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DEVELOPMENT AND EXPERIMENTAL VERIFICATION OF ASYMMETRICAL CAPACITOR THRUSTER (ACT) FOR MICRO-PROPULSION SYSTEMS

Abstract

An asymmetrical capacitor thruster (ACT) is a micro-electric propulsion concept that could deliver exceptional thrust levels with minimal electrical power. The simplest ACT thrusters consist of asymmetrical capacitors located at an optimal distance, with a dielectric medium between them. Thrust levels strongly depend on the input power, leakage current, capacitor geometry, dielectric material, vacuum level, and separation distance between the capacitors. In theory, the working principles behind ACT thrusters are the Quantized Inertia (QI) and or quantum tunnelling, however, none of these theories has been validated for the said thruster in the laboratory yet. In addition, the scientific community remains divided on this concept due to its propulsive capability and the hypothesized defiance of Newton's 2nd law and momentum conservation. According to the QI theory, such thrusters might be able to produce 120 N/kw and could arguably be a potential candidate for ground-based launch systems. This paper aims to validate the working theory of ACT and prove its consistency with Newton (except for quantum tunnelling) and momentum conservation laws based on numerical and extensive experimental campaigns. Numerical simulation was carried out in COMSOL for quantum tunnelling theory, and data will be validated with experimental data. Conversely, experimental tests focus on verifying all the above propositions with benchmark experimental set-up at varying vacuum levels. During the preliminary experiments, an ACT configuration was tested at different vacuum levels using an in-built torsional pendulum inside a mu-metal cage to eliminate external noise during measurements. During the preliminary tests, thrust levels increased linearly with vacuum levels. The torsional pendulum was calibrated using a novel electrostatic technique. Despite the lower thrust level of 60.5 N for an input DC voltage of 16 KV, the data is consistent and validates the QI principle, disregarding earlier claims like ion-wind effect and electrostatic phenomenon for ACT thrust. However, the thrust levels could be amplified with better electrode and geometry materials, dielectric medium or n-type semiconductors (for quantum tunnelling), optimal input voltage, electrode separation distance, Ultra High Vacuum levels under better calibration (voice-coil) and measurement techniques (laser interferometer) in the upcoming experiments using benchmark experimental setup. Further, a simple yet novel experimental setup development is in progress to extract quantum tunnelling data, which will be validated against the numerical results.