Paper ID: 17254
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SPACE PROPULSION SYMPOSIUM (C4)
Poster Session (P)

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THE DYNAMIC OPERATION OF A HIGH Q EMDRIVE MICROWAVE THRUSTER

Abstract

The static operation of an EmDrive microwave thruster has once again been demonstrated by the Chinese experimental work reported in REF 1. The work repeats and enhances results obtained in earlier UK experiments, REF 2, and confirms the direct relation between specific thrust and Q factor of the cavity. This paper considers the dynamic operation of a thruster with the very high Q factors obtained when a cavity employs superconducting technology. The very high specific thrusts resulting from such second generation (2G) devices must be subject to the law of conservation of energy. It follows therefore, that there must be a mechanism which limits the acceleration of any vehicle propelled by a 2G EmDrive thruster. A mathematical model of a 2G thruster is described which illustrates such a mechanism. The results from the model illustrate the Doppler changes which occur when a thruster is subject to acceleration. For Q factors around 1 x 109, the total Doppler shift moves the frequency outside the narrow resonant bandwidth of the cavity. This causes the loaded Q of the cavity, and thus the specific thrust, to decrease and therefore limits the acceleration. A technique, employing pulse operation and dynamic control of the cavity length, is described which enables partial compensation for the effect. The resulting thruster design, employing YBCO superconducting walls and liquid hydrogen cooling, achieves a specific thrust of 1 Tonne per kW, provided the acceleration is limited 0.5m/s/s. This low acceleration rate is compatible with primary in-orbit propulsion applications, and will be particularly suitable for deep space missions. For launch vehicles, the acceleration limitation is no obstacle; as a flight profile is proposed where high velocity is only achieved once clear of the atmosphere. Indeed the reusable, EmDrive propelled carrier vehicle itself, is only used to lift the payload to geostationary altitude, where a simple, solid fuelled ABM is used to provide orbital velocity. The resulting costs to geostationary orbit are predicted to be 130 times lower, when compared to current launch vehicles. REF 1. YANG JUAN et al "Net thrust measurement of propellantless microwave thrusters" NWPU, College of Aeronautics, Xi'an. Acta Phys. Sin. Vol.61, No. 11 (2012) REF 2. SHAWYER, R.J. "Microwave propulsion – progress in the EmDrive programme" SPR Ltd UK. IAC-08-C4.4.7