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Investigation of Electrical Insulation Options for Battery Cooling Plate Surfaces

Untersuchung zur elektrischen Isolierung von Batterie-Kühlplatten Oberflächen

A Thesis
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Abstract

With recent political and social developments regarding the use of fossil fuels as the main energy source in the mobility sector, the demand for alternative propulsion systems is on the rise. The production and use of electric vehicles is being advanced on a grand scale and a very important aspect of these new transportation means is their safety. Much focus is placed on preventing a thermal runaway of the high voltage energy storages in electric vehicles: the batteries.

One such preventive measure is the electrical insulation of battery cooling plates. These plates come into direct contact with the battery cells and are responsible for the thermal management of the battery packs. This is where Modine Europe GmbH comes in. As a world leader in thermal management for the vehicular sector, Modine is expanding its product range to cater for the new e-mobility market.

This thesis deals with an investigation of several insulation options for such cooling plates. Different insulation systems were evaluated based on electrical, mechanical, thermal, chemical and manufacturing properties as well as cost factors. Of these, the electrical properties were experimentally examined.

The core of the thesis was the experimental determination of the insulation resistance and dielectric breakdown voltage of different coating systems. These coatings can be grouped into anodization, a ceramic coating, polymer powder coatings, liquid paints and insulating films. The electrical tests performed showed that anodization, the ceramic coating, some powder coating systems and a coating process named e-coat do not suffice with regard to the two quantities under consideration. They experience a failure mechanisms referred to as dielectric breakdown. On the other hand, a number of insulating films, a silicon-based conformal coating and a 150µm epoxy powder coating system were found to be suitable for use on battery cooling plates. An approximate cost comparison of these final three coating methods was done to complete the project. This showed that powder coating and liquid painting outweigh the film application by a factor of two, in terms of capital invest costs.

Since merely the electrical quantities were experimentally examined, future work includes a quantitative analysis of all the other factors mentioned above. This will then give a comprehensive overall assessment for the insulation systems. Furthermore, since the evaluation in this thesis was done on existing insulation systems future research could be done to obtain the optimal coating system and application technology. This may even encompass new functional materials with specifically engineered properties.

The results of this thesis should aid Modine in deciding which insulation system would be most suitable for its battery cooling plates. In the long run, the research desires to contribute to improving the safety of electric car users.