IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies to Enable Space Systems (3)

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SCIENTIFIC RESULTS OF FARGO - A VERIFICATION OF NOVEL FERROFLUID SYSTEMS ON THE ISS

Abstract

A great potential for the future of spaceflight lies in ferrofluid based systems which offer a wide range of advantageous applications. FARGO (Ferrofluid Application Research Goes Orbital) represents a detailed investigation of promising ferrofluid application in a micro-gravity space environment. Three different ferrofluid based systems have been developed and will be validated on the ISS during a 30-day mission in spring 2023. These ferrofluid systems contain a novel ACS (attitude control system), a thermal switch, and an electrical switch. FARGO is a student project developed by a multinational and interdisciplinary group of 25 students as well as supervisors from the IRS (Institute of Space Systems) at the University of Stuttgart. The students are part of the small satellite student association (KSat Stuttgart e.V.) at the University of Stuttgart. This project was made possible by the *Überflieger 2* competition, organized by the Space Agency of the DLR (German Aerospace Center) Through this research, the three developed ferrofluid concepts are to be demonstrated as functional in both on-ground tests and in space verification on the ISS. Ferrofluids consist of nanoscale magnetic particles suspended in a carrier fluid. Therefore, they can be manipulated by sufficiently strong magnetic fields. These ferrofluid systems allow, among other potential benefits, the reduction of mechanical moving parts, which can reduce wear and tear of components. Therefore, they potentially extend the lifetime of components and thus the duration of space missions while reducing maintenance needs. These assumed benefits of ferrofluid-based systems have been further substantiated by this research. The ACS is based on a low-friction rotor system through a ferrofluid cushion bearing. The stator consists of coils from a DC-motor and generates a rotating magnetic field. This magnetic field accelerates the rotor, thus generating torque and storing angular momentum. Various maneuvers for torque excitation and angular momentum storage are investigated. The developed electric switch offers a reduced power consumption compared to conventional electromechanical switches. By moving metallic Galinstan ferrofluid, the electrical circuit can be opened or closed. The behavior of the switch as well as its power consumption are characterized. The thermal switch provides a ferrofluid-based solution to the relatively new field of active thermal switching. It enables the active closing and opening of a thermal heat circuit through ferrofluid movement. Different switching loads and their heat conduction properties are investigated. These experiments are an important step towards realizing the implementation of ferrofluid-based systems in future spaceflight activities.