer data available
- What I do: (I'm not an expert on this)
  - Charge/Discharge cycle at 1C or less 2 to 3 times
  - Perform a ground (load) test: (see next slide)
    - Run "flight" profile monitor battery voltage and watts
    - Stop test once the first cell hits **3.3 volts**
    - Let battery recover for ~1 minute measure voltage and view the Run-Time, Amp Hours, and Watt Hours consumed
    - Is the outcome reasonable?
  - Limit power draw (current) and flight times (voltage) for first few flights check battery capacity after each flight how much was used?
- Anyone have recommendations?, Ideas?, ...





### Fly Safe!