Improving Power Conversion Efficiency in an Electric Aircraft

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Abstract

In the age of climate change caused by the excessive use of fossil fuels, there has been an increase in demand for reducing the use and dependence on fossil fuels. Currently, the limiting factor is the state of battery technologies available, as the specific energy of batteries is much less than the specific energy of jet fuel. Calculating the energy requirements for a flight is vital to estimating the mass of energy storage material required for the flight to succeed. The purpose of this tool is to calculate the energy requirements for a flight and applying it to the gas, electric, and hybrid powertrains to predict the mass of fuel or batteries needed.

Introduction

The purpose of this project is to create a tool for engineers to approximate the mass, costs, and GHG emissions of an aircraft with three different powertrain systems: gas, electric, and hybrid. To solve the aircraft dynamics and the power requirements, Aircraft Power Requirement Efficiency Calculator (APREC) has been previously created in Microsoft Excel. Excel was chosen for its simplicity and ease of data presentation.

Methods

Microsoft Excel was chosen for its ease of use Multiple scripts have been added to the Excel tool with the help of Visual Basics for Applications (VBA). The purpose of the main optimization scripts is to adjust the initial fuel mass, battery mass, or battery parameters. A user interface has been added to the tool using VBA. The interface simplifies the tool for the user to limit the necessary inputs and outputs. A plotting function has also been added to allow the user to view trends in variables as functions of other variables

Results

The tool is capable of accurately predicting power requirements of a user-defined flight. A plot of CO_2 emissions as a function of time through flight is shown.

Discussion/Conclusion

APREC allows the user to compare the potential, costs, and environmental effects of aircraft with gas, electric, or hybrid powertrains. With a highly customizable mission profile, a wide range of flights can be optimized and analyzed. The aircraft dynamics have been improved over the previous version. Battery calculations have been implemented to design appropriate battery packs from battery cells for different flight profiles. Favorable battery properties are highlighted, as shown below. A hybrid powertrain combines gas and electric powertrains with user defined contributions from each energy source. VBA scripts have been added to iteratively adjust the mass of batteries or gas to optimize the flight profile.

	System A	System B
Mass (kg)	21054.83	20021.56
Volume (m^3)	9.78	9.77
Cost ($)	$2,816,251.20	$2,887,586.00
CO2 Emmisions (kg)	1781.62	1790.09

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