Paper ID: 64449
oral
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (2) (6)

Author: Mr. Mobin Malik
University of Manchester, United Kingdom

Mr. Sahil Maharaj
University of Manchester, United Kingdom
Dr. Katharine Smith
University of Manchester, United Kingdom
Dr. Alistair Revell
University of Manchester, United Kingdom

CURRENT COMPUTATION WITHIN AN ELECTROHYDRODYNAMIC ATOMISATION PROCESS FOR ELECTROSPRAY THRUSTERS.

Abstract

A spectacular rise in demand for nanosatellite systems has been noticed over the past decade. The number of nanosatellites launched has increased over tenfold while generating $143.7 million in 2017. Many organisations and academic research have started using nanosatellite systems for space exploration, communication, Earth observation, remote sensing and many more applications. With the help of the current technological advancement, including the arrival of Micro-electro-mechanical systems (MEMS) technology, it has become quite convenient to design and develop nanosatellite systems compared to previous commercial satellites. However, one key constraint on nanosatellites missions is the absence of high-performance propulsion systems capable of providing manoeuvrability significantly to perform critical abilities, including de-orbiting, formation flying and LEO maintenance. While there are numerous electric propulsion types available, this study focuses specifically on electrospray thrusters due to their high specific impulse and low thrust specific power requirements.

Electrospray thruster technologies use an electrohydrodynamic atomisation process (also known as electrospray), where an electrostatic field is used to generate charged particles and ions from a fluid surface. A standard setup includes injecting fluid into an emitter supplied with electric potential, and a grounded extractor placed downstream that results in electric field generation. The fluid exiting the emitter interacts with the electric field. Once certain conditions are met, the fluid meniscus transforms into a conical shape, popularly known as the Taylor cone. Due to the high electric field gradient at the cone's apex, a jet emits from the apex, which eventually breaks to form droplets or ion emission for highly electrically conductive liquids directly from the cone apex. An essential output parameter measured in the electrospray process is the spray current. The current helps determine the charge to mass ratio for the spray, and ultimately the available thrust and specific impulse as charged particles are accelerated in an electrostatic field.

The present study uses a custom-built OpenFOAM model to simulate the electrospray process to compute the current numerically in the jet region. The benefit of numerically modelling the process is that it can accurately predict the electrospray setup's performance, which can be highly depended on the geometric configuration. Heptane of various electrical conductivities was chosen for the present study as it has been used considerably in experimental and numerical research. The study introduces a numerical approach taken and its impact in accurately determining key thruster performance parameters. The current obtained was compared against experimental data, which showed remarkable agreement.