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REVOLUTION

YOUR ONE PARTNER IN ELECTRIC VEHICLE PRODUCTION

HALL 06 STAND B26

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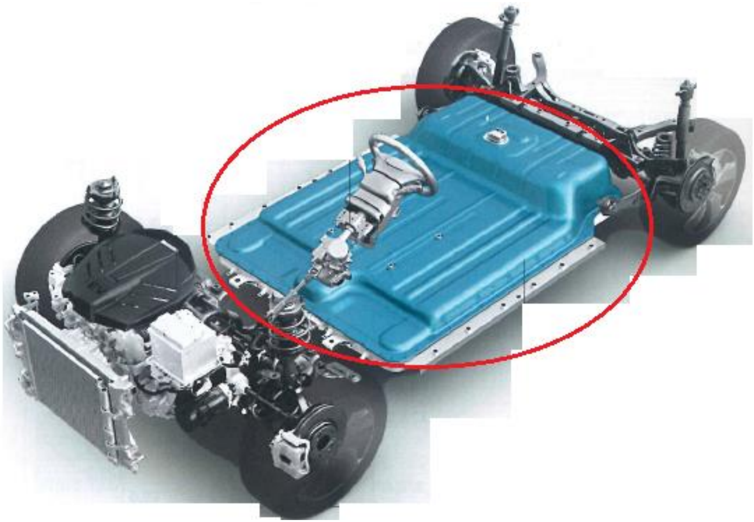
EV BATTERY PACK TEST: IP PROTECTION CLASS vs. LEAK TESTING

EMO Hannover

OUR EXPERIENCE

- You know full well the importance to secure the water tightness of the Li-ion battery packs used in EVs. Safety and reliability are at stake!
- In the last couple of years Marposs has worked in a significant number of leak test projects for battery packs and battery frames
- Our Customers are System Integrators, Tier 1s and OEMs. They seek an automatic 100% test solution, either in manufacturing or in assembly



OUR EXPERIENCE

- We get requests for leak testing of battery frames and packs under diverse conditions and with different reject limits → different test methods, either in air, or with helium
- In most of the cases, together with a “leak test specification”, also a “IP ingress protection class” is indicated (typically IPX7 or IPX8)
- Is it possible to compare the IP requirements and the leak test reject limits?
- What are the main differences between IPX7 (for instance) and the leak testing methods?

IP vs LEAK RATE

- According to ISO 20653 and IEC 60529, the IP codes rate the "*protection of electrical equipment inside the enclosure against harmful effects due to ingress of water*".
- The standard defines several IP protection classes, sets their requirements and describes the tests to be performed to verify the compliance
- As you know, the IPX7 refers to the "*temporary immersion in water*" (1m depth, for 30 min)
- When the IPX9K code is added, the enclosure must protect also against water during high pressure/steam-jet cleaning
- IP tests and IP test set-ups are appropriate for the validation of prototypes and certification of products, but cannot be performed in a mass production

IP vs LEAK RATE

- A leak test is an quantitative measurement of a physical dimension (e.g., fluid flow) that can be performed automatically on 100% of a large scale production
- Leak tests are not focused specifically on water ingress in an enclosure, but can give relevant results selecting the appropriate gas (air or helium) and test conditions (e.g., how much over/under pressure? what reject limit?)
- How to compare the two different methods?
  1. By IP you need to objectify how much water could produce harmful effects or impair performance. E.g., only a few drops, or not a single one entered in 30 min?
  2. Estimate the leak test reject limit that corresponds to a given IP rating

IP vs LEAK RATE

- Reject limit estimation methods:
  - Theoretical: transform a water leak permissible amount (e.g., < 0,05 ml/30 min for IPX7) into a air leak amount through a simplified leak hole model (e.g., orifice or straight pipe), at a defined test pressure (e.g., +100 mbar = 1m water depth for IPX7), using the proper formula
  - Experimental: determine the max diameter of a capillary tube of defined length through which water cannot pass at the given delta pressure, then calculate the gas flow through it using the proper formula, considering the influence of different materials
- Assuming not a single drop is allowed in 30 min, these methods could estimate the reject limit in the 10^{-4} scc/s range, when testing at 100 mbar delta pressure, with large variations experimenting on different materials
- Many examples available on the technical literature and the web

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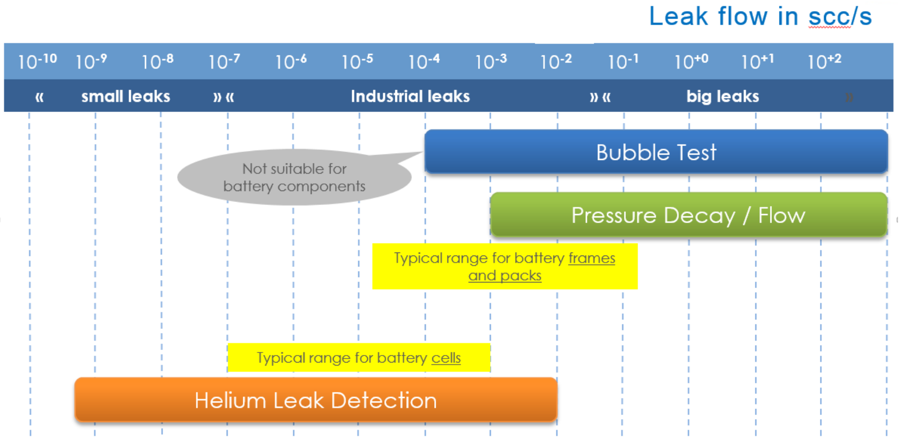
IP vs LEAK RATE

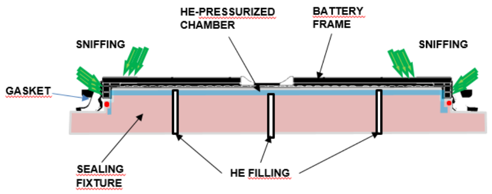
- It looks straightforward but in reality it is not so, otherwise why the actual leak test specifications would be so different?
- E.g., the reject limits could range from few 10^{-5} scc/s in He, to some 10^{-1} scc/s in air (approx.)
- The test pressure and the trace gas dilution have a great influence. The test methods have different detection capabilities and constrains
- Our role is to support the Customer with the right solution for each requirement



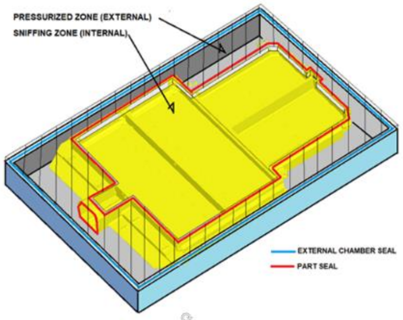
IP vs LEAK RATE

The test pressure problem:

- E.g., the leak test pressure specification could be in the 25-150 mbar range (approx.). Parts are either inside pressurized, or outside pressurized (similar to the IPX7 conditions)
- Why notably different test pressures, often below 100 mbar (nominal for IPX7)? Because the parts under test could not withstand a higher pressure without the risk to be somewhat damaged
- The Leak Test solution provider can help the Customer in the definition of the best solution



INSIDE PRESSURIZING

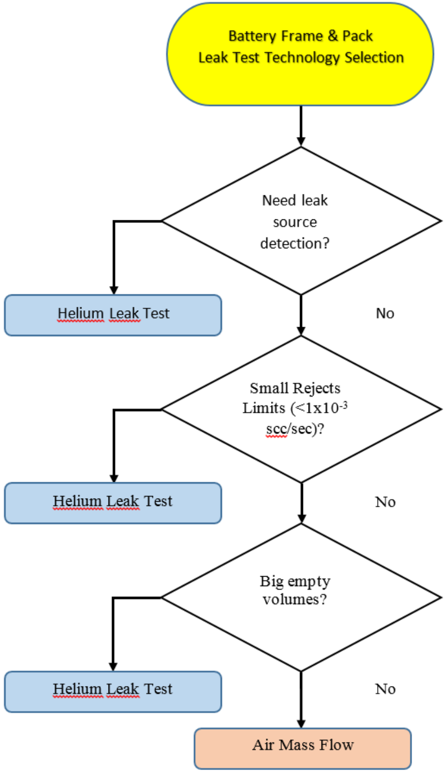


OUTSIDE PRESSURIZING

AIR vs HELIUM

The Air vs. Helium dilemma:

- We offer both technologies and use an objective selection criteria: the reject limit and the application type
- If the reject limit is above $1x10^{-3}$ scc/s, then Air could be the right choice
- If the limit is lower, or you need to localize the leak, or you need to test large empty volumes in short time, then Helium is the right choice
- For large parts, like battery packs, the He sniffing technique is a practical solution



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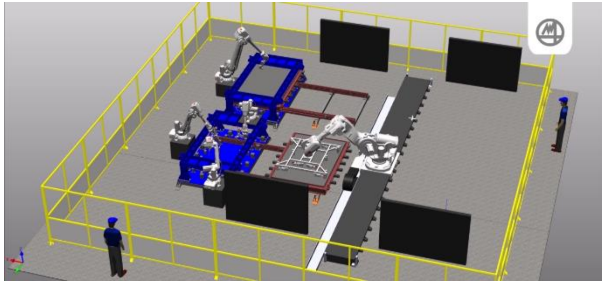
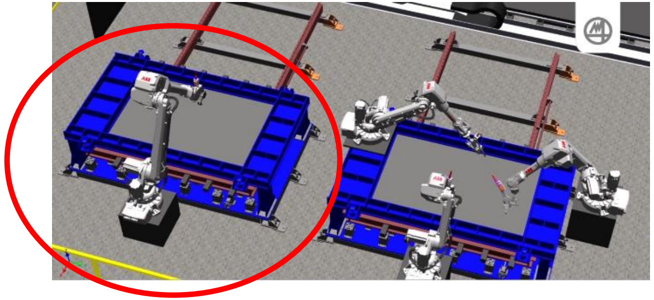
EXAMPLE OF AUTOMATIC TESTING

A robot cell for the automatic 100% leak testing
Flexible solution for different types of battery trays
Helium sniffers on robot arms to detect leaking areas

- SHORT RE-TOOLING TIME: to change part type, the sealing fixture can be replaced (over- or under pressurized)
- SHORT CYCLE TIME: cycle time can be shortened by adding more sniffing robots

A model of this application is visible in our booth at EMO in Hannover: HALL 06, STAND B26





THANK YOU!

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