Energy storage and electro mobility

Today, more than ever, environmentally friendly technology solutions are needed to prevent further global warming. Our world has surpassed the threshold of 400 ppm carbon dioxide in the atmosphere and the average temperature in nearly hundred years has increased by almost 1°C.

The ongoing transition from fossil energies to renewables requires short-term storage media with high efficiency, like batteries and flywheels. One of the most promising future energy storage options are electrical vehicles with grid capability. In addition to environmentally friendly mobility, this option increases the flexibility of a power system by making optimum use of the energy whenever it is available from a renewable source, like a photovoltaic solar cell installation.

General

Batteries, especially Li-Ion batteries, have become an integral part of our everyday life. They are used in mobile devices such as laptops, smartphones and other wearables. Batteries are even powering our cars. But how are these compact power storage devices manufactured and what does it all have to do with vacuum and leak detection?

This article will answer these questions by providing a detailed look into production related vacuum applications in the manufacturing of today's most wanted technology: Li-Ion batteries.

Electro mobility

Mobility has to become more climate-friendly in the future. The CO_2 emissions caused by traffic amount to around 24% of global CO_2 emissions. Thus mobility has a considerable impact on our environment. More and more CO_2 is being released into the atmosphere. The consequence: our earth is getting warmer and warmer. Batteries have the potential to reduce mobility related CO_2 emissions. Additionally, they can be used for energy storage from renewable energy sources.

Grid stability

Battery storage systems can also be used to stabilize power grids. These are intended to ensure grid stability by stabilizing short-term fluctuations in the grid frequency. In order to compensate for these fluctuations, energy must be supplied to or withdrawn from the grid as quickly as possible, depending on demand. Battery storage systems are perfectly suited to quickly react to these grid fluctuations.

Future technologies

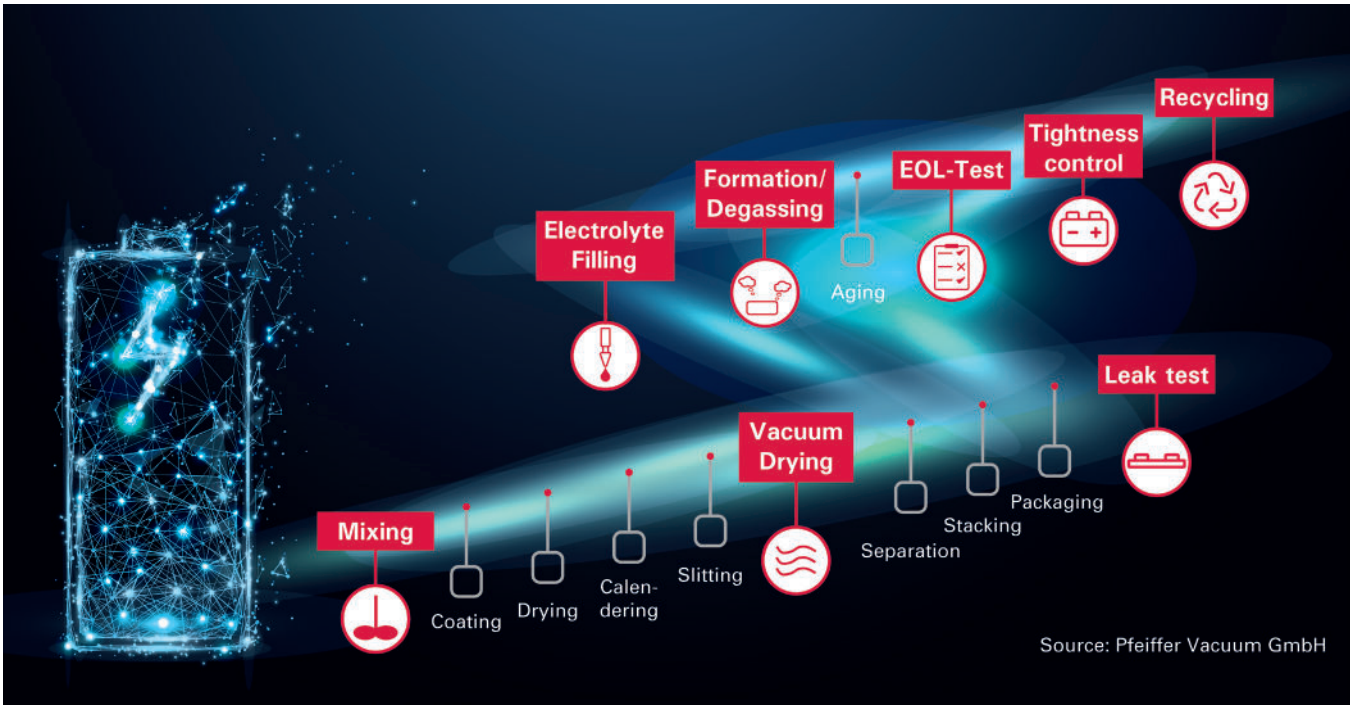
In addition to the Li-Ion battery cell with liquid electrolyte, research is already underway into a new generation of Li-Ion batteries: the so-called 'solid state battery', which is characterized by a solid electrolyte. Other vacuum applications compared to the present production processes of Li-Ion batteries will then become relevant. However, it will require some more time before the new battery generation is ready for the market.

Production steps that require vacuum

Fundamental research

Battery components play a major role in battery production. Especially the composition and structure of the electrodes which have a considerable influence on the performance characteristics and lifetime of a battery cell. Furthermore, coating processes under vacuum are crucial to protect the battery from corrosion or negative effects on the boundary layers between the electrodes. The housing of a battery should also not be neglected. A high tightness is mandatory to prevent moisture from penetrating the battery which would cause an unacceptable deterioration in performance. Therefore, fundamental research is of great importance.

PrismaPro compact mass spectrometer



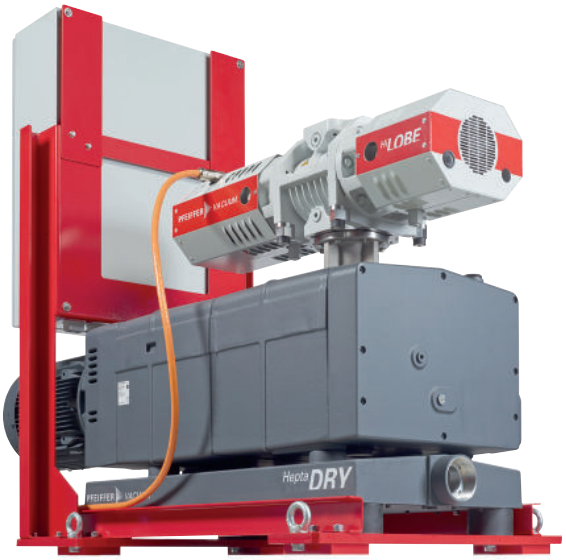
Mixing

When mixing the slurry for the electrodes of the cell, it is necessary to avoid the introduction of gas bubbles. With the help of vacuum, air pockets inside the slurry can be prevented and thus homogeneous slurry can be produced.

Screw pump HeptaDry

Vacuum drying

An important step in battery production is the in-depth drying of the materials. Residual moisture in the cells leads to rapid loss of performance and premature aging. Drying the coated electrodes of the cell under vacuum guarantees minimum residual moisture and prepares the electrodes for the next production steps in the dry room.



Pumping station CombiLine with HiLobe Roots pumps

Electrolyte filling

When filling the cell, the electrolyte is introduced via a high precision dosing lance under vacuum. A defined pressure profile, by alternating evacuation and inert gas purge of the cell, activates the capillary effect. This leads to a homogeneous distribution of the electrolyte. By this optimized wetting process quality and lifetime of the cell is increased.

Scroll pump HiScroll

Formation/Degassing

During formation of battery cells, a strong gas evolution occurs in the first charging process of the cell. Under a protective atmosphere in vacuum, the emitting gases will be extracted. Due to the toxicity and sometimes explosive risk nature of those gases, customer specific requirements on vacuum technology have to be taken into account.

Pumping station with screw pump HeptaDry

Leak detection, end-of-line test

At the end of production, a battery cell has to fulfill the manufacturer's quality level. Electrical safety, leak tightness, and also the ordered specifications of the end-customer are the main reasons to run end-of-line tests. High cycle times have to be met as the current and future demand in terms of quantity and quality needs 100% testing.

Gas analyzer GSD 350

Leak detection

In order to ensure long-term performance and safe operation of a battery, leak detection is an essential step in quality control. This applies to battery components, cooling, battery modules and battery packs. The cell has to be protected from moisture ingress in order to ensure the safety of the system.

Leak detector ASI 35

Battery recycling

To enable the shift from conventional to electrical mobility, the availability of resources has to be secured. As with any other product, recycling is a cost efficient and sustainable way to reduce the need for constant flow of freshly mined resources. New promising recycling methods can reach up to 91% recycling rate with utilization of processes under vacuum.

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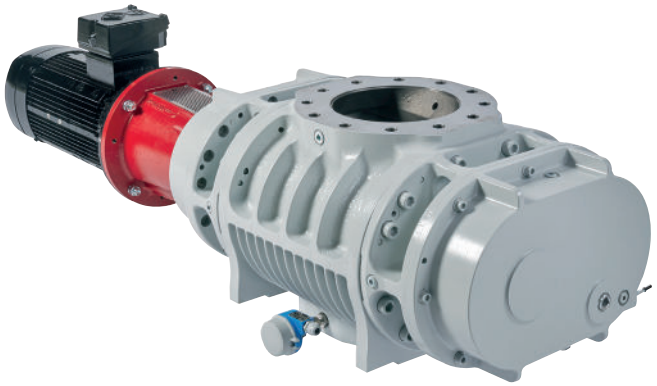

OktaLine ATEX Roots Pumps