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Corresponding author: SIELEMANN Michael
e-mail of corresponding author: michael.sielemann@modelon.com
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Title

Fundamentals Of Aircraft Hydrogen Tank Design With System Simulation

Authors

Michael SIELEMANN [1], Daniel Andersson [2], Clément Coïc [3]*

** Corresponding author*
[1] Modelon Deutschland GmbH, 80997 MÜNCHEN, Germany, michael.sielemann@modelon.com
[2] Modelon AB, 22370 LUND, Sweden, daniel.andersson@modelon.com
[3] Modelon Deutschland GmbH, 80997 MÜNCHEN, Germany, clement.coic@modelon.com

Abstract

As the number of researched propulsion concepts relying on hydrogen as energy storage increases drastically, both for hybrid electric and purely hydrogen-electric designs, the storage tank design becomes critical. It must be understood whether high-level assumptions made during early concept investigation are plausible, for instance on gravimetric efficiency. For this, the corresponding trade-spaces must be explored, which is usually not practical with overly detailed and computationally expensive field simulations such as Computational Fluid Dynamics or the Finite Element Method. Instead, a system simulation or analytical modeling approach is required, which is efficient and accurate. Such approaches have been discussed in the literature individually and often without much classification or context. The objective of this paper is twofold, first to describe the types of system simulation methods for aircraft hydrogen tank design including sample literature references, and second, to investigate interrelations and consistencies between select references. It was found that methods range from steady-state sizing as well as assessment using dynamic simulation to sizing using dynamic optimization. Interrelations between types of designs, for instance tanks with boil-off and tanks with finite dormancy, and different system simulation methods are reported on a point design and a limited sample trade study. For the point design, predictions of a system simulation method are compared to those of detailed field simulations with Computational Fluid Dynamics and the Finite Element Method, and results were found to compare favorably.

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