Battery packs for EVs / HEVs

DESCRIPTION OF TECHNICAL CHALLENGE

The production of batteries for electrically driven cars has recently ramped up significantly. It is very important to achieve a decent life time and performance of the battery in this new drive train technology as to not scare away any new users of this technology due to an initial bad experience. Typically battery cells are pretested during the cell production process. Subsequently, the battery cells are assembled into battery modules and then the modules are assembled into battery packs.

Both, the battery modules as well as the battery packs typically include some cooling channels which are operated either with a water-glycol mixture or with refrigerant which is by-passed from the AC system of the vehicle. In addition, the electronic module controlling the operation of the battery is usually also somehow cooled, again either with a water-glycol mixture or with refrigerant. Leak tightness is critical to avoid loss of water or refrigerant from the cooling system. For water-glycol cooling, typically leak rates of 10^{-3} mbar l/s (0.06 sccm) are set as the threshold level. Refrigerant loops must be leak checked for leaks in the 10^{-5} mbar l/s range.

Battery packs in electrical vehicles need to be tested for loss of cooling fluid and against intake of water.

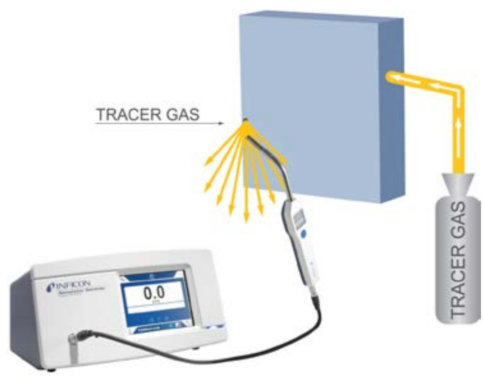
The complete battery pack is usually mounted in a housing. This housing usually must meet the IP67 standard and tested to leak rates in the $5*10^{-3}$ mbar l/s range.

System to be tested	Specification	Equivalent leak rate
Battery cooling circuit – glycol-water solution	No significant loss of cooling fluid	~ 10^{-3} mbar l/s (~0.06 sccm)
Battery cooling circuit – refrigerant	No significant loss of refrigerant	~10^{-5} mbar l/s (5 g/a of refrigerant)
External integrity of battery pack housing	IP67	~ $5*10^{-3}$ mbar l/s (~ 0.3 sccm)

THE INFICON SOLUTION

Leak testing the cooling circuit of the battery pack

For testing the cooling circuit of the battery pack, it is recommended to first evacuate the cooling circuit of the battery and then backfill with forming gas (an inflammable mixture of 5% hydrogen in 95% nitrogen). Subsequently, all welds and brazes are scanned by moving the sniffer tip of the Sensistor Sentrac leak detector across those areas. In the presence of a leak, forming gas will escape from the leak outlet and will be detected by the Sensistor Sentrac. The exact leak location can be determined by moving the sniffer tip back and forth. The exact leak is found where the highest leak rate is shown by the leak detector.



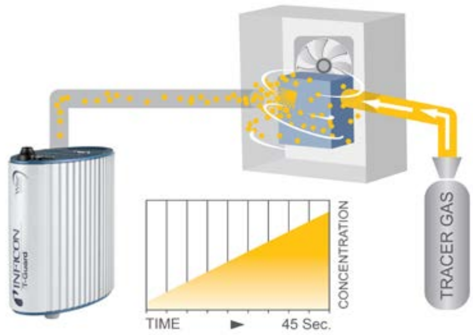
Cooling circuits of battery packs are typically tested in a sniffing process, directly locating the leak in one testing step.

For cooling circuits filled with refrigerant, leaks can also be detected when already filled with refrigerant. In that case, sniffing with the Ecotec E3000 multi-gas leak detector is recommended for leak testing. The Ecotec E3000 will directly detect the refrigerant escaping from the leak without any cross sensitivity to other gases / liquids present.

Final leak test of battery pack housings

Two options are available for leak testing of the battery pack housing:

	Accumulation	Sniffing
Recommended tracer gas	Helium	Forming gas (5% hydrogen)
Typical cycle times	1 – 2 min	2 – 5 min
Battery size	Small to medium	All sizes
Test result	Integral testing	leak testing in predefined areas only
Localization of leak	No, needs to be performed subsequently	yes



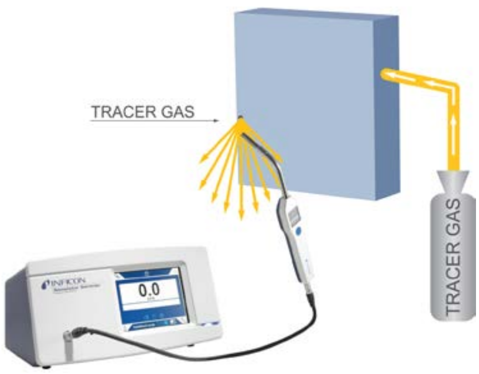
The integrity of small to medium size battery pack housings may be tested in a T-Guard accumulation system without operator intervention.

Automated, integral testing without localization (accumulation testing)

For automated integral testing of small to medium size batteries, the housing of the battery pack is first pumped down to about 100 – 250 mbar underpressure and then backfilled with helium to an overpressure of 100 – 250 mbar. This leads to a helium concentration inside the housing of approx. 20 – 50% helium. The battery pack is then placed in a simple chamber and the lid is closed. Now, helium from any leaks will accumulate inside the atmospheric chamber over time and the increase in helium concentration will be detected with the T-Guard accumulation leak detector.

If a leak is detected, the battery pack can be taken from the chamber and areas prone to leakage can be scanned by sniffing these with a Protec P3000(XL) leak detector to localize the exact leak location.

Leak testing in predefined areas via sniffing



For larger size battery packs or for a manual process, sniffing of forming gas with the Sensistor Sentrac hydrogen leak detector is recommended.

Larger size battery packs must be tested in a manual process or by robotic sniffing. The housing of the battery pack is filled with forming gas (5% hydrogen in 95% nitrogen) and the sniffer tip of a Sensistor Sentrac sniffer leak detector is moved along the areas prone to leakage - either by a human or by a robot. If the sniffer tip crosses a leak outlet, it will detect the hydrogen phase of the escaping gas and detect the leak.

BENEFITS OF LEAK TESTING WITH TRACER GAS

- Accurate, traceable and repeatable measurements for confident leak testing
- Highly sensitive testing methods, able to detect small leaks (10^{-4} .. $.10^{-6}$ mbar l/s range)
- Testing independent of temperature and humidity
- Dry process, no risk of water intake during testing
- Option of automated, operator independent process as well as manual, lower cost process available

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