

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]

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