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Waste Heat Recovery for Fuel Cell Electric Vehicle with a Thermochemical System

Mounir Nasri*, Michael Schier and Horst E. Friedrich

Institute of Vehicle Concepts, German Aerospace Center, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany

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For the preheating of the battery, fuel cell and cabin environment of a fuel cell electric vehicle, there is not sufficient waste heat especially at the beginning of vehicle operation. This lack of waste heat is usually covered by a positive temperature coefficient (PTC) heater, which converts the electricity from the battery into heat, and consequently the electric range is considerably reduced.

This paper deals with the development of a novel thermal management system for a fuel cell electric vehicle which uses thermochemical heat storages to store the waste heat of the powertrain components and relieve the cooling system during vehicle operation. At the beginning of the vehicle operation, the powertrain components are cold. Therefore, the stored waste heat is used to heat the powertrain components before and during vehicle start-up. This leads to a reduction of the strain on the battery and improved performance of the powertrain. The focus will be on metal hydride storages, which have a higher specific energy density than the phase change energy storages and will thus be more advantageous for vehicle application. Various integration concepts delivering the thermal energy needed for the transient component heating are explained and developed. In order to investigate the integration concepts in a vehicle simulation environment, a complete vehicle simulation model including thermochemical heat storage model is developed. It is found that the integration of the thermochemical heat storages into the thermal management system leads to increase the range of the fuel cell vehicles by up to 17 %.

Keywords: waste heat recovery; fuel cell vehicle; thermochemical system; powertrain; thermal management

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John Smith[1*]，张三[2]，李四[3]

[1]*School of Engineering, University of Aberdeen, Aberdeen AB24 3UE, UK*
[2]*Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA*
[3] *中国 北京清华大学工程力学系，北京 100084*

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