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Monitoring the battery State of Charge

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Monitoring the battery State of Charge (SOC) is probably the most important task to perform with a solar system. Unfortunately this is difficult to assess with a high degree of accuracy, particularly for the novice. There are three main methods to determine battery SOC.

1. Voltage: The voltage must be measured when the battery is 'at rest'. This means that there is no charge going into the battery and no load going out. Ideally the battery should be 'at rest' for 20-30 minutes before measuring the voltage. Approximate values for a 12 Volt battery are:

Voltage % SOC

12.57 100%
12.36 80
12.15 60
11.94 40
11.73 20

As you can see, the voltage range is fairly narrow so you need quite a good digital multimeter to measure these values.

2. Specific Gravity: You can use a hydrometer to measure the density of the electrolyte to give you an indication of the SOC. This is also prone to interpretation and assessment. When a battery becomes discharged, the electrolyte becomes lighter. When you charge the battery up, this lighter electrolyte will tend to float on top and give you a very pessimistic reading. This is known as electrolyte stratification and is only overcome when the electrolyte is mixed up again by the bubbling action of a good charge. Adding distilled water to your battery will affect the reading in the same way. There are also issues with how to read a hydrometer and the quality of hydrometers. A dirty hydrometer can contaminate a battery. To get an accurate reading, you need to adjust the figures for temperature compensation. Different battery manufacturers can use different acid strengths in their batteries. So, in conclusion, judging battery SOC from a hydrometer reading also has many difficulties and inherent inaccuracies.

Plasmatronic PL regulator: The last method involved monitoring amphours in and out of your battery. To quote from the Plasmatronic Manual:

"SOC (State of Charge) should be read as a percentage estimate of how full the battery is.

The estimate is based on the amp hour balance counter. This counter keeps a running balance of amp hours in versus amp hours out. The SOC display shows this balance as a percentage of the battery size. Note that the battery size must be entered by the installer with the BCAP (battery capacity) setting before SOC will be meaningful.

Over time, the amp hour balance counter will drift out of line with the real battery State of Charge To realign the counter the PL makes two corrections:

1. When the regulator state changes from Absorb to Float AND the charge duty cycle is less that 25%, SOC is reset to 100%.

2. SOC is capable of reading more than 100%, however as soon as 1Ah of discharge is recorded it will be set back to 100%.

Note: The SOC figure should be treated with caution, as there are several reasons that it may be inaccurate:

* The PL does not automatically have knowledge of the whole system. For SOC to work at all, the PL must be measuring all charge (Ah in) and discharge (Ah out). If the battery can charge or discharge without the knowing PL, SOC will not be meaningful.

* Variations in charge efficiency mean SOC will tend to be a little optimistic.

* The effective capacity of the battery reduces with age. BCAP should be reduced in older batteries to adjust for this.

* Self discharge and variations in temperature will also cause some inaccuracy."

The battery inefficiency and self discharge losses show up when the SOC reads more than 100%. So it is not unusual to see the SOC at say 112% when your battery comes into Float. The 12% represents the extra power your charging sources had to put in to make up for battery losses.

If your battery is in float – say showing 112% - it will drop to 99% once one amphour is discharged. Let's say it goes down to 80% and the next day it only rises to 90%. Unfortunately the 10% that has gone in does not account for the losses in charging the battery. So it is probably only about 89% charged rather than 90%. This is pretty minor. However, with prolonged cloudy weather or charging for several successive days without reaching float, the error becomes cumulative. So a similar charge on the second day will only take it to 88% charged, etc. A couple of weeks of cloudy weather could easily lead to an error of 15-20% (on the optimistic side). Charging inefficiency decreases as the battery becomes discharged so to some extent this error decreases as the battery becomes discharged.

So to conclude, I feel that the %SOC display is extremely useful. For most occasions I feel it is more accurate than measuring battery voltage or specific gravity. However after several days with the battery not going into float the display can become significantly misleading. In this case, we'd also suggest you have a look at your minimum and maximum voltage to make a better judgement as to your battery State of Charge.

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