PowerControl

LITHIUM-ION BATTERIES IN DATA CENTRE UPS

WHITEPAPER

The uptake of lithium-ion batteries (LIB) within UPS solutions has grown significantly over the last five years. With much greater appeal than lead-acid, li-ion batteries offer higher density, lifespan and TCO (Total Cost of Ownership). They are also lighter weight with a smaller footprint.

This whitepaper explores lithium-ion chemistry and the use of LIB systems within data centres.

INTRODUCTION

Lithium-ion cell prices are being driven down by greater demand and increased manufacturing. With a predicted decrease in price of up to 50% in the next 10 years, the use of li-on batteries is already becoming much more commonplace.

Commercial development of lithium-ion battery solutions only came into the public domain 30 years ago. They were first introduced by Sony and Asahi Kasei in 1991 and have since allowed our modern electronics to be more compact and powerful. It is important to note that this li-on battery structure differs considerably from that used within UPS systems.

HOW LITHIUM-ION BATTERIES DIFFER FROM TRADITIONAL LEAD ACID BATTERIES

The fundamental difference between lithium-ion and lead acid batteries is their chemical make-up, which determines the batteries capabilities. This is also true for the various li-ion structures that are available. Whilst lithium-ion is the general term used, within data centres it is most likely that this is referring to lithium-iron phosphate (LiFePO4/LFP).

Sealed lead acid batteries (SLA), also referred to as valve regulated lead acid batteries (VRLA) have been used extensively within UPS systems for decades. Whilst they have helped facilities achieve greater runtime, they do require significant space and maintenance. With numerous battery racks and countless strings of batteries, possible points of failure are more prevalent.

As the name suggests, VRLA batteries are sealed and regulate gas release dependant on pressure levels. This is made possible through the recombination of oxygen, which is generated at discharge, and hydrogen produced from the negative plates. This process is critical for battery life and can be altered if there is a change in temperature and humidity levels.

Separate battery rooms are less conventional nowadays as sealed VRLA batteries can be safely housed alongside UPS units. Whilst this helps to simplify positioning, it is important to keep battery strings free from enclosed containers. Ensuring an ambient environment is critical to battery performance and longevity.

Lead acid battery technology offers a reliable and familiar solution but developments of lithium-ion technology mean that LIB solutions are superseding VRLA at a fast rate.

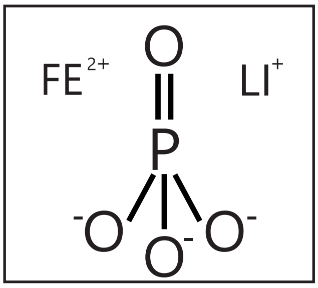
	LI-ION BATTERIES	LEAD ACID BATTERIES
Life span	10 - 15 years	3 - 6 years
Cycle life*	1000+ cycles	200 - 400 cycles
Temperature tolerance	40°C/104°F	20-25°C/68-77°F
Recharge to 80%	Up to 24hours	Up to 40mins
Shelf life	18 months	6 months

Figures based on standard LIB and VRLA batteries
**Cycle = Full discharge to recharge*

The biggest advantage of li-on technology over lead-acid is their longer life. VRLA batteries typically need replacing every four to five years. If a large number of batteries is situated on a single site it is likely the

LITHIUM CHEMISTRY FORMS

There are several types of lithium-ion chemistries which deliver different characteristics. The most common are lithium-ion, which is used widely across commercial electronics, nickel manganese cobalt (NMC) and lithium-iron phosphate (LiFePO4/LFP), lesser known chemistry forms but which are more suited to UPS in data centres and industry applications as they more stable at higher temperatures.



Similarly to lead acid batteries, li-ion uses a positive cathode, a negative anode and an electrolyte as a conductor. The key difference being the chemical characteristics found within them. Lithium-ion cathodes are metal oxide based and the anodes carbon based. VRLA batteries use lead dioxide cathodes and lead anodes. It is these differing chemical compositions of the anode and cathode materials that determine the overall performance of the battery.

SPECIFICATIONS	LI-COBOLT	LI-MANGANESE	LI-PHOSPHATE	NMC[1]
Voltage	3.60V	3.70V	3.30V	3.60/3.70V
Charge limits	4.20V	4.20V	3.60V	4.20V
Cycle life[2]	500	500 - 1000	1000 - 2000	1000 - 2000
Operating temperature	Average	Average	Good	Good
Specific energy	150-190Wh/kg	100-135Wh/kg	90–120Wh/kg	140Wh/kg
Specific power	1C	10C, 40C pulse	35C continuous	10C
Safety	Average. Requires protection circuit and cell balancing of multi cell pack. Requirements for small formats with 1 or 2 cells can be relaxed		Very good, needs cell balancing and V protection	Good, needs cell balancing and voltage protection
Thermal runway[3]	150 °C (302°F)	250°C (482°F)	270°C (518°F)	210°C (410°F)
Cost	Raw material high	Material 30% less than cobalt	High	High
In use since	1994	2002	1999	2003
Research manufacturers	Sony, Sanyo, FDK, Saft	NEC, Samsung, Hitachi	UT, QH, MIT A123, Valence	Sony, Sanyo, Nissan Motor
Notes	Very high specific energy, limited power; for cell phones, laptops	High power, average to high specific energy, power tools, medical, EVs	High power, average specific energy, higher self-discharge than other Li-ion	Very high specific energy, high power; tools, medical, EVs

Source: www.batteryuniversity.com

SAFETY CONSIDERATION FOR LI-ION BATTERIES

All batteries whether lithium or lead acid based contain chemical energy and have the potential to be hazardous. When li-ion solutions first entered the commercial market there were negative reports around their safety. The volatility of li-ion performance was brought into question, with the increased density making LIBs more susceptible to being over charged.

Advancements in molecular structure and cell packaging have made li-ion batteries considerably safer over the years. Manufacturers continue to work on lithium technology and for added security have adopted stringent regulatory checks such as imaging and overcharge protection to reduce thermal runway. This has already been achieved with lithium iron phosphate, where both chemical and thermal stability is vastly improved over both lithium-ion and VRLA solutions, making these idea for the data centre market.

Transportation and disposal challenges are also minimised with LFP systems. Where standard lithium-cobalt batteries are regarded as hazardous, lithium iron phosphate is non toxic so can be easily transported, disposed of and recycled.

With regards to lithium-ion battery use within UPS systems, all reputable suppliers include a battery management system (BMS). This typically displays accurate battery status information such as available runtime, temperature and charging rate.

PLACEMENT WITHIN THE DATA CENTRE

The greatest uptake of li-ion battery systems in industry has been in data centres. It is a known fact that VRLA battery failure accounts for over 50% of data centre downtime so an alternative more reliable, extended lifespan solution is a long awaited addition for the sector.

In an industry where lead acid batteries have had years of dominance, DC operators have been sceptical over the introduction of a substitute. However, LFP batteries are rapidly being adopted for use within UPS systems in datacentres. The integrated BMS that comes with LIB solutions can control charging cycles, which not only offers greater preventative maintenance but also offers energy storage and helps to minimise energy consumption costs.

Like many industries, there are mounting pressures to reduce OPEX within data centres, which makes the longer life, compact lithium-ion battery solutions very appealing. The size and weight of LIBs alone delivers huge financial gains through more flexible positioning and freeing up valuable floorspace. Further OPEX savings can be recognised with peak load shaving and reduced cooling as li-ion has a higher ambient temperature tolerance.

Advances in technology, improved manufacturing efficiency and increased demand are all contributing to further cost reductions which are making LIBs more viable as an everyday choice. LIBs also help address environmental goals as their recyclability naturally makes them more environmentally friendly than lead acid batteries.

With so many clear advantages of li-ion batteries, they will soon become the preferred choice within UPS solutions and data centres. Owner operators will need to be vigilant when choosing to install LFPs to ensure that they are compatible with existing UPS systems. Other considerations should also be factored in such as existing and future environment and growth, runtime requirements, replacement schedules and cumulative costs, or TCO estimations.

DO NOT FORGET

Despite batteries being the primary source for UPS failure, other key components cannot be overlooked. These include capacitors, fans and filters.

For more information please visit www.powercontrol.co.uk, email info@powercontrol.co.uk or call the office on 01246 431431