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ORIGAMI-BASED TANK FOR GEOSYNCHRONOUS REFUELLING STATION

Abstract

Embarking on the forefront of space exploration, our project, led by ISAE-SUPAERO engineering students, presents an innovative solution – the Geostationary Orbital Garage (GOG). Positioned strategically in geostationary orbit, the GOG serves as a pioneering centre for resource management, in-situ resource utilization, and satellite servicing.

The necessity of propellant storage poses a significant challenge for the refuelling station, impacting launch capacity during in-orbit assembly. The station is designed to house two primary species: liquid water (H2O) and liquid methane (CH4), adaptable to transformation into gaseous species like hydrogen when required. Currently, tank structures fall into two categories: solid and inflated. While inflated structures, exemplified by the LIFE Habitat of Sierra Space, offer reduced launch footprint, their pressure resistance remains a limiting factor for storing gaseous propellants, necessitating oversized tanks to meet capacity demands. Additionally, tanks must withstand the rigors of the space environment, including micrometeoroids and orbital debris (MMOD).

To mitigate size constraints and pressure resistance issues, we explore origami-based tank designs. Origami structures present a promising avenue for minimizing launch volume while maximizing in-space capacity. Deployment involves inflating an underlying layer upon propellant injection, conforming to the origami structure's contours at a designated "deploying pressure", which once deployed, provide stable structural support for the inflated underlayer. This approach enables support for higher pressures compared to conventional inflated tanks. Various parameters, such as origami shape, material composition, and thickness, can be adjusted to optimize performance.

Integration of origami-based tanks into the GOG design aims to revolutionize propellant storage solutions in space, advancing the capabilities of future missions while enhancing sustainability in orbit. This abstract underscores the critical importance of innovative structural solutions in enabling the next generation of space exploration and utilization.