

Electric Flight – Potential and Limitations

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ABSTRACT

During the last years, the development of electric propulsion systems is pushed strongly, most notably for automotive applications. For ground based transportation, the system mass is relevant, but of relatively low importance. This paper addresses the application of electric propulsion systems in aeronautics, where all systems are much more constrained by their mass. After comparing different propulsion system architectures the focus is cast on the energy storage problem and here especially on battery storage systems. Using first order principles the limitations and required technology developments are demonstrated by introducing battery powered electric propulsion systems to small and medium sized aircraft.

Abbreviations and Symbols

b = wing span [m]

C = capacity [Wh]

D = drag force [N]

E' = mass specific energy content [Wh/kg]

f_e = empty mass fraction m_e / m

g = gravity acceleration [m/s^2]

L = lift force [N]

m = mass [kg]

$m_{initial}$ = initial mass at takeoff [kg]

m_e = empty mass without fuel and payload [kg]

m_{final} = final mass at landing [kg]

$m_{battery}$ = battery mass [kg]

$m_{payload}$ = payload mass [kg]

m_{pass} = mass per passenger [kg]

PAX = number of passengers

P = power [W]

$P_{battery}$ = electric power provided by battery [W]

R = range [m]

t = time [s]

T = thrust [N]

V' = volume specific energy content [Wh/m³]

v_∞ = flight speed [m/s]

η = efficiency

ρ_∞ = density of air [kg/m³]

Electric Flight Potential And Limitations

Jet Propulsion Laboratory (U.S.)



Electric Flight Potential And Limitations:

Electrified Aircraft Propulsion Kiruba Haran, Nateri Madavan, Tim C. O'Connell, 2022-05-26 What are the benefits of electrified propulsion for large aircraft What technology advancements are required to realize these benefits How can the aerospace industry transition from today's technologies to state of the art electrified systems Learn the answers with this multidisciplinary text combining expertise from leading researchers in electrified aircraft propulsion The book includes broad coverage of electrification technologies spanning power systems and power electronics materials science superconductivity and cryogenics thermal management battery chemistry system design and system optimization and a clear cut road map identifying remaining gaps between the current state of the art and future performance technologies Providing expert guidance on areas for future research and investment and an ideal introduction to cutting edge advances and outstanding challenges in large electric aircraft design this is a perfect resource for graduate students researchers electrical and aeronautical engineers policymakers and management professionals interested in next generation commercial flight technologies

Vehicle Electrification Igor Bolvashenkov, Jörg Kammermann, Alexander Rubinraut, Hans-Georg Herzog, Ilia Frenkel, 2021-09-15 This book provides a comprehensive assessment and presentation of various feasible application of electric propulsion system considering their weight volume reliability and fault tolerance The results of feasibility analysis can be used today or in the near future for development of electric propulsion system for the ships planes helicopters and spacecrafts To solve the above task new theoretical approaches are applied including combined random process methods the Lz transform technique for multistate systems and statistical data processing

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