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THERMAL ENERGY STORAGE FOR THERMAL MANAGEMENT IN E-MOBILITY

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Introduction

The transition towards e-mobility raises the necessity for a smart thermal management of vehicles. This is forced by the high number of thermal components with different operation temperatures, hardly available waste heat at high temperatures, and in particular the narrow temperature window to be ensured for the battery. Within the Austrian flagship-project Tes4seT, a novel thermal management based on a compact energy storage is developed for hybrid vehicles.

Approach

A compact thermal energy storage based on closed sorption technology is designed for this application. The system can be charged using waste heat and deliver heat or cold on demand when discharging. Energy densities higher than 100 Wh/kg on material level are state of the art and long-term storage is possible in principle without any thermal losses. For the considered application, the design of the storage system targets at both high energy density and high power density, which is the major challenge.

Methods

The various key components of the storage system, like sorption reactor, evaporator and condenser, are designed and optimized according to the specific requirements. These components are assembled to a thermal energy storage system and investigated experimentally in a dedicated test rig (see Figure 1, left hand side). The test rig is used to compare the performance of three different sorption reactor designs for a given set of boundary conditions. A hardware-in-the-loop test rig will be constructed to test the storage system under realistic conditions including a driving profile. A simulation model of the system is developed and validated using the experimental results. The model is used to assess the storage system's performance at various boundary conditions, as well as to further optimize the system, in particular considering the control strategy.

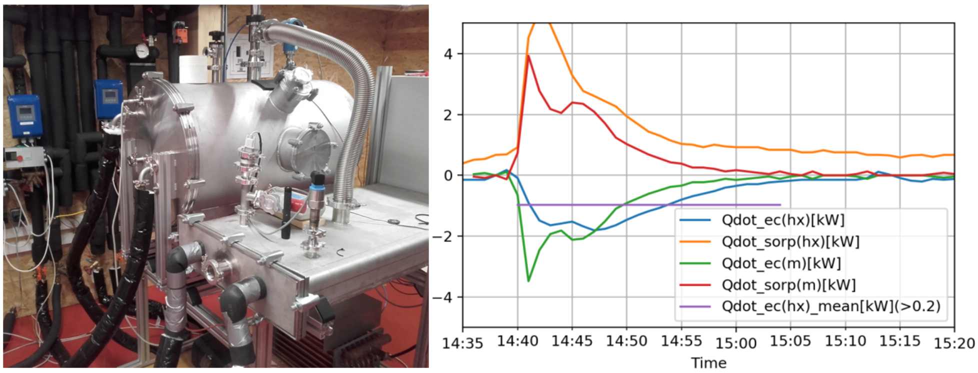

Figure 1: Picture of the sorption thermal storage system test rig (right hand side) and preliminary power performance in discharge mode (right hand side). An average cooling power of almost 1 kW could be achieved for a period of 25 minutes.

Results

First results show that the storage system including 2.5 kg of adsorbent provides cooling up to 2 kW peak and 1 kW on average (see Figure 1, right hand side). First simulation results show that the thermal storage can significantly contribute to the thermal management system and increase its resource efficiency (see Figure 2). Further results will become available and presented at the conference.

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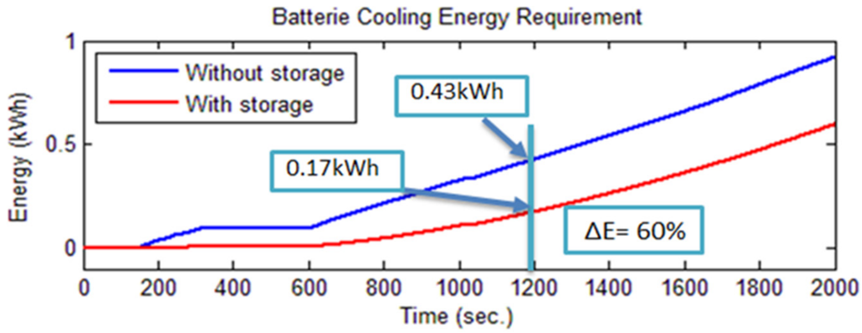

Figure 2: Preliminary simulation results showing the impact of the thermal storage on the thermal management in the vehicle. In comparison to a thermal management without thermal storage, the required conventional cold supply could be reduced by 60 % within the first 20 minutes of the ride.

Discussion/Conclusion

The compact thermal energy storage system is a promising extension for the thermal management in e-mobility. Experimental and simulation studies will be continued, and optional improvements investigated.