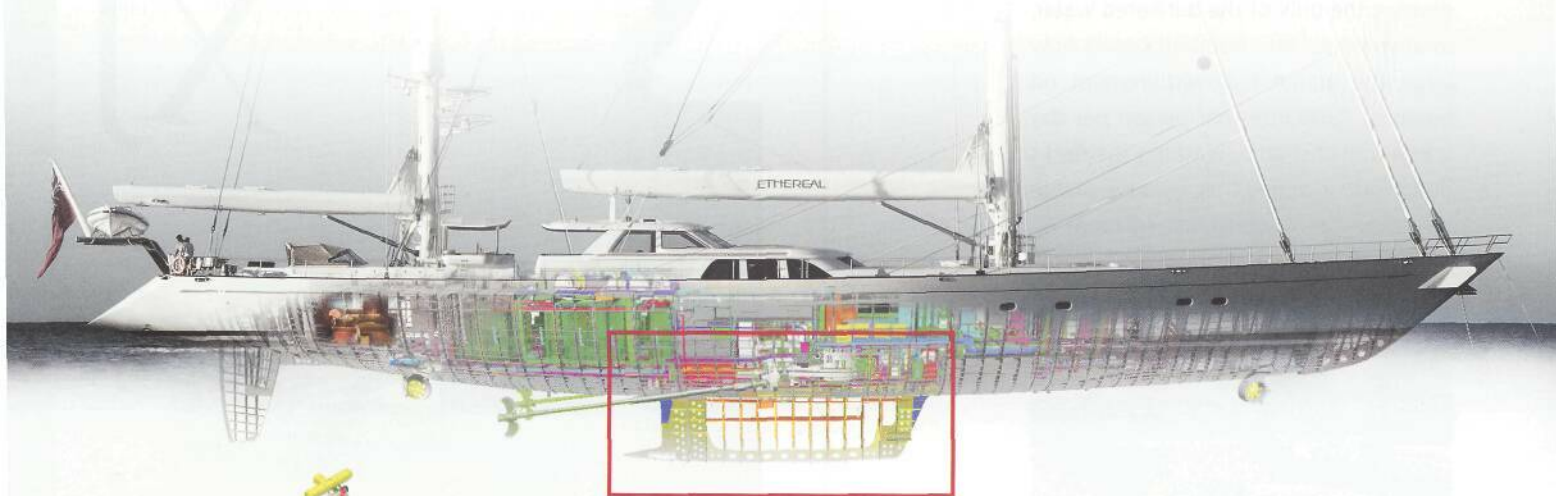


# CHARGED IN A FLASH

Joachim F. Muhs explains what lithium-ion batteries can really do.



The 58-metre ketch, “Ethereal” features purpose-built lithium-ion batteries. Rated voltage = 120 volts. A battery block consists of a total of 99 individual cells, series-connected in three parallel rows of 33. The 400 kWh power unit, accommodated in the upper section of the yacht’s keel, takes up a total volume of 9 cubic metres. It delivers eight hours worth of silent, emissions-free power for sailing and ultra-quiet operation. The yacht’s generators can recharge it in less than one hour.

Yachtspeople love it as nature. They need to have the wind in the shrouds and relish the rush of the waves against the yacht’s sides. What happens though if a small crew can no longer sail a large yacht manually, if hydraulic winches and electric furlers have to substitute for the deckhands that are usually needed? Then a standard power unit has to operate in parallel – a conventional generator. The silent yacht or green craft vision soon falls by the wayside. But batteries can also supply these power-driven aids with electric power and even cater for silent propeller operation. However this requires powerful batteries. Conventional lead cells are not up to the job – their power

density does not meet requirements, their charge factor leaves a lot to be desired and it takes an inordinately long time for chargers to replenish all those used amperes and for the batteries to be recharged. Often enough a full recharge takes 24 hours or longer. Royal Huisman therefore installed lithium-ion batteries on board 58-metre “Ethereal” – still very much uncharted territory for a yacht. These batteries do not exhibit such deficiencies. These on-board Li-ion batteries have a cell voltage of 3.6 instead of just 2 volts, feature an energy density of 100 to 120 Wh/kg and are 80% charged after just one hour.

Particular charging procedures are necessary, because lithium-ion batteries are highly

sensitive to deep discharge and overheating. They have powered notebooks and mobile phones in mini-cell format for a long time now. However since vehicle manufacturers have realised that they can be used in electric and hybrid vehicles, manufacturers such as Varta and Mastervolt have also started to produce them as battery blocks with correspondingly higher capacity.

Like all batteries, Li-ion batteries store energy on the basis of an electrochemical reaction – electrical energy causes lithium ions to migrate via an

electrolyte. That generates a voltage drop. The active material in the positive electrodes (cathodes) is lithium-cobalt-oxide, whilst that of the negative electrodes (anodes) is either graphite or nano-crystalline silicon. Lithium salts in organic solvents, such as lithium hexafluorophosphate, act as electrolytes.

These agents make Li-ion batteries 33% lighter than lead batteries. Varta for instance interconnects eleven 3.6-volt cells to create 40-volt blocks with a capacity of 40 ampere-hours for mobile op-

eration. Each individual cell is electronically monitored to prevent overheating and short-circuits, because entire blocks can be quickly damaged and possibly burst into flames. Nowadays the manufacturers have got over these teething troubles. They charge lithium-ion batteries using chargers that switch off, once low voltage levels are reached. If a fully charged cell starts at 4.2 volts, this decreases during discharge to 2.3 volts. Once this floor has been reached the charger switches off, before the cells get into hazard-

ous deep discharge territory. Lithium-ion batteries are particularly suited to use on board yachts because they recharge quickly. This is precisely what distinguishes them from lead batteries, which are normally used on board. They can easily absorb a large number of amperes, and even after sailing through the night only take up minimal generator or shore connection time – probably the most persuasive argument in favour of their use on board.

**Next topic: pump jets**

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