51st IAF STUDENT CONFERENCE (E2)
Student Team Competition (3-GTS.4)

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THE STUDENT PROJECT FARGO - A FERROFLUID EXPERIMENT ON THE ISS

Abstract

Sustainability is no longer just a marginal topic but a key challenge for modern space flight activities. Consequently, the student group experiment FARGO (Ferrofluid Application Research Goes Orbital) is dedicated to increasing the longevity of specific space components and, thus, reducing wear and tear and resource consumption while simultaneously enabling a system-cost-reduced implementation.

In addition to the successful advancement of space applications, the project is characterized by a high degree of educational achievement for graduate and undergraduate students through first-hand experience with space hardware development, manufacturing and operations. Team FARGO is an interdisciplinary team with over 25 students from diverse technical fields. The fast-paced environment of only one year of project time intensifies the learning aspect as well as the challenges of the experiments. The novel approach is to replace moving solid contact surfaces in critical components and assemblies with ferrofluid-based technological solutions. Within the scope of the FARGO project, three applications are designed, matured, and tested for 30 days on the ISS in spring 2023.

The selected experiments for the FARGO mission are an electrical switch, a thermal switch, and an attitude control system (ACS) integrated into a 2 Unit experiment cube. The electrical switch experiment seeks to replace conventional electrical relays utilizing a liquid metal ferrofluid droplet. It is tested extensively by applying different electrical loads, switching times and the necessary magnetic forces required in the microgravity environment. The thermal switch uses a ferrofluid droplet and gas to achieve a thermal diodicity due to their varied thermal conductivity, enabling an active switch. In both switches, the necessary magnetic field is applied by electropermanent magnets, which combine the advantageous properties of permanent and electromagnets. Consequently, an on-demand switching capability can be achieved, resulting in particularly energy-efficient switches. In the ACS, circularly arranged coils generate a rotating magnetic field, which induces an angular momentum on a ferrofluid-bearing disc. Especially the ACS technology is a likely key component for the future space industry as highly-reliable, and low-cost reaction wheels are critical to most missions. At the same time, the advantageous properties of the switches make an earthly application likely.

The possibility of developing these innovative applications is granted by the space agency of the German Aerospace Center (DLR) within the Überflieger 2 competition program. The purpose of this paper is to provide a summary of the project concepts, development, and successful implementation on the ISS.