VDE Study: Battery systems for multiple units

Emission-free drives powered by lithium ion cells

Which battery technologies are suitable for use in traction batteries for multiple units? This question was investigated by the VDE in its first study on the decarbonisation of rail transport by 2050.

Special requirements for traction batteries

Electric drives are the ideal alternative to diesel engines. Supplying electric motors with power from a battery represents a good emission-free alternative to diesel engines on railway lines with no catenary. However, there are highly exacting demands on the reliability and quality of multiple units, as they are expected to provide more or less 24-hour service (usually on a tight schedule) for up to 30 years. The requirements placed on traction batteries are correspondingly stringent with regard to charging and discharging currents, safety, low-temperature performance, operating time and cycle stability. In addition, the battery has to deliver high power for starting and accelerating and at the same time carry enough energy to provide sufficient range. Accordingly it makes sense to examine existing and new cell technologies in detail and also to consider new battery solutions.

Lithium ion cells with LTO anodes

The study compares battery technologies and cells that are suitable for use in traction batteries for multiple units and are already available on the market, or are expected to become available in the next ten years. The exacting technical requirements for railway use considerably restrict the choice of suitable battery systems. Lithium ion cells with lithium titanate (LTO) anodes, which are offered as a special technology by a handful of cell manufacturers, represent a reliable but costly solution. The high price and the relatively low energy density represent further significant disadvantages.

New battery solutions for dynamic performance and range

As an alternative to the purely LTO-based solution at the cell level, the study also draws attention to a battery solution that meets the exacting requirements at the battery system level. It highlights the possibility of splitting the total battery system into two parallel lines: one battery with high power density for dynamic acceleration performance, and another with high energy density and capacity for range. In this case the expensive LTO technology is limited exclusively to the dynamic battery. Standard cell chemistries such as NCA/C, NCM/C or LFP/C are sufficient for the range battery. Here, the automotive industry has already exerted a great deal of price and innovation pressure. In addition, intelligent battery and thermal management allows the extreme demands on the multiple unit to be shifted to the battery pack level, for example by thermally isolating the individual cells and keeping them in optimum operating condition by means of targeted preheating and cooling.

Support for battery research

LTO technology offers a long operational life of 30 years with few maintenance cycles. Standard cell chemistries such as NCM/C hold the promise of future leaps in innovation which will yield greater range and lower costs.

Irrespective of the technology, the study appeals to politicians to provide greater support in Germany for battery research and for innovative companies active in this field.

This study and further information on regional passenger rail transport and climate-neutral mobility can be found at www.vde.com/alternative-drive-solutions