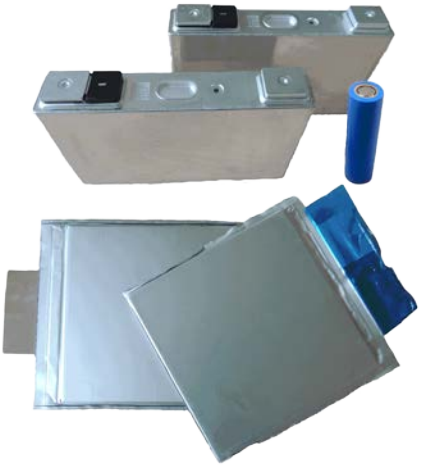
LEAK TESTING OF COMPONENTS

Battery Cells for Drive Batteries (EV)



Different designs of battery cells are used to create power batteries for electrical and hybrid vehicles. Cylindrical cells are used in the Tesla Model S for example, but more commonly prismatic and pouch-type cells are used.

DESCRIPTION OF TECHNICAL CHALLENGE

The production of battery cells for electrically driven cars has recently ramped up significantly. It is very important to achieve a sufficient lifetime and performance of the battery in this new drive train technology so as to not scare away any new users of this technology due to an initial bad experience.

There are three different mechanical designs of a battery cell: Cylindrical cells, Prismatic cells and pouch type cells. Cylindrical cells (also called type 18650) and prismatic cells have a sturdy housing, whereas pouch-type cells have a flexible housing (they are also referred to as flexible battery cells).

Battery cells need to be tested for physical leakage because:

- No electrolyte must leak out of the battery cell, as missing electrolyte will have a negative impact on the battery's performance
- Maybe even more importantly, no humidity must get into the battery as humidity will also negatively impact the battery's performance and even destroy the battery completely over time

To guarantee both requirements, modern battery cells must be leak tested to leak rates in the range of 10^{-5} … 10^{-6} mbar*l/s (depending on the size / volume of the battery and its design). These small leaks cannot be detected with older technologies like water bath or soap spray testing, nor with pressure decay testing.

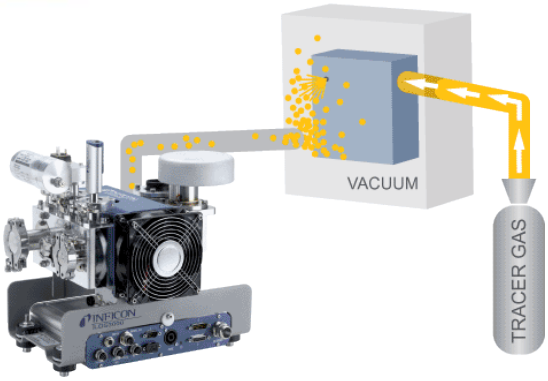
THE INFICON SOLUTION

Production testing of prismatic cells is performed in several steps:

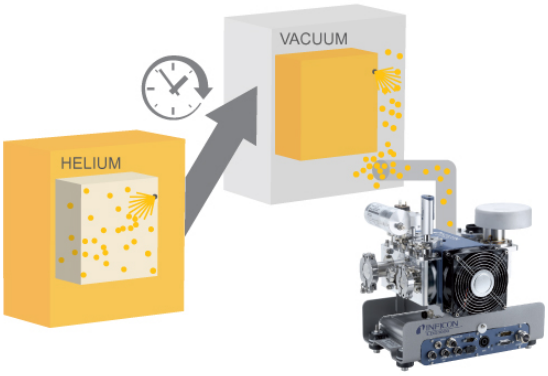
Pretesting of components for prismatic battery cells

Sometimes the battery cell housing of prismatic battery cells is pretested before filling with electrolyte to ensure e.g. electric feedthroughs do not leak. This pretesting is usually performed in vacuum chamber leak testing with high throughput. The housing of the battery cell is filled with helium and then placed in a testing chamber connected to a vacuum system. Once the chamber lid is closed, large vacuum pumps pull a vacuum on the testing chamber. Helium then has the opportunity to migrate outwards and if a leak is present, the INFICON LDS3000 Helium Leak Detector (connected to the vacuum chamber) detects the helium as it emerges from the battery cell.

Only if the housing of the battery cell is tested as leak tight will it be filled with electrolyte and finally sealed.



Battery cells prefilled with helium are typically tested via vacuum chamber leak detection. This process is very common for cylindrical, type 18650, battery cells.



Battery cells that cannot be prefilled with helium are typically tested via bombing followed by vacuum chamber leak detection. This process is mainly used for prismatic and pouchtype cells.

Final testing of fully assembled battery cells

Even if the housing of the battery cell has been pretested as described above, the filled and sealed battery cell must be retested to ensure the integrity of the final seal. Pouch-type batteries are typically only tested once after final sealing.

If the design of the battery cell allows, a small amount of helium (up to 5%) is added to the battery cell when filling with electrolyte (this process is typically used for cylindrical, type 18650, battery cells but also for some prismatic cells). The battery cell is then tested in a vacuum chamber leak detection system equipped with an INFICON LDS3000 Helium Leak Detector with the same testing sequence as described before.

If adding helium to the electrolyte filling is not an option, the battery cell can only be tested via bombing. This process is mainly used for prismatic cells and pouch-type cells. In that case, the final battery cell (filled with electrolyte and sealed) is placed in a 100% helium atmosphere at some overpressure for an extended period of time. The longer the parts are exposed, the more helium can accumulate inside the battery cell if a leak is present.

After this bombing process, the parts are taken from the helium atmosphere and put into a vacuum chamber. Subsequently, the same vacuum chamber leak detection process as above is applied. Pouch-type batteries may have to be placed into a supporting structure so that no damage to the seals occurs due to the internal pressure blowing up the pouch during the vacuum process. Again, an INFICON LDS3000 Helium Leak Detector will detect any helium leaking back out of the battery housing / pouch.

The helium concentration inside the battery cell will be significantly lower compared to the battery cells prefilled with some share of helium, as only small amounts of helium penetrate through the leak channel. The amount of helium inside the battery cell is also influenced by the leak size. Larger leaks will allow for more helium inside the part. All of this needs to be taken into account- when calculating the actual leak rate from the leak detector signal.

BENEFITS OF LEAK TESTING WITH TRACER GAS

- Accurate and repeatable measurements for confident leak testing
- Highly sensitive testing methods, able to detect small leaks (10^{-4} .. $.10^{-6}$ mbar l/s range)
- Highly automated process with high throughput
- Test result independent of operator intervention
- Dry, non-corrosive process

For more information, please visit us at
www.inficonautomotive.com or call our nearest representative.

INFICON Instruments for Intelligent Control®

www.inficon.com reachus@inficon.com