

Lithium Batteries Myths and Misunderstandings

As the availability of new lithium battery technologies grows, there are a number of myths and misunderstandings being perpetuated within the market. As an independent battery supplier working with a range of technologies, including lithium, we would like to try to clarify some of the advantages and disadvantages of lithium batteries.

There are a number of comparisons available on the Internet and in magazines comparing lithium batteries with lead acid. These are wide generalisations as, in the same way that lead acid batteries have a number of variants (wet, AGM, Gel, etc), "lithium" is used as a generic name covering a range of lithium products. Generally, the lithium technology in question is the rechargeable Lithium-ion (Li-Ion), Lithium-ion Polymer (Li-Po) or Lithium Iron Phosphate (LiFePO₄) couples but it can also cover primary cells like Lithium Sulphur Dioxide (Li-SO₂) or Lithium Manganese Dioxide (Li-MnO₂).

The three main rechargeable types could have their own comparison guide as they have important differences that determine their suitability for different applications. For example, LiFePO₄ typically has a lower energy density to the others but is generally safer in less controlled applications. Li-Po has a higher cell voltage than LiFePO₄ but may not achieve the same cycle life expectancy.

The differences between the different types of lead acid batteries are better understood due to the long history of these batteries. We have tried to cover some of the most common statements made regarding lithium below and taken an independent view as to these attributes. For comparison to lead acid we have used the attributes of an AGM battery and where there are differences in lithium characteristics we have tried to clarify these in each point.

Lithium batteries are lighter than lead acid equivalents.

True

When comparing batteries by capacity, lithium batteries offer a weight saving over both lead acid and NiMH. This is probably the principal attribute of lithium. However, the overall weight saving will depend on the battery pack construction and the additional systems required for battery management.

Cycle life is much higher for lithium batteries

True (but take care!)

When stating cycle life for batteries, the test conditions must be considered (e.g. depth of discharge). Stating, "lithium batteries offer thousands of cycles" is meaningless without clarification. AGM batteries can offer "thousands of cycles" if the depth of discharge is only 10%!

We believe a good comparison level for cycle life is either 50% or 80% depth of discharge as these figures are already widely available for AGM and Gel lead acid batteries.

When looking at cycle life, some of the lithium chemistries are significantly better than lead and some are not.

- LiFePO₄ cells generally offer in excess of 1200 cycles at 80% depth of discharge compared to around 500 for a very good AGM battery.
- Lithium-ion cells generally offer around 500 cycles at 80% depth of discharge so there is no practical difference.

In deep cycle applications, cycle life expectancy is an excellent way of predicting overall battery life and so should be a key consideration if appropriate.

Lithium Ampere Hours are greater than lead acid Ampere Hours

Myth

Ampere Hours are Ampere Hours. Claiming that lithium AHrs are in some way "better" than lead acid AHrs is similar to claiming that a pint of milk is of greater volume than a pint of water. Capacity is capacity irrespective of the medium.

Sometimes, "lithium equivalent AHrs" is mentioned. This is meaningless.

This misleading claim may be made due to the higher pulse currents possible from similar capacity batteries, when comparing some lithium batteries with lead acid, but this is a pulse current and is not capacity.

Better Deep Discharge Tolerance

True

This is generally true for most rechargeable lithium batteries and particularly for the LiFePO₄ chemistry as illustrated by its high cycle life at deep depths of discharge. However, lithium batteries do have a recommended discharge cut-off voltage below which they may be damaged.

One of the common reasons for failure of AGM and Gel batteries is being left in a discharged state for an extended period of time. Through in-house investigations it appears that this characteristic is not as problematical for some lithium batteries. We have found that when they are left fully discharged for an extended time period and then recharged as normal they may quickly return to full capacity. Although there is a degree of uncertainty how repeated treatment like this may affect the overall life expectancy of the battery, it appears robust on a low number of occurrences.

Stating CCA Ratings for lithium batteries

Misleading

Cold Cranking Amps (CCA) is defined as "*the current a lead-acid battery at 0 °F (-18 °C) can deliver for 30 seconds and maintain at least 1.2 volts per cell (7.2 volts for a 12-volt battery)*".

This rating is specifically designed for lead acid batteries and is not applicable to lithium as these have different discharge characteristics. It should be noted that, in general, lithium batteries perform less well below about -5°C and therefore it is unlikely a lithium battery would achieve a low temperature cranking figure close to a lead acid equivalent.

DMS technologies has a strong heritage in engine start applications and we believe a more representative cranking current figure might be for a 30 second discharge at 20°C. This also allows for easier comparison between chemistries.

Fast recharge

True

Rechargeable lithium batteries generally have a better charge acceptance than lead acid equivalents meaning that they can be recharged quickly. This attribute does vary with different lithium chemistries and manufacturers so should be evaluated when choosing your battery.

Stated temperature characteristics of lithium

Misleading

Generally speaking lithium chemistries are not ideal for low temperature operations (below about -10°). If you have ever left your mobile phone in the car on a cold night you will have experienced this limitation. There are lithium chemistries available that cope well with extreme temperatures although these tend to be more expensive, specialist cells.

We would advise caution using lithium in any applications where performance at low temperature is critical. It would be prudent to ensure that any manufacturers' claims are verified and tested in the required environment.

Generally, the high temperature performance of lithium batteries is comparable to lead acid and NiMH chemistries. There are certain types of lithium cell that perform well at very high temperatures (up to $+180^{\circ}\text{C}$) but these are usually designed for "down-hole" applications and can be very expensive.

"Greener" than lead acid batteries

Misleading

It is often claimed that lithium batteries are better for the environment than their lead acid counterparts. This is not necessarily correct.

If we use a deep cycle application as our example then a LiFePO_4 battery used in this application might be expected to last two to three times as long (assuming 80% depth of discharge). This means that an AGM alternative is going to have two to three times the impact on the environment when considering transportation and manufacturing impact. However, a lead acid battery is generally 95% recyclable so most of the materials can be reused.

In this application only one LiFePO_4 battery needs to be made for every three AGM, however lithium production carries high environmental impact and it is largely non-recyclable at end of life.

As with "green" claims in much of industry it is a hard one to judge!

UN testing regulations

Largely misunderstood

All lithium batteries and individual cells must be tested for safety in accordance with the UN Dangerous Goods Regulations in order for them to be permitted to be transported by land, sea or air. There are very few exceptions to this rule.

The regulations can be viewed here: www.dmstech.co.uk/admin/upload/datasheet/UN_Li_Tests-Rev5.pdf

Lithium batteries can be dangerous and we would advise extreme caution if dealing with any cells or batteries that have not undergone these tests.

Batteries larger than 100Whrs must be shipped as Class 9 Dangerous Goods and the appropriate precautions taken in packaging and consignment. Batteries smaller than 100Whrs may be exempt from Class 9 requirements but must be tested as above and be properly marked.

Smaller than equivalent capacity lead acid batteries

Misleading

Generally speaking this isn't true of LiFePO_4 batteries. Lithium-ion and Lithium-ion Polymer cells do offer a higher energy density meaning that the same capacity can be achieved in a lower volume. Again, this attribute varies so should be evaluated when choosing your battery.

You also need to take account of the space required for battery management systems and battery thermal management.

Combined Claims

Misleading

There are products on the market that claim to have all of the described benefits of lithium technology. Be very wary of these claims. The reality is that like many things, you cannot have all of the benefits and none of the drawbacks.

While a lithium cell may have an excellent cycle life and fast recharge, it may not perform as well at low temperatures. Equally a cell may operate excellently at -20°C but the cycle life may suffer for this attribute.

Which attributes any particular cells have is down to the chemistry, manufacturer and model.

At DMS technologies we believe that the key advantages and disadvantages to lithium (LiFePO_4) compared to lead acid (AGM) are;

Advantages

- Lightweight
- High Cycle Life
- Deep discharge tolerance
- Fast recharge

Disadvantages

- Cost
- Temperature performance
- UN regulations

Lithium, just like NiMH and Lead Acid, has some very worthwhile advantages but also has some drawbacks. As an independent battery company we do not promote any individual chemistry. Instead, we work with our customers to provide the best solution for your needs.

**Which is the best battery chemistry?
It depends entirely on the application!**

If you would like to discuss any of the points raised in this document or have any questions please do not hesitate to contact us.