Battery care, maintenance & diagnosis

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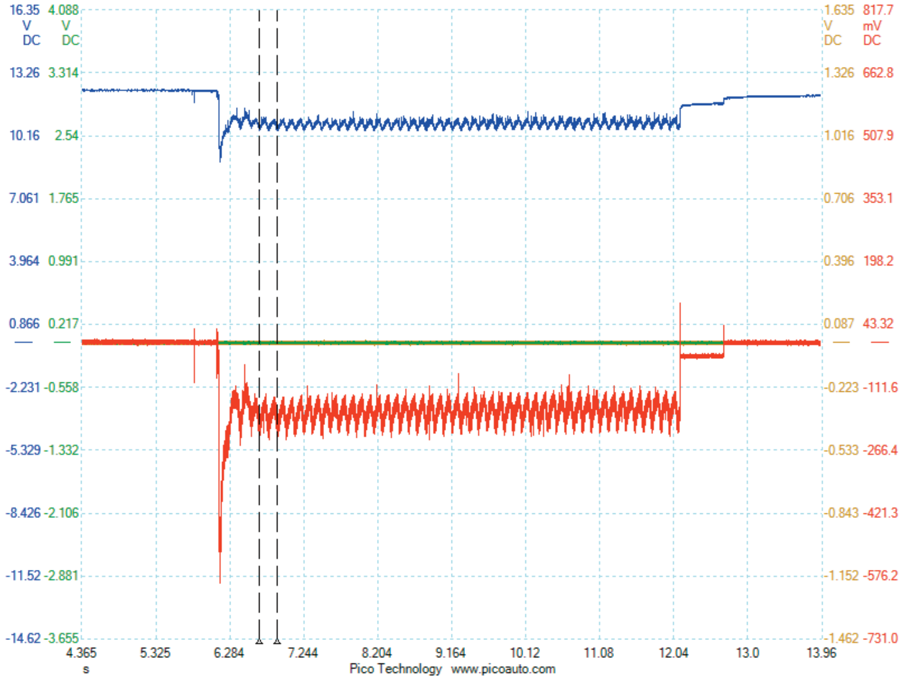
The vehicle battery is a critical integrated component of the electronics network. Increasingly, it also is responsible for the total electromotive force in electrical vehicles. I will comment on this development later! Despite this, it remains little understood or respected by many techs.

Many independent battery manufacturers limit the critical internal components to reduce cost, maximise profit and range application. This includes smaller cell capacity and increasing the electrolyte strength to artificially meet CCA rating. Reducing lead content reduces reliability, specification, and lifecycle. The electrolyte has a direct effect on performance and lifespan. Increasing electrolyte strength to artificially meet capacity specifications will increase internal corrosion.

The end of battery life is directly affected by the number of start cycles over time, this is the defining feature of 2/3/4/5-year battery construction. The battery begins its decline at manufacture! The initial formatting drives impurities off the plates, as a result the peak CCA performance should be achieved. The peak performance period (life span) depends on its warranty specification, the final phase is a rapid decline in output and eventual failure. The correct action is to replace the battery before the final decay!



Battery Voltage (blue trace) and starter current draw (red trace) during engine cranking can be used to determine the current state of the battery and decide if it needs to be replaced

Health checks

Hands up, who checks batteries at the point of delivery? If any battery is below 12.4V, send it back. Six cells at 2.12 volts each produce a voltage differential of 12.72 when fully charged. At 0°C, a battery has 66% available capacity. Excessive heat can also have a negative effect on battery performance, accelerate failure and end of life due to plate corrosion, increase self discharge, and increase electrolyte loading. A 10° rise in temperature will increase the self-discharge rate from 0.1v to 0.2v per month. 10°C= 60-month battery life. 25°C= 36-month battery life,

Plate sulphation is normal during battery discharge. When both plates are coated with lead sulphate or the plate voltage falls below 12.4V. Prompt recharge will displace the lead sulphate, the battery will normally recover and perform normally. However, if allowed to stand, it will crystalize and harden.

The death zone of a battery, rendering it unrecoverable is, Specific Gravity (SG) of 1.04, cell voltage of 1.9V, or a total battery voltage of 11.3V.

Recovery is marginal from an SG@ 1.2, and a battery voltage of 12.3 volts. Acid stratification accelerates failure and can occur due to cold weather and short drive cycles. The separation of acid has the effect of increasing the open circuit voltage whilst reducing the CCA performance. Superficial testing appears to show a healthy fully charged battery!

Conventional flooded batteries should be maintained within 5% of fully charged state if premature cell failure is to be avoided, whereas AGM batteries can operate normally with a 50% cycle rate.

24 volt systems and vehicles using two batteries require both the CCA and OCV be in balance.

This is also a critical factor with electric vehicles using lithium batteries, as cell differential will lead to differential cell charge and overheating.

Stop/Start vehicles will be fitted with either an Enhanced Flooded Battery (EFB) or an Absorbent Glass Matt (AGM) battery. The key differences with EFB & AGM are:

- Extended life over conventional batteries
- Improved temperature resilience
- Improved charging and cycle times
- Additional internal plate components
- Leak resistant to 55 deg.

AGM performance improvements include:

- 4x extended cycle times
- Sealed plates at 1bar preventing loss of active material
- Very low internal resistance
- High energy yield
- Electrolyte is totally absorbed in the glass matt; 100 % leak free.

Testing opportunities

Hopefully, by now most repair shops have a conductance tool. It applies a small load, current @ approx. 1-1.5amps. The load is proportional to the correct battery specification provided the correct battery specification has been entered. The internal resistance and state of charge is checked against an algorithm providing a linear comparison with a load discharge test.

We can also use a scope with a hall effect current clamp, this will provide real time voltage drop and current draw across the whole cranking spectrum, a healthy battery will return at least 100 amps more than the CCA rating during the initial starter ring gear engagement.

Pico diagnostics also provides a battery test facility with very similar results to a conductance test. It is also worth a word about correct battery support whilst downloading software or conducting diagnostics: Voltage drop over networks is critical and may lead to functional failure.

The Lithium battery and electric vehicles

I have been very outspoken over the current euphoria with plug in electric vehicles. So, let me make this a technical critique and not just personal or political!

The current known lithium reserves are estimated at 350 million tons. Most of it is politically and geographically accessible. The demands can be simply split into 3 equal groups, batteries, lubricants & ceramics, propulsion & weapons technology.

A 65-watt lithium battery requires 10kg of lithium. If current predictions are correct with 500 million EVs by 2040, the global resources will only last 18 years. This does not factor in the economic expansion from emerging continents, China, India, and South America. It also does not factor in the much bigger battery demands for 4x4 and small commercial vans. Lithium recovery and extraction from exhausted batteries only offers 20% at best. Disposal will be an environmental problem as lithium is essentially a brine, with the 4th lightest mass in the periodic tables.

Charging is without doubt one of the most contentious subjects. Some manufacturers are claiming a very short stop over, by using high current charging strategies. Other considerations include the poor business model for charging stations, lots of vehicles stationary over long periods of time, together with the power network required to carry the load, and what about the operating overheads for charging ports?

For me, the biggest issue is the primary energy source. Coal, oil, gas, biomass, nuclear and renewables, are all currently used to produce electricity. Given the battery production processes, transportation and energy loss in the conversion processes, it doesn't look so clean anymore.

The current marketing battles remind me of the past video format, Beta Max versus VHS, with hybrids and plug-in's all competing for the myth of clean transportation for the future. My opinion for future personal vehicle development lies with the hydrogen cell. Interestingly China has announced an ambitious program for hydrogen powered vehicles. Europe, on the other hand, rarely gives lip service to this obvious development. I suspect the problem with new clean vehicle technology is how governments will apply taxation in place of petrol and diesel?