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# RIGID ELECTRODYNAMIC TETHER SYSTEM (RETS)

**Abstract**

The recent proliferation of satellites in Low Earth Orbit (LEO) has spurred major space debris issues and technological challenges in active debris removal (ADR) solutions. Electrodynamic tether propulsion has significant potential and advantages for ADR application in LEO due to its ability to produce substantial amount of delta-V. However, most research and experiments have focused on flexible tether design, which pose crucial challenges in tether stability control and deployment mechanism, while rigid tether structures are rarely explored due to structural and mechanical design challenges. This study proposes a state-of-the-art Rigid Electrodynamic Tether System (RETS) and presents the spacecraft design concept and mission analyses focused on the orbital mechanics.

Inflatable deployment mechanism was introduced to overcome the inherent tether deployment issues, and to optimize the tether stowage volume on the spacecraft. The tether is a hollow tube made of carbon fiber or fiberglass composites incorporated with ultraviolet (UV) curable resin. Once the tether is fully deployed in orbit, it will rigidize through the curing process by the Sun's UV radiation. The spacecraft comprises of three main bodies, connected in series by two identical rigid tethers where the electrical conductor and signal cable reside. Each spacecraft main body contains both electron collector and emitter, thus allowing aligned and opposite current flows between the two rigid tethers. The aligned current flows produce the delta-V for orbital maneuvers, while opposite current flows allow the spacecraft to rotate around the axis perpendicular to the rigid tethers.

The spacecraft design and mission were optimized through simulations by Ansys Systems Tool Kit (STK) software. Orbital maneuver simulations in STK show that RETS has potential to serve as a large-scale space debris remover with an overall 500 meters length of rigid tether, over a 5 years mission life. The overall tether length becomes the base for the spacecraft system level design, which builds up to an overall spacecraft mass of less than 150 kg with 10 % margin. The rigid tether structural design, material, and mechanical properties were discussed for future studies. Additionally, other potential methods and design parameters were reviewed for consideration.