Aerodynamic Study of Boeing 737-800 with Distributed Propulsion System

Abstract

The Boeing 737-800 is a widely used commercial aircraft known for its efficiency and versatility. It belongs to the Boeing 737 Next Generation (NG) family, characterized by its advanced technology, spacious cabin, and impressive range. This twin-engine, single-aisle jetliner typically accommodates around 162 passengers in a two-class configuration and offers a maximum range of approximately 3,850 nautical miles. [3] However, its operational efficiency comes at a cost to the environment. With a fuel consumption rate of 850 US gallons per hour, the Boeing 737-800 emits a substantial amount of carbon dioxide during each flight.[2] Addressing the carbon emissions associated with this aircraft is crucial for reducing its environmental impact, making it an ideal candidate for the transition to NH3-based fuel as part of this capstone project. The modifications and optimizations to the Boeing 737-800's design and propulsion system aim to significantly reduce its carbon footprint while maintaining its essential features and capabilities.

This project's scope is comprehensive and multifaceted, reflecting the complexity of the task at hand. It involves designing an aircraft structure optimized for ammonia fuel, considering factors such as weight distribution, balance, and safety. in parallel, the development of a novel ammonia-based propulsion system for the aircraft, which must be not only efficient but also safe for operation will be designed that will be fitted onto the new aircraft design. To visualize the aircraft design effectively, a detailed 3D model will be created, serving as a visual representation of the proposed aircraft. Additionally, the project explores the feasibility of utilizing 3D printing technology to create a physical prototype of the aircraft, which will be instrumental in testing and validating the design. Ensuring that the design adheres to aviation regulations and safety standards is paramount, requiring meticulous attention to detail and rigorous compliance checks.

To create a new airplane design with an untraditional fuel such as the NH3 based fuel engine; first we will use the Boeing 737-800 as a starting base for the new design. This design is a particularly good starting point for creating a new aircraft design as this model of the Boeing aircraft has gone through many kinds of upgrades throughout the years and its versatility will be particularly good at the addition of the new NH3 based fuel engine. We will have to redesign the fuel system to accommodate the new fuel system as traditional jet fuel systems can only use kerosene-based fuel, so the entire system must be redesigned with the NH3 fuel in mind. For creating the new aircraft design, we will be using SolidWorks to create a 3d design model of the new aircraft design. We will be basing the model on the Boeing 737-800, but we will be adding modifications on the plane as our model in the end will be different compared to the actual model of the Boeing 737-800 plane. The areas of focus that will be different are the fuselage and the wings, as the addition of the NH3 fuel system will affect how the airplane structure is built. From the SolidWorks model, it will be transferred to a 3d printer where we will print the model. The printed model will then be put into a wind testing tunnel to test how it performs in a simulated situation to serve as a basis of how the design of the airplane could perform if it were built.

References:

[1]. Environmental and Energy Study Institute (EESI). “Issue Brief: The Growth in Greenhouse Gas Emissions from Commercial Aviation (2019, Revised 2022).” EESI, www.eesi.org/papers/view/fact-sheet-the-growth-in-greenhouse-gas-emissions-from-commercial-aviation.

[2]. “Boeing 737-800.” Epic Flight Academy, 9 Oct. 2023, epicflightacademy.com/boeing-737-800/.

[3]. “Boeing 737 next Generation.” Wikipedia, Wikimedia Foundation, 9 Nov. 2023, en.wikipedia.org/wiki/Boeing_737_Next_Generation.