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Car as Power Plant: SOFC-PEMFC integrated high efficiency transportation systems

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Automobile industry is expected to change significantly in the coming years and decades. A convenient, technically and economically viable and environmentally friendly transportation system for the future needs to be developed. This requires a comparison between different technical choices based on best possible designs achievable. The role of hydrogen and fuel cells in the future transportation systems is being widely debated. As they are getting continuously compared with other possible options, for example with battery vehicles, it is necessary that efficient system concepts for fuel cell based transportation systems are developed. In this paper, we present an approach to increase the efficiencies while using different fuels for transportation applications, by making use of different types of fuel cells. A concept is presented in which a high temperature fuel cell is used as an electricity producing fuel reformer, in this case a Solid Oxide Fuel Cell (SOFC) and low temperature fuel cells onboard for vehicle propulsion, in this case Proton Exchange Membrane Fuel Cells (PEMFC). A trigeneration system fed with natural gas and capable of producing electricity, heat, and hydrogen is proposed. Two modes are presented: a Car as Power Plant (CaPP) mode, in which fuel cell electric vehicles (FCEVs) act as energy and water producers while parked; and a pump mode, in which compressed hydrogen is produced and pumped to the vehicle's fuel tank. Different reforming options are presented and compared, a catalytic reformer (CR), and a solid oxide fuel cell operating as reformer (SOFCR). Additionally, the option of integrating carbon capture and storage (CCS) is also presented. Results indicate that the SOFCR unit significantly reduces the energy destruction resulting a trigeneration energy efficiency of around 60%. Additionally, a brief presentation on applying the concept for other types of vehicles also is presented.

Biography

PV Aravind is an Associate Professor at Delft University of Technology, The Netherlands (Faculty of Mechanical, Maritime and Materials Engineering). He teaches courses on Thermodynamics of Energy Conversion and Fuel Cell Systems. He also teaches at Technical University Munich in Germany and contributes to a course at KU Leuven in Belgium. He is/was involved in several national, European and international energy related research projects focusing on fuel cell systems. Currently, he supervises a team of ten PhD students, three Postdoctoral Researchers and several MSc students. He is a member of the International Energy Agency SOFC Annex and is also in the steering committee of European Energy Research Alliance for Hydrogen and Fuel Cells.

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