CONCEPTUAL LOADS ASSESSMENT OF AIRCRAFT WITH FUSELAGE INTEGRATED LIQUID HYDROGEN TANK

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Abstract

The advancing climate change and the necessity for climate-neutral mobility to reduce the impact of air traffic on global warming are leading to new demands on the aviation industry. Hydrogen fuel offers a promising opportunity to achieve the high energy requirements of commercial aircraft with zero-emission [1,2]. Hence, aircraft with liquid hydrogen propulsion architecture are one key to meet the challenging requirements for climate-neutral aviation without fundamental configuration changes. Three hybrid-hydrogen aircraft concepts have been already proposed by Airbus as part of their zero-emission (ZEROe) program to develop a zero-emission commercial aircraft by 2035 [3].

The EXACT (Exploration of Electric Aircraft Concepts and Technologies) project of the German Aerospace Center (DLR) the main concern is the investigation and optimisation of hybrid-electric propulsion system concepts and overall aircraft design (OAD) for possible configurations. Furthermore, the impact of those aircraft configurations on climate, energy supply, aircraft costs and their ecological balance during a lifecycle are investigated [4].

This paper presents the current activities of the DLR on liquid hydrogen aircraft configurations in conceptual aircraft design with respect to conceptual loads estimation and analysis. The work in this paper is related to the overall aircraft design of such aircraft configurations with special emphasis on the structural dimensioning and mass estimation of fuselage, wing and liquid hydrogen tank taking conceptual loads into account. For the OAD a multidisciplinary design process was implemented using DLR in-house tools. For this purpose, the Remote Component Environment (RCE) software [5] is utilized, where the available tools are used to build up such an OAD workflow. For the data exchange within RCE the Common Parametric Aircraft Configuration Schema (CPACS) [6] is used, where the parametrized aircraft data are stored.

The work briefly presents the analytical handbook methods used in the in-house tools LOADzero [7] and LGLOADzero for the estimation of flight, ground and landing loads. The tools have been designed for quick loads estimation for a rigid aircraft and have been further developed to meet new challenges in liquid hydrogen overall aircraft design. The focus is on the loads assessment of aircraft with fuselage integrated liquid hydrogen tank in conceptual design. The impact of additional masses of the hydrogen tanks and therefore altered mass models on conceptual loads is analysed. Critical load cases crucial for structural dimensioning are identified to investigate the influence of the varying masses in more detail. Therefore, a loads comparison is carried out between the baseline aircraft configuration and aircraft with fuselage integrated liquid hydrogen tanks.

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