Funktionsbeskrivning top ballansering

Fritt stulet från http://www.pbase.com/mainecruising/lifepo4_on_boats&page=1

Sist vår egen erfarenhet

Manual top balance

For off-grid / marine use top balancing is quite often the preferred method so the cells converge or are in excellent balance at the top, when fully charged, rather than when dead or fully discharged. I chose a top balance f and even after 750 cycles the cells have tended to converge in cell voltage rather than diverge.

Balancing The Cells

First charege individual cells

I first charged these cells, INDIVIDUALLY, to 3.65VPC[1] and X current taper. The bench-top power supply allows you to set the voltage to 3.65 and let the cell become "full" at 3.65VPC. I held the voltage at 3.65V and allowed the current to tail off to exactly 20A then stopped charging and moved onto the next cell.

Within seconds of wiring in parallel only 0.59A was moving between cells which means my balance to 3.65VPC was pretty close.

TIP: Never trust the volt meter on the bench top power supply as there may be voltage drop or inaccuracies between the supply & actual battery terminals. ALWAYS measure the actual battery terminal voltage using a good quality DVM.

DO NOT leave the cells unattended.

Keep an infrared thermometer on hand and closely monitor cell temps. Hit all the cells at the same spot, when checking on the cells, to track any changes or anomaly's. They should ideally remain below 25-30 ºC.

WARNING: It is fairly important that you top each cell up[2] prior to wiring them in parallel, unless you have a large power supply or do them in series using a large inverter/charger. They should ideally be very close in SOC/balance before placing the parallel jumpers in place. This helps to get most of the balancing done.

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[1] Winston cells should not be top balanced or have the voltage pushed beyond 3.800VPC, this despite what the Chinese manual tells you. In reality, I personally would not advise pushing them to any more than 3.65V for a top balance as there is no need to do this for a fractional C system.

[2] It is really a net myth that simply wiring the cells in parallel will serve to get them balanced. While they may be at the same "voltage" they may not be at the same SOC. This is because once voltages become at parity, there is little to no voltage to move any meaningful current between the cells. You need to actively charge in parallel, this can take lots of time.

The resting parallel conundrum

As the voltages converge, after being wired in parallel, the movement of current between cells slows to a crawl, it is simple Ohm's law. We are talking 0.0001A level current movements and at this rate "balancing" takes forever.

Balancing parallel cells

You need to actively charge in parallel above the resting voltage in order to get the cells to balance. Once this is achieved, discharge them[3] to about 50-60% SOC, in parallel, and they can sit there for long periods.

TIP: Never trust the volt meter on the bench top power supply as there may be voltage drop or inaccuracies between the supply & actual battery terminals. ALWAYS measure the actual battery terminal voltage using a good quality DVM.

Please **keep an infrared thermometer on hand and closely monitor cell temps**. Hit all the cells at the same spot, when checking on the cells, to track any changes or anomaly's. They should ideally remain below 25-30 ºC.
Allow the voltage to rise to 3.80 V[4] and hold the cells[5] at 3.800VPC for about 15-20 minutes once you get there. Once the current has tapered at 3.8V for 20 minutes or so. Dropp the voltage to 3.65V and allow the power supply to take the batteries to 100% full with the power supply bouncing between 0.0A and 0.1A. This actually puts the cells in balance at that voltage. At this point the cells are balanced. Remember, when these cells are wired in parallel you have a 1600Ah 3.2V bank. Even the last 0.05 V VPC requires many, many hours to get there.

After balancing, disconnect the charge source.Let them sit, in parallel, for as long as you want, after discharging them to a storage SOC of 50-60% SOC.

If you MUST shunt balance

Shunt cell balancing begins at about 3.55VPC, with the 3.6V cell boards. In order for my own system to do shunt balancing I must disable HVC and then push the cells into the shunting voltage range manually.

I DO NOT ALLOW MY BMS SYSTEM TO "BALANCE" AUTOMATICALLY !

The need for balancing LFP cells, in a well designed fractional C system, is proving to be far less often than equalizing lead acid batteries. **Proper initial balancing and safe charging voltages can result in your cells not drifting thus no need for automated cell balancing** every cycle. Again, this is with safe & sane design voltages. Keep your charge voltages below where pack balancing occurs and you will do just fine. My cells are now beyond 750 cycles (took a very long time and lots of work to do that) and has exhibited virtually no capacity loss, no notable changes in internal resistance and no cell drift. Most cycles to 80% DOD. They have only been balanced once, 750+ cycles ago.

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[3] You don't want to charge to 100% SOC then let them sit there as this can serve to degrade the cells, don't let your batteries linger at or near 100% SOC for very long.

[4] for Winston cells

[5] Some say you can stop once you hit 3.800 VPC but I like to let the current taper a bit and 15-20 minutes is plenty, once you hit the top balance voltage.

I am a believer that shunt balancing should be a "monitored" event. If you do ever need to balance the cells I much prefer doing this on the bench with a power supply. It is my belief that a bench-top power supply with independent voltage and current control should be used to supply the LEAST amount of current that it takes to do the job of balancing whether you use the shunting of the BMS system or wiring the cells in parallel and doing it manually. If you have a current source that can limit current similar to a bench top power supply then that will work too. The point being these resistors can only "shunt" so much.

If this bank is any indication the need for this would be about once ever 5-6 years for a coastal cruiser and about every two years + for a full time cruiser. A hassle? Not at all.... I am also a believer that high charging voltages, above 14.2V, per 12V nominal pack, simply result in more of a need for "balancing". Pushing the charge voltages too high results in more need for balancing and it becomes a vicious cycle. A real catch 22. Interestingly this actually serves to create a need for a "balancing" BMS systems.

Så här gjorde vi

Vi hade en ström/spänningsgenerator som klarade max 20 A. Vi laddade med 2,5 mm^2 kablar vilka gav lite spänningsfall så vi justerade laddspänningen tills vi fick önskad spänning mätt på cellerna.

Vi började med att ladda cellerna var för sig. Vi mätte spänning direkt på cellen med en digital voltmeter. Med max ström (20 A) laddade vi tills vi nådde 3,65 V. Sedan justerade vi spänning till 3,65 V och väntade tills laddströmmen gick under 14 A då laddningen avslutades. Det tog mellan 10 och 11 timmar att ladda var cell och det var inga problem att göra det vid olika tillfällen, t ex börja ena kvällen och fortsätta nästa.

I nästa steg parallellkopplade vi cellerna. Innan vi parallellkopplade hade cellerna en spänning på mellan 3,353 och 3,362 V. Parallellkopplade blev spänningen 3,358 V. VI laddade först med max ström (20 A). Efter ungefär en och en halv timme var vi uppe i önskad spänning på 3,800 V. Vi laddade där till laddströmmen sjunkit till 10 A. Sedan fick vi stänga av laddningen och vänta till spänningen på cellerna sjönk till 3,650 V vilket tog ca 15 minuter.

Därefter började en tidsödande utjämningsladdning. Vi körde var kväll och ibland när vi var hemma även på dagtid men aldrig utan övervakning. Sammanlagt laddade vi i nästan 50 timmar innan laddströmmen var nere på 0,000 A, vi hade då 3,649 V innan vi stängde av. Efter en dag hade vi 3,635 V.

Urladdning till ca 65 % gjorde vi med hjälp av en ca 15 m lång 1,5 mm^2 kabel som ”kortslöt” batterierna med. Vi kunde då ladda ur med ca 13 A, vilket var lite lågt/långsamt men det var inga problem att kyla kabeln. Vi la den i en slinga på gräsmattan utanför. Det tog oss drygt 40 timmar att ladda ut drygt 550 Ah under 6 dagar. I slutet var i nere på 3,300 V innan vi avbröt urladdningen. Efter några dagars vila hade den stigit till 3,311 V vilket motsvarar 13,24 V i det seriekopplade batteriet.

Under hela processen mätte vi utvändig temp på cellerna. Vi hade bara 2-3 graders temperaturhöjning och i vårt ca 15 gradiga gästrum kom vi aldrig över 21 grader. Urladdningen gav ingen mätbar temperaturhöjning alls.