Charge & Discharge Limitations

LEAD is NOT Dead

The internal (or external) BMS of a lithium battery limits the amount of current that the battery can accept during both charging and discharging. This limitation is dynamic – a battery in a warm environment or, one that has been rapidly charged/discharged has a limit that is below that stated by the manufacturer.

Typically, the limitation during charging is 60A. To increase this level, two batteries would need to be joined in parallel to accept the charge from say a 120A alternator. Lithium manufacturers often state that a single lithium battery “will do the job” of two 31 sized AGMs, it is often not possible given that most OEM alternators are in the 80-150A output range.

The limitation during discharge is around 100A. At 12V this is 1200w – so you may (just) run a 1200w windlass on a boat (and nothing else), cannot run a bow thruster and would be limited to an inverter of just 1000w.

In a number of applications, especially those found in vehicles and boats, transient loads of 100, 200 or even 500A are required. A single Terra battery will happily provide this power. To achieve the same with lithium, 1, 2 or 5 (respectively) would be needed. Often, in the case of applications where short-term high current is required (which IS the case in many of our target markets), a Terra pack of batteries is smaller, lighter, less complex, more reliable and safer than an equivalent lithium offering.

BMS Limitations

There are two types of BMS (Battery Management System) controls on lithium – internal (built into each battery) and external (connected by a communications network).

Internal BMS – there are limitations, typically a maximum of 10 batteries, that can be connected in parallel, and up to 4 batteries in series (to provide 48V). This requires a complex arrangement of series/parallel connections that must terminate on equal length cables to a busbar (NOT simply 'over the terminals' that you'd current see with lead/acid batteries). This adds weight to the installation. Strictly speaking, ABYC rules determine that a battery must be fused within 18 inches of the positive terminal – so each interconnecting cable from battery to busbar would need a fuse.

External BMS – in the event of a single communications cable failing (bear in mind that underslung batteries in automative and those aboard boats are in some of the most corrosive environments known to man), the entire battery bank will shut down and fail to operate. Most Mastervolt and Victron installations use this approach which is concerning when employed aboard ocean going and passenger carrying vessels, ambulances etc.

Electrical System Damage

Lithium cells feature an electro-mechanical 'fail-safe' that pops open if the battery is overcharged or about to fail. When this occurs, the battery goes open circuit. If you open circuit an alternator when running, the DC voltage will suddenly rise to hundreds of volts – this will destroy the alternator, regulator, engine ECUs, radar and even non sensitive electronics instantly.

Electrical System Re-Design

It is a misnomer to state that a lithium battery can simply replace a lead/acid (or other) technology battery without significant redesign of the electrical system. To maintain efficient charging and safety, batteries of different technologies must never be run in parallel.

The electrical system aboard the majority of vehicles and boats use a split charging system to allow the alternator to charge both the engine battery and auxiliary battery simultaneously. Because the engine battery must be lead/acid (for the reasons stated above – vis cranking current), there will almost always be different battery technologies aboard.

The industry proven and accepted best method of split charging is to combine batteries (run them in parallel) during charging and to disconnect them again (into independent battery banks) during discharge – this uses battery switches, voltage sensitive relays, battery combiners etc. They simply cannot be used with Lithium – the only solution is a DC-DC charger (which imposes a charge current limitation of usually 30-50A which negates the fast charge benefit of lithium). We have also found that most DC-DC Chargers derate by over 50% when warm which further extends recharge time (and reintroduces many charging issues that were resolved decades ago).

Sudden Power Loss

One of the benefits of lithium batteries are their very flat voltage discharge curves. It is also a major disadvantage; That is, at 12.1V only a few amp hours remain while equipment still happily operates, when flat, the voltage plummets in a matter of minutes or even seconds. When flat, the lithium battery will go into a self protection mode and shut down (going open circuit) without warning. This means that lighting, comms etc can fail without warning – and can in some cases cause damage.

There is then a further problem. If the above happens a normal battery charger (or DC-DC Charger if used) won't start up (as the internal electronics for the charger run off the 12v battery).. the only way to get the battery to reconnect and recover is to "jump start" it with another battery. This is not possible in a mobile application miles from a garage or marina and a prime reason why critical use applications should not use lithium batteries.

Unreliable Warranty

Most lithium suppliers offer a 5 or 10 year warranty. The problem is, that due to plummeting costs thanks to Chinese influence, the suppliers of lithium are regularly going out of business – making any such warranty (or the possibility of returning failed batteries for disposal) impossible to claim for.

Environmental Protection

The internal components of a lithium battery are very fragile. Typically a battery is located in wet, oily and dirty environments. Therefore, the case must be extremely well constructed to resist moisture and dirt while operating in a high vibration environment. A good seal is not easily achieved with a conventional heat seal using PVC or polypropylene cases (which many low cost lithium's are).

Poor Quality Manufacture / Inappropriate Design

There are typically two types of manufacturing technique employed in lithium batteries that use cylindrical cells:

Mechanical Carrier

A mechanical carrier holds the lithium cells in a series/parallel configuration to provide a 12V battery. These carriers allow slight movement and wear in high vibration environments. Mobile use is, in all cases, a high vibration environment.

Soldered Connections

Each cell is connected using a copper busbar which is soldered by hand to the top and bottom of each cell. Unless the operator is highly skilled and focused, a poor quality soldering joint is possible. Furthermore, the heat required to achieve a large solder weld is enough to damage the actual cell itself – reducing battery life and injecting possible catastrophic failure later in life before it even leaves the factory.

Spurious Marketing Claims

The claims made by lithium manufacturers when comparing against lead/acid are often disingenuous. A lead/acid battery of 100Ah varies hugely in terms of quality of manufacturer, types of lead, grids, busbars, cases etc. The costs of which vary by hundreds of dollars. Lithium manufacturers often compare their product against the very worst case lead/acid battery, not a high quality one.

Many claims are made such as depth of discharge, number of cycles etc. However, many of the claims cannot be made simultaneously – just like a high quality lead/acid, you can discharge the battery to deep levels (75% or greater) but, at the same time, you will reduce the number of cycles achievable – the same rule applies for lithium.

Complex Installations

With many of these considerations in mind, a properly installed lithium system should mounted inside a containment box, with automatic fire extinguisher, heating pad, interconnecting busbars and updated charging electronics. Therefore, the complexity, weight and cost negates the claims of lighter weight, deeper discharge etc. By using a conventional system with Terra batteries you will achieve all of these things PLUS the number of cycles which is why many contemplate lithium in the first place.