Paper ID: 8521
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SYMPOSIUM ON VISIONS AND STRATEGIES FOR FAR FUTURES (D4)
Access to Space in the Far Future (3)

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IN SERVICE POWER REQUIREMENT FOR A MOTORISED MOMENTUM EXCHANGE TETHER

Abstract

The Motorised Momentum Exchange Tether (MMET) was proposed by Cartmell in 1996 and first published in 1998 [1].The MMET introduced a new way to propel sizeable masses in space by exploited orbital dynamics and solar powered motorised spin .The concept was then developed further by Ziegler and Cartmell [2], Ziegler [3], McKenzie [4] and Chen [5]. MMET has the potential for reducing operational cost for space transportation and Ziegler and Cartmell [2] have introduced the use of MMET as an orbital transfer vehicle. In 2004 Cartmell, McInnes and McKenzie [7] proposed a preliminary design for mission architecture for Earth-Moon payload exchange using the MMET concept. In this paper, the study is focused on the power requirements of the motor located in the central facility of the MMET specifically for an Earth-Moon return mission for circular and elliptical orbits.

The MMET is likely to be driven by a large electric gear-motor consuming between 100 and 500 kW of power, possibly a bit more dependent on the parameters which drive the performance of MMET. The definition of the power requirement of the MMET is derived from the torque required to spin up the tether to the required tangential velocity, and the terminal velocity achieved for the orbital conditions under consideration. A simulation was run using a specially written computer program to obtain the required minimum power for typical duty cycle, and also to study the responses for three different conditions; before payload released, torque off and reverse torques conditions for both the propulsion and outrigger systems. The differences in the responses when using rigid body and a flexural model of MMET are highlighted and discussed in order to look at the sensitivity of the model to the power budget calculation. The study then continues with a comparative study between MMET and conventional propulsion systems in terms of the energy used.