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Opinion

A Note on System of Electrodynamic Tethering

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OPINION

Electrodynamic Tethers (EDTs) are long conducting wires, such as those deployed from tether satellites, that can work on electromagnetic principles as generators (converting kinetic energy to electrical energy) or motors (converting electrical energy to kinetic energy). The travel of a conductive cable through a planet's magnetic field generates electric potential across it. Crafts can employ long, powerful conductors (albeit not all tethers are conductive) as part of a tether propulsion system to modify the orbits of spacecraft. It has the potential to dramatically reduce the cost of space travel. When direct current is applied to the tether, it exerts a Lorentz force against the magnetic field, while also exerting a force on the vehicle. It can either accelerate or decelerate a circling spaceship. Several uses for electrodynamic tethers have been identified throughout the years for prospective usage in industry, government, and scientific research. A number of factors influence the metal conductor chosen for use in an electrodynamic tether.

The primary factors are usually strong electrical conductivity and low density. Cost, strength, and melting point are secondary considerations depending on the application. An object is tethered to an electrodynamic tether, which is directed at an angle to the local vertical between the object and a planet with a magnetic field. The far end of the tether can be left naked, allowing electrical contact with the ionosphere. When the tether contacts the magnetic field of the planet, it generates a current, converting some of the orbiting body's kinetic energy to electrical energy. Electrons flow from the space plasma into the conductive tether, then through a resistive load in a control unit before being expelled as free electrons into the space plasma by an electron emitter. An electrodynamic force operates on the tether and attached object as a result of this mechanism, decreasing their orbital speed.

The technique is similar to a traditional windmill in that the drag force of a resistive medium (air or, in this case, the magnetosphere) is utilised to transform the kinetic energy of relative motion (wind or the satellite's momentum) into electricity. Compact high-current tether power producers are theoretically viable, and tens, hundreds, even thousands of kilowatts appear to be achievable with basic technology. An electrodynamic tether is a form of thermodynamically "open system." Because another tether will provide a similar voltage, electrodynamic tether circuits cannot be completed by simply adding another wire. Fortunately, the Earth's magnetosphere is not "empty," and there are highly electrically conductive plasmas in near-Earth regions (particularly near the Earth's atmosphere) that are kept partially ionised by solar radiation or other radiant energy. The density of electrons and ions fluctuates depending on a number of factors, including location, altitude, season, sunspot cycle, and pollution levels.

However, the opposite (negative) end of the tether has a more difficult time ejecting free electrons or collecting positive ions from the plasma. It is possible that enough ions can be gathered by employing a relatively wide collection area at one end of the tether to allow sufficient current across the plasma. This was shown during the Shuttle orbiter's TSS-1R mission, when the shuttle was employed as a massive plasma contactor to provide more than an ampere of current. Creating an electron emitter, such as a thermionic cathode, plasma cathode, plasma contactor, or field electron emission device, is one of the improved techniques.

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