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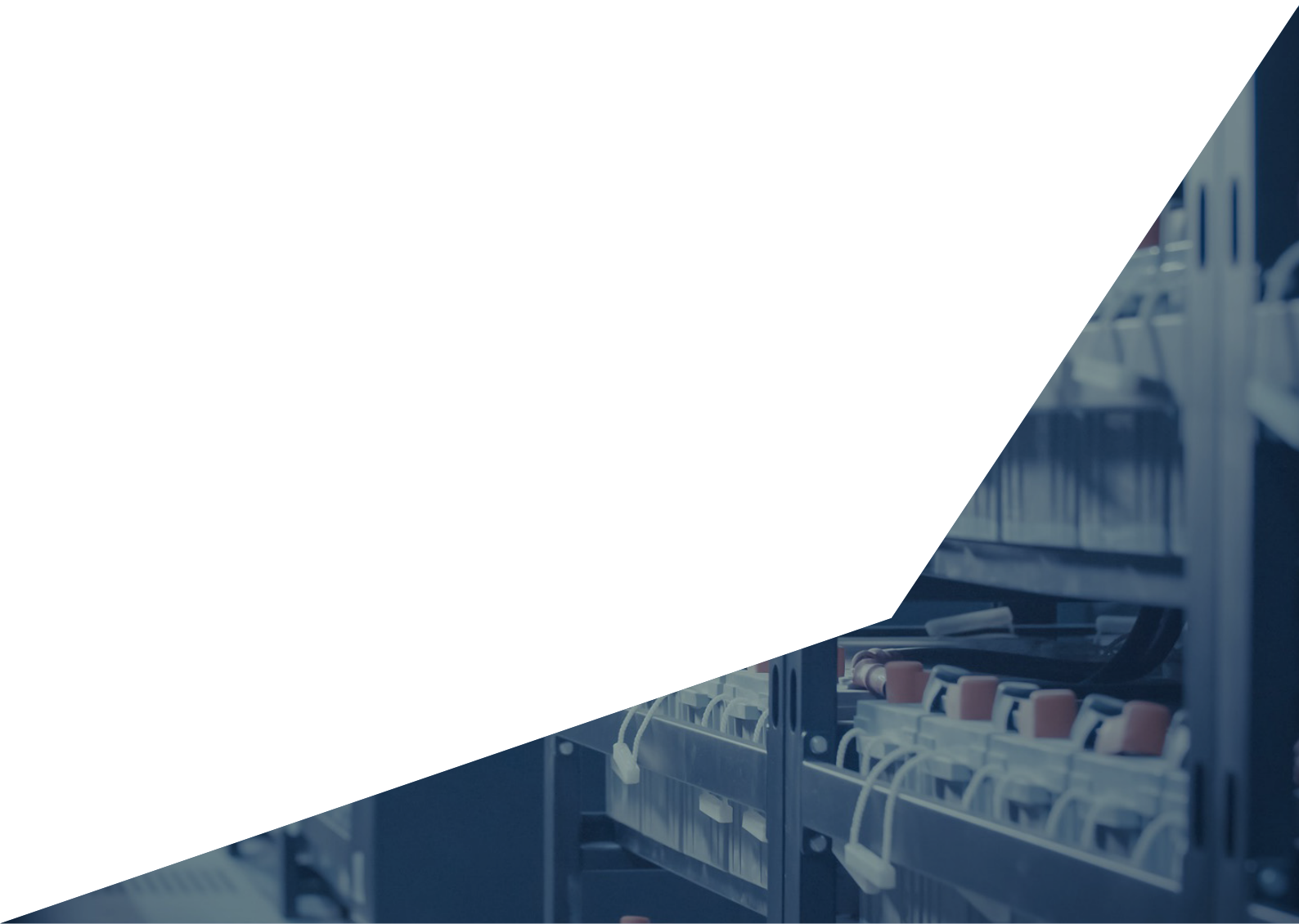
LITHIUM-ION BATTERIES, AN ALTERNATIVE TO VRLA

WHITEPAPER

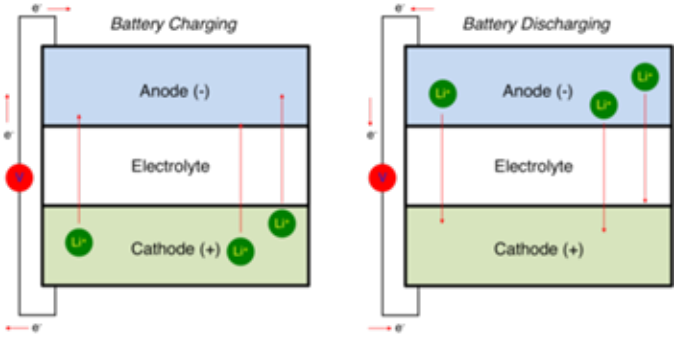


Valve-regulated lead-acid (VRLA) batteries are the most commonly used batteries in UPS systems today due to their track history of proven reliability and low initial purchase cost. However, VRLA batteries are susceptible to high or uneven temperatures, require continuous charging to replace self-discharge losses and their ever-increasing impedance potentially causing the battery to overcharge. It is because of these issues that lithium-ion batteries have caught the attentions of those requiring critical energy infrastructures and has captured media interest.

THE CHEMISTRY

All batteries contain a cathode and an anode whereby the electrolytes (a catalyst for the electrochemical reaction) are flowing from the cathode to the anode when charging and from the Anode to the Cathode when discharging, due to an external power source reversing the flow.

The principle difference between li-ion batteries and VRLA batteries is the chemical makeup of molecules in the electrodes (anode and cathode) and of the electrolytes. In a li-ion battery, the anode is generally made from carbon, the cathode is a metal oxide and the electrolyte is a lithium salt in an organic solvent. On the other hand, the anode of a VRLA battery is lead, the cathode lead dioxide and a form of sulfuric acid makes up the electrolytes.



TYPES OF LITHIUM-ION BATTERY

There are a number of compound variations of li-ion batteries. Depending on material choices, the voltage, energy density, life and safety of a lithium-ion battery can change dramatically. As pure lithium is high reactive with water to form lithium hydroxide and hydrogen gas, a non-aqueous electrolyte is typically used, and a sealed container excludes moisture from the cells. A common way to differentiate types of Li-ion batteries is based on their chemical formula that gives the battery its unique intrinsic attributes. The most common types of li-ion batteries are:

- Lithium Cobalt Oxide (LiCoO2)
- Lithium Manganese Oxide (LiMn2O4 or "LMO")
- Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2 or "NMC")
- Lithium Iron Phosphate (LiFePO4)
- Lithium Nickel Cobalt Aluminum Oxide (LiNiCoAlO2)
- Lithium Titanate (Li4Ti5O12)

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LITHIUM-ION BATTERY PERFORMANCE

The chemistry determines, to a large extent, the battery's performance capabilities. The table below highlights some of the key performance differentiators between Li-ion and VRLA batteries. The electrodes of a lithium-ion battery are made up of lightweight lithium and carbon elements. Lithium, being a highly reactive element can store a lot of energy in its atomic bonds, translating into very high energy density for lithium-ion batteries. It should be understood that the figures in the table shows typical performance ranges when used in UPS systems. Due to the variability in batteries it is difficult to generalise and summarise unless a specific application and design is assumed.

PERFORMANCE INDICATOR	LEAD-ACID (VRLA)	LITHIUM-ION
Specific energy (energy density)	15-50Wh/Kg	70-260Wh/Kg
Life span	4-6 Years	10-15 Years
Recharge time	6-12 hours	1/2-1 hour
Number of charge/discharge cycles*	200-400	>1,000

*dependent on specific battery design and depth of discharge.

THE BENEFITS

Lithium-ion batteries (Li-ion), whilst having a higher initial cost than alternative batteries, hold their charge much better and can handle hundreds of charge/discharge cycles. Due to their molecular structure, they are also considerably lighter, up to 70% smaller and can work reliably at a wider temperature than other rechargeable battery options making them perfect for energy markets. Their performance is more easily defined and they do not require a complete discharge before recharging because of their no memory effect.

It is important to note that like all electronic or electrical equipment, loss of battery capacity over time is inevitable, with li-ion batteries it is more steady and predictable than other battery types. Li-ion batteries also have a longer service life, they do still require maintenance, but with longer intervals and simpler servicing methods than for VRLA batteries. Unlike other types of li-ion batteries that have caused combustion issues in home electronics.

BATTERY STORAGE

Although Lithium-ion batteries are more tolerable of varying temperatures that other types of battery, they should still be stored in a cool place to slow the aging process. The recommended storage is 15°C although this should be checked with the manufacturer. The table below shows the affect temperature has on battery capacity.

TEMPERATURE	40% CHARGE	100% CHARGE
0 °C	98% (after 1 year)	94% (after 1 year)
25 °C	96% (after 1 year)	80% (after 1 year)
40 °C	85% (after 1 year)	65% (after 1 year)
60 °C	75% (after 1 year)	60% (after 3 months)

*estimated recoverable capacity when storing li-ion for one year at various temperatures.

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BATTERY MAINTENANCE

Lithium-ion batteries require far less maintenance than the alternative VRLA battery commonly found in a UPS. This is due to there being no battery memory or the need to cally cycle the batteries to calibrate their runtime. Their long life span of over 10 years also reduces the need to replace them over the course of the UPSs life.

ARE THEY RECYCLABLE?

Yes, they are. Lithium-Ion batteries are subject to disposal and recycling regulations that vary by country and region. Always check and follow your applicable regulations before disposing of any battery.

CONCLUSION

Although a lithium-ion battery is more expensive initially, the total cost of ownership for li-ion batteries is less. Unlike the VRLA batteries commonly found in UPS systems, the unique chemistry of li-ion batteries make them lighter, smaller, don't need separate, temperature controlled rooms, have longer life, reduced maintenance and a better power density.

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

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