Battery Information Sheet

This worksheet contains basic information on lead-acid batteries

Lead acid batteries store energy in the form of a reversible electro-chemical reaction between lead plates and sulfuric acid. Lead acid batteries are used to store electrical energy in many systems, including off-grid renewable energy systems.
They are direct current (DC) devices. Batteries are comprised of cells, each with a voltage of around 2V DC. Typical battery volatges are 6, 12, 24 and 48V DC, the 6-cell 12V DC battery is the most typical.
Battery capacity is measured in amp-hours (Ah). This is the number of hours a certain current can be maintained. To find the energy (watt-hours or Wh) contained within the battery, multiply the battery capacity by its voltage.
Battery capacity depends upon the magnitude of the current being drawn from the battery. *For example:* a battery might be able to supply 1A for 120 hours (120Ah at 1A rate) but only supply 10A for 10 hours (100Ah at 10A rate). Good quality batteries will have a number of capacity ratings at different currents, usually quoted as the capacity (C) divided by a factor. *For example:* a battery might be rated at 100Ah at C/10 (C = 100Ah so current is 100/10 = 10A), 70Ah at C/1 (current is 100A) and 120Ah at C/100 (current is 1A). It is best to ensure the average charge current is not greater than the C/10 rate of the battery.
It is very difficult to accurately assess how much energy is contained within a battery (usually called its **State of Charge**). As a result they are generally not well maintained frequently fail before other parts of the system. A well maintained battery with light use can last up to 10 years, but typical lifetimes are 3-5 years, which can drop to 6 months if the battery is not cared for. Lifetimes are dependant on a number of factors including: *the number of charge/discharge cycles, temperature, under charging and over discharging.* The efficiency with which energy is stored and retrieved from the battery depends on the current, and may be low. Typical average battery efficiency is around 70-80%. The main types of lead acid battery are described below. You must use 'leisure' or 'deep cycle' batteries for reliable energy storage.

Types of battery

Automotive batteries:
Not suitable for long term energy storage. Do **NOT** use in an off-grid system.
The lead plates have a weak sponge design which are damaged by excessive charge-cycling.

Flooded or Wet Cells:
Very common lead-acid battery for off-grid systems.
Ensure they are 'leisure' or 'deep cycle' type.
Not sealed so user can check and replenish electrolyte
Lower cost

Absorbed Glass Mat (AGM):
AGM batteries use a fibreglass - like separator to hold electrolyte in place.
This makes AGM spill proof and impact resistant
Sealed and cannot be refilled with electrolyte - do NOT over-charge
Use same voltage set-points as wet cells, so can be used as drop-in replacement for flooded batteries
Higher cost

Gel Cells:
These use a thickening agent to immobilise the electrolyte.
Can be used in any orientation - electrolyte will not spill
Sealed and cannot be refilled with electrolyte - do NOT over-charge
Use different voltage recharge set-points
Higher cost

Battery State of charge

Battery **state of charge** (SOC) is dependent on a large number of variables. These include:
temperature, charge/discharge current, age of battery, type of battery and number of battery cycles.
Monitoring SOC is difficult as there is no visual indication of what is happening within the battery.
There are three main techniques for finding state of charge of a lead-acid battery:

Electrolyte specific gravity
The specific gravity of the battery electrolyte will change depending upon the SOC. This can be tested with a battery hydrometer. This technique only works with open vented/flooded lead-acid batteries with access to the electrolyte. This method can be very accurate.

Voltage measurement
Measuring the voltage and knowing the current in or out of the battery can allow SOC monitoring. Graphs are available which show how the SOC versus voltage varies at various currents and temperatures. This method is not very accurate and depends on access to battery data from the manufacturer.

Amp-hour monitoring
Amp-hour SOC monitors (sometimes called coulombic monitoring) measure the current (and hence the amp-hours) going into and out of the battery and make some calculations of the energy left within the battery. Using the voltage along with the amp-hours these monitors can accurately montior the state of charge. These monitors are generally quite expensive, but are the easiest to read and are relatively accurate.

Worksheet written and designed by: renewable energy innovation
www.re-innovation.co.uk

Battery Maintenance Sheet

Use this worksheet to take care of your lead-acid batteries

Maintenance schedule

Weekly:

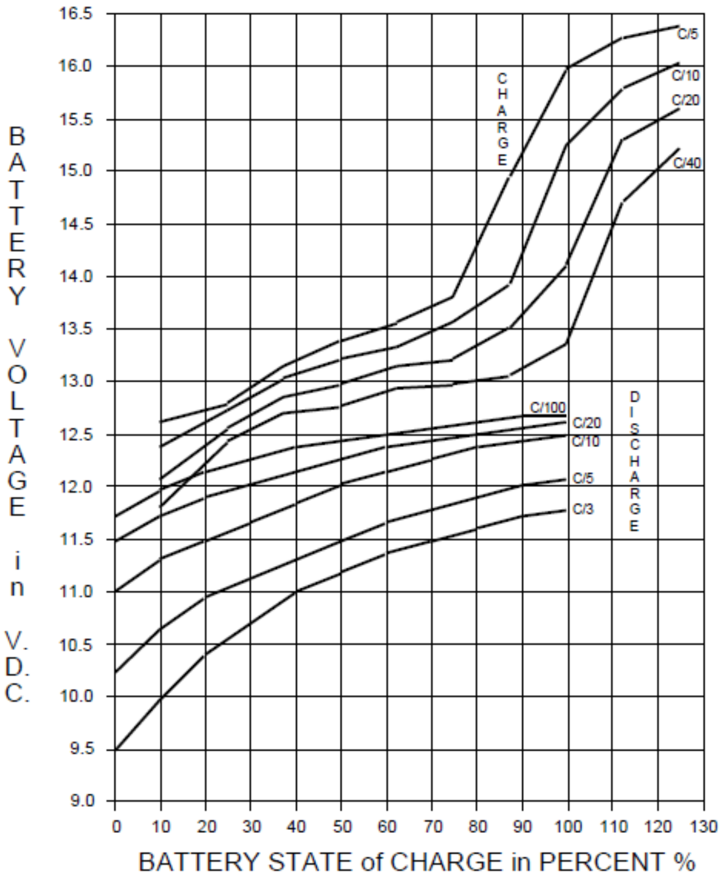
- Check voltage - Is it within range 11 - 14V?
- Check any regulators or battery monitors

Monthly:

- Clean battery tops
- Check electrolyte levels (if flooded) with graph below
- Switch off outputs and leave to rest for 2 hours
- Check voltage and compare with SOC graph below

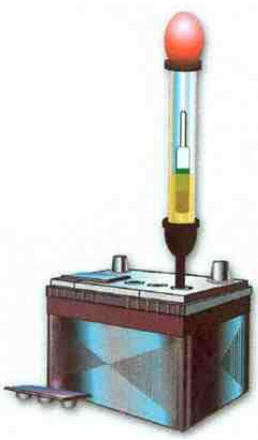
Use this graph to calculate the state of charge from the ***measured voltage***:

12 Volt Lead-Acid Battery Chart- 78°F. / 25C



Source: Homepower #36 1993

Use this graph to calculate the state of charge from the ***measured specific gravity*** (electrolyte):



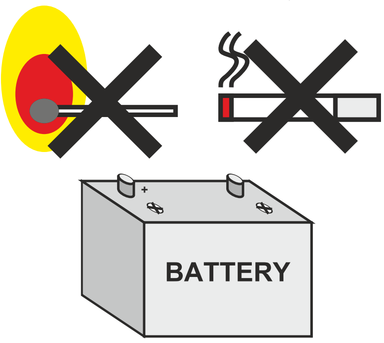
Specific gravity is measured using a *hydrometer*. This device uses a small floating weight which shows the density of the electrolyte.
The reading is affected by temperature.
Follow the hydrometer instructions for correct reading.
Always wear gloves and goggles.

State of Charge	12 Volt	6 Volt	Specific Gravity
100%	12.9	6.4	1.265
75%	12.4	6.2	1.225
50%	11.9	6.0	1.190
25%	11.4	5.8	1.155
Discharged	10.5	5.5	1.120

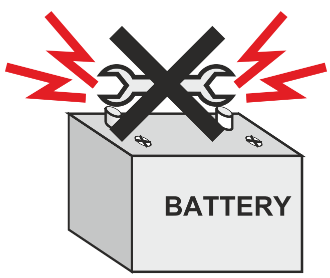
For guide only - check hydrometer instructions

Safety

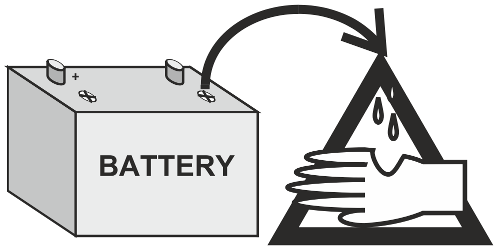
- **Battery acid is corrosive - wear goggles, gloves and appropriate safety gear. Do NOT wear jewelery.**
- **No flames or sparks around batteries - when charged batteries can vent explosive hydrogen gas - ensure adequate ventilation and avoid sparks and flames**
- **Do NOT short circuit - batteries can supply very large currents which can cause burns and start fires**
- **At their end of use, ensure batteries are correctly and safely recycled.**



NO FLAMES



DO NOT SHORT



DANGER: CORROSIVE ACID