Pressure Loss and Thrust Optimization for Electroaerodynamic Propulsion Electrode Geometry in Drone Applications

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The operation of aircraft has numerous impacts on the world; it negatively impacts climate change, and it creates noise/air pollution. Electroaerodynamic (EAD) propulsion provides us with a propulsion system that addresses all of these problems. EAD propulsion systems produce ions in the air, and accelerate them across the air gap between the electrodes. As the ions are accelerated, collisions occur between the ions and neutral air molecules, generating thrust. Recent studies have attempted to use EAD propulsion, but the problem of a low thrust density/efficiency still remains. Various other studies have shown that creating multi-stage propulsors can lead to significant improvements to its thrust density and efficiency. However, introducing more stages to EAD propulsion systems increases the frontal surface area of the thruster. This research project aims to accomplish two tasks: to optimize the configuration of electrodes in a multi-stage ducted (MSD) thruster for the lowest amount of pressure losses, while maintaining a reasonable thrust density, and implement novel electrode geometries such as microgrid and dielectric barrier discharge setups. In this study, there was a limit to how many electrode stages became useful past a certain flow velocity. By varying the placement of the emitting electrodes, and testing asymmetric electrode configurations, an ideal balance of velocity and efficiency for each design was found while using the improved characteristics of MSD thrusters. These results confirm the viability of the application of this propulsion form in vertical takeoff/landing aircraft with further developments in weight reduction and power conversion efficiency.