Success Story
COMET

SafeBattery – Safe Lithium-Based Traction Batteries
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Equivalent Vibration Life Expectancy Profile for Lithium-Ion-Batteries

In order to investigate the influence of mechanical vibrations of initial load on traction batteries and their crash safety it is necessary to create equivalent vibration life expectancy profile. Such a new profile has been successfully determined in SafeBattery based on real test data for test bed applications under laboratory conditions and was, for example, successfully applied directly to the newly developed batteries at the industrial partner Kreisel Electric GmbH & Co KG. In this way the quality of safeguarding concerning the function and integrity of batteries can be improved significantly.

Vibration load on traction batteries

Battery powered vehicles generally show a different vibration behavior than conventionally powered vehicles. Norms showing oscillation load profiles are usually based on vehicles with combustion engines and therefore they are not optimally suitable for battery powered vehicles. For this reason, the determination of an equivalent vibration life expectancy profile (VILEP) for a Lithium-Ionian traction battery is of high interest i.e. it is subsequently also the basis for investigations on the influence of mechanical vibrations of initial load on traction batteries concerning crash safety.

Due to the absence of a VILEP profile for traction batteries, SafeBattery determined such a profile based on real tests. The main focus was on a most efficient time compression on the vehicle service life in order to minimize expensive time spent on test beds and test prototypes very early with a realistic vibration profile.

Reduction of test duration

The basis for determining an equivalent oscillation profile was provided by measuring signals of a traction battery (figure 1) derived from test drives with an electrically powered vehicle on various road surfaces (smooth asphalt, rough asphalt and smooth cobblestone) and different speeds (30 km/h, 50 km/h, 70 km/h und 90 km/h).

Fig. 1: Traction battery
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The calculation process was based on parts of the measured power spectral density (PSD) of measuring drives taking into account different energy inputs in x, y and z direction of the battery.

The results were categorized and dispersed according to distribution of literature on driving speed and road surface and vehicle service life for electric vehicles.

In order to determine the actual testing cycle, the driving performance of the electric vehicle was brought in and with the aid of the record of the vibrational energy while driving on cobblestone, a testing time up to the achievement of an energy equivalent was calculated, which leads to the new VILEP (see Fig. 2).

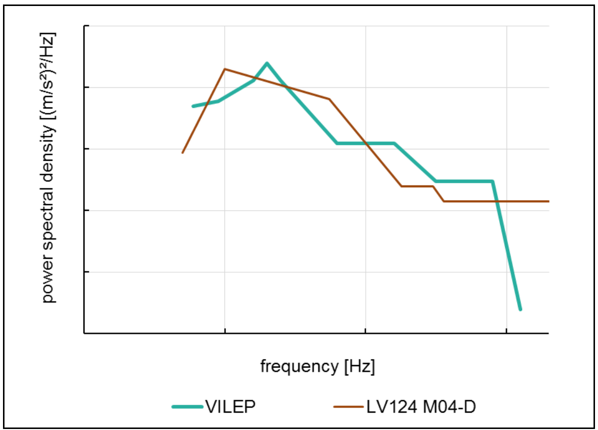

Fig. 2: comparison of vibration profiles

By these means the duration of the testing profile for the vibration life duration profile was calculated. In order to reduce the calculated vibration duration, the amplitude which was measured while driving is artificially increased. By this a direct proportional increase of vibrational energy is achieved. But due to the fact that the entire energy input should remain constant, the testing time is directly proportionally reduced.

The calculated vibration life expectancy profile corresponds for the most part with the existing norm profile of LV-124 M04-D but differentiates from the testing time and in the lower frequency range. The calculated testing time of the VILEP profile is reduced by approx. 50% in comparison to existing norm profiles with an average defined vehicle lifetime for traction batteries of electric vehicles.

Impact and effects

With these investigations and results it was possible to develop a general approach to the derivation of a vibration profile based on measuring drives. By this a new realistic vibration life extension profile (VILEP) especially for battery powered vehicles was developed. The VILEP, for example, allows the industrial partner Kreisel Electric GmbH & Co KG, testing their Lithium-Ionian batteries cost-efficiently and time-efficiently for operational stability.

On the basis of the procedure determined and the resulting VILEP, future traction battery concepts can be safeguarded more effectively in regard to their function and integrity. Specific vibration profiles can be created according to the application and the vibration test duration can be significantly reduced.

The next step will show that this vibration profile also represents the basis for the research project SafeBattery, in order to be able to carry out first-time explicit investigations of the possible influence of mechanical vibrations of initial load of traction batteries regarding crash safety.

Contact and information
K-Project SafeBattery

Vehicle Safety Institute
Graz Universyty of Technology

Inffeldgasse 23/I, 8010 Graz
T +43 316 873 30301
office.vsi@tugraz.at, www.safebattery.eu

Project coordinator
Dr. Wolfgang Sinz
Dr. Christian Ellersdorfer

Project partner

Organisation	Country
Graz Universyty of Technology Vehicle Safety Institute	Austria
Kreisel Electric GmbH & Co KG	Austria
Competence Center Virtual Vehicle GmbH	Austria