Battery life and aging

A battery is an electro-chemical device. The purpose of a battery is to store and release energy at the desired time and in a controlled manner. However, ***a battery ages even when kept charged and doing nothing***, mainly due to oxidation of the positive plate grid.

Premature aging 1: The battery is discharged too deeply.
The deeper a battery is discharged, the faster it will age due to shedding, and once a certain limit is exceeded (approx. 80% depth of discharge) the aging process advances disproportionately fast. Additionally, if the battery is left discharged the plates will begin to sulphate. ***Batteries are considered to have reached the end of their service life when the capacity they can hold has reduced to 80% of the rated capacity***.

Although most batteries will recover from a full discharge, it is nevertheless very detrimental to their service life. ***Batteries should never be fully discharged, and certainly not left in discharged state***.

It should also be noted that the voltage of a battery that is in use is not a good measure for its level of discharge. Battery voltage is affected too much by other factors such as discharge current and temperature. Only once the battery is almost fully discharged (DoD 80% to 90%) will voltage drop rapidly. Recharging should have been started before this happens. Therefore a battery monitor is highly recommended to manage large, expensive battery banks effectively.

Premature aging 2: Charging too rapidly and not fully charging.
Batteries can be quickly charged and will absorb a high charge current until the gassing voltage is reached. While charging with such high current might work well a few times, this will actually shorten the service life of most batteries substantially (the exception: spiral-cell and some other AGM batteries). This is due to accelerated loss of cohesion of the active material, which results in shedding. ***Generally it is recommended to keep the charging current down to at most C / 5, in other words a fifth or 20 % of the rated capacity***. When a battery is charged with currents exceeding C / 5, its temperature can rise steeply. Temperature compensation of the charging voltage then becomes an absolute necessity.

Premature aging 3: Temperature.
Temperature plays a big part in charging batteries. The gassing voltage and consequently the optimum absorption and float voltages are inversely proportional to temperature. ***This means that at a fixed charge voltage a cold battery will be insufficiently charged and a hot battery will be overcharged.***

The temperature of a battery can vary greatly for various reasons:
- Rapid discharging and, to a much greater extent, rapid charging heats up a battery.
- A battery's location. A high average working temperature results in accelerated aging because the rate of the chemical decomposition process in the battery increases with temperature.

A battery manufacturer generally specifies service life at 20°C ambient temperature. ***The service life of a battery halves for every 10°C of rise in temperature.***

NB: Please note that other factors (humidity, altitude, exposure to weather extremes) can affect the battery as well.

Temperature compensation

As mentioned above, temperature is of importance when charging batteries.
Both effects (too cold, or too hot) are very harmful. Deviations of more than 1% of the correct (temperature dependent) float voltage can result in a considerable reduction of service life (according to some studies up to

30 % when the battery is float charged for long periods of time), particularly if the voltage is too low and the battery does not reach or stay at 100 % charge, so that the plates start to sulphate.

On the other hand over-voltage can lead to overheating, and an overheated battery can suffer "thermal runaway". Because the gassing voltage decreases with increasing temperature, the absorption and float charge current will increase when the battery heats up, and the battery becomes even hotter, etc. ***Thermal runaway quickly results in destruction of the battery*** (the excessive gassing pushes the active mass out of the plates), ***and there can be a risk of explosion*** due to internal short-circuits and high quantities of oxygen and hydrogen gas coming out of the battery.

The charging voltage (as quoted by European battery manufacturers) ***applies at 20°C battery temperature and may be kept constant as long as the temperature of the battery remains reasonably constant (15°C to 25°C)***.

Although manufacturers' recommendations differ to some extent, a temperature compensation of - 4 mV / °C per cell is a generally accepted average. This means – 24 mV / °C for a 12 V battery and – 48 mV / °C for a 24V battery.

Where the manufacturer specifies an absorption voltage of for example 28.2 V at 20°C, then at 30°C the absorption voltage must be reduced to 27.7 V. This is a difference of 0.5 V that certainly cannot be neglected.

When in addition to an ambient temperature of 30°C, the internal temperature of the battery rises another 10°C, which is quite normal during charging, the absorption voltage must be reduced to 27.2 V.

Without temperature compensation the charge voltage would have been 28.2 V which would quickly destroy a gel or AGM bank worth some ten thousand dollars! What the above means is that temperature compensation is important, and must be implemented, especially on large, expensive house batteries, and when a high rate of charge current is used.