Instytut Lotnictwa, Warszawa

Doktorant mgr inż. Borys Łukasik

Streszczenie rozprawy doktorskiej

Temat pracy: **„Analysis of the possibility of using full-electric, hybrid and turbo-electric technologies for future aircraft propulsion systems, in terms of mission energy consumption, NOx/CO2 emission and noise reduction"**

Obszar i dziedzina nauk technicznych
Dyscyplina: budowa i eksploatacja maszyn

Promotor: dr hab. inż. Witold Wiśniowski, prof. Instytutu Lotnictwa

Promotor pomocniczy: Prof. Meyer J. Benzakein, Ph.D., The Ohio State University, USA

Abstract

The dissertation presents a comprehensive analysis of the feasibility of using electric propulsion systems for commercial aircraft, as a replacement for turbofan engines in the 20 30 year time frame. The main study was preceded by the identification of the potential customer needs and expectations for future propulsion systems. Safety regulations, environmental issues, economic conditions, and maintenance requirements were widely considered. Potential methods and technical solutions, which would allow to fulfill new demands, were reviewed in terms of pros and cons of specific solutions, and based on that, the juxtaposition of different competitive methods was presented. Three main types of electric propulsions were discussed: all-electric, hybrid and turboelectric systems, including different variants of system architecture. Strengths and weaknesses of each architecture were discussed and their technical limitations were presented. In the next step, thesis focused on the field of electric components, in terms of their efficiency, power density and energy density, as well as their possibilities for further development. Then a full review of the currently designed all-electric airplanes and their performance and planned upgrades were presented. In addition, the feasibility of all-electric propulsion for small-business jet aircraft was extensively investigated. Based on the conclusions drawn at this stage of thesis, extensive analysis of a distributed propulsion system, which utilizes turboelectric and hybrid architectures, was performed for regional jet, narrow-body and wide-body class aircraft. The obtained results were compared with performance of the selected baseline airplanes which represented three given classes. The analysis was performed in three stages. In the first stage thermodynamic cycle performance of uninstalled propulsion system was calculated. In the second stage the mass of the propulsion system was assessed, and in the third, the aircraft mission analysis was performed. The possibility of reduction of the total mission energy consumption, as well as expected emission reduction were studied. That showed the potential benefits of the use of electric propulsion system, at different time frames and levels of electric devices advancement. The same analysis was also performed for boundary layer ingestion, which can greatly increase the potential benefits. The summary of this study

presents conclusions about the eventual use of electric propulsion systems. At the end, the recommendations for future analysis and potential fields of further research were presented.