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Fuel cells for civil aircraft application: On-board production of power, water and inert gas

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ABSTRACT

Fuel cell systems are regarded as a promising solution for future electrical energy generation on board of commercial aircraft. In addition to an improved efficiency such systems offer the opportunity of producing water usable for on-board purposes and provide additional functions such as inerting (providing a non-inflammable atmosphere) of the jet fuel tank. This paper presents an evaluation and assessment of different system architectures as well as experimental results demonstrating the feasibility of the multiple functions in a laboratory set-up. First, the conventional system requirements and the results reported by the Federal Aviation Administration (FAA) are discussed. A system design evaluation based on simulating cruise and ground operation of aircraft is performed demonstrating the benefits of systems with pressurized hydrogen tank storage and cabin air use. The requirements for a fuel cell system regarding aircraft inerting function are calculated based on the FAA analysis. Experimental results based on laboratory systems confirm the feasibility of the implementation of various functions with a single fuel cell system. Test platforms for further investigation of the systems are shortly described.

Keywords: Fuel cells; Aviation; Multi-functional systems; Reduction of emissions

1. Introduction

According to the Intergovernmental Panel on Climate Change (IPCC) reports (Penner et al., 2000), air transport is currently responsible for about 2 percent of global CO_2 emissions, and this figure will probably rise to 3.5 percent with increasing air traffic. Although the global emission share is low, there is increasing pressure on aircraft manufacturers to improve the efficiency of their aircrafts and lower their environmental impact. Therefore, future aircraft generations have to face enhanced requirements concerning productivity, environmental compatibility and higher operational availability, thus effecting environmental, technical, operational, and economical aspects of in-flight and on-ground power generation systems. Today's development in aircraft architecture undergoes a trend towards a "more electric aircraft" which is characterized by a higher proportion of electrical systems substituting hydraulically or pneumatically driven components, and thus, increasing the amount of electrical power. Fuel cell systems in this context represent a promising high-technology solution regarding the enhancement of energy efficiency for both cruise and ground operations.

In cooperation with Airbus, the German Aerospace Centre (DLR) has identified several fuel cell applications within the aircraft for both ground and cruise operation (Renouard-Vallet et al., 2010). Consequently, fuel cell systems capable to support or even replace existing systems have been derived. The provision of inert gas for the jet fuel (kerosene) tank, the

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