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THE STUDENT PROJECT FERRAS - A FERROFLUID EXPERIMENT ON A REXUS SOUNDING ROCKET

Abstract

Sustainability is no longer just a marginal topic but a key challenge for modern space flight activities. Consequently, the student team experiment FerrAS (Ferrofluid Application Study) is investigating the ability to increase 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 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 processes, manufacturing, testing, verification and experiment operations. Team FerrAS is an interdisciplinary team with 20 students from diverse technical fields of the University of Stuttgart. The novel approach is to replace moving solid contact surfaces in critical components and assemblies with ferrofluid-based technological solutions to avoid wear. Within the scope of the FerrAS project, two pumping applications are developed, matured, and tested autonomously in micro-gravity onboard a REXUS sounding rocket to be launched in March 2024.
In space missions, pumping applications are vital for fluid-management and useful for thermal management, but can also be employed as flexible systems for attitude control by utilizing a change of angular momentum of the pumped fluid. Two novel ferrofluid-based applications were developed for the FerrAS mission, a Displacement Pump (DP) and a Linear Pump (LP). In the DP, ferrofluid coated permanent magnets are displaced by external electromagnets. With oscillating movement of the permanent magnets, a secondary fluid is pumped, while the ferrofluid acts as bearing, seal and lubricant for the magnets. The LP works entirely without oscillating masses, and only uses ferrofluid pinned to two independent permanent magnet reservoirs. A ferrofluidic bridge between the reservoirs is moved through subsequent activation of solenoids, pushing the non-magnetic secondary fluid. Both experiments are operated autonomously and in parallel during the limited sounding rocket micro-gravity phase of approximately four minutes. The primary goal is verifying the functionality of the pumps in micro-gravity and thereby increasing the technology readiness level (TRL). As a secondary objective, the pumping performances are characterized at different operational parameters during the flight and then compared to performances on ground.
The FerrAS project is developed through the German-Swedish student programme REXUS/BEXUS, organized by the German Aerospace Center (DLR), Swedish National Space Agency (SNSA) and European Space Agency (ESA). This paper provides a summary of the experiment concepts, project development and operation on the REXUS 31 sounding rocket.