IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Sciences on board ISS and beyond (6)

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IN-ORBIT OPERATION AND PRELIMINARY ANALYSIS OF THE ISS EXPERIMENT PAPELL

Abstract

This paper discusses the experiment results of the first 30 days of in-orbit operation and subsequent analysis of the ISS experiment PAPELL (Pump Application using Pulsed Electromagnets for Liquid reLocation). The experiment is a technology demonstrator of a non-mechanical pumping mechanism. During the "Überflieger" competition, issued by the German Aerospace Center (DLR), the PAPELL experiment was selected as one of the three winning proposals. The award was to launch a self-designed student experiment to the International Space Station to be executed in 2018. In this paper the first 30 days of operation of the experiment PAPELL, including initial experiments and respective outcome is elaborated. For this, the recorded sensor and video data of the flight model as well as of the reference ground model is being discussed. The non-mechanical pumping mechanism is achieved by moving a paramagnetic fluid, a ferrofluid, by activating electromagnets. Ferrofluid itself is a magnetically neutral liquid, when no external magnetic field is applied. Activating the magnets generates local magnetic fields. Suspended iron oxide particles within the ferrofluid are aligned by an external magnetic field source, magnetizing the liquid. Due to the interaction of the magnetizable particles in the carrier liquid with the magnetic field, the ferrofluid flows accordingly from one magnetic field source to the next. Experiments are conducted on a free movement grid, where ferrofluid is allowed to flow on a honeycombed array of electromagnets. Several execution patterns were established and adapted during the operation time. Due to video analysis the drops volume, velocity and mass flow has been derived. After this initial operation period of operation, the experiment time was extended to another 30 days. Advantages in future space applications can be found in the reduction of wear and tear and a lower maintenance demand due to the absence of mechanical moving parts, as well as in a reduction of vibrations. This can for example allow for noise reduction on crewed spacecraft, which would allow to reduce the stress level of astronauts. Similarly, vibration sensitive payloads will be less disturbed. The project PAPELL was achieved by members from the Small Satellite Student Society at the University of Stuttgart (KSat e.V.) and supported by the Institute of Space Systems of the University of Stuttgart.