IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Science Results from Ground Based Research (4)

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ENHANCED HEAT TRANSFER IN A CYLINDRICAL ANNULUS UNDER 1G AND LOW-G CONDITIONS

Abstract

A dielectrophoretic (DEP) force is induced in a dielectric fluid when an alternating electric field is applied. The DEP-force is not only induced when the electric field is inhomogeneous by geometry, but, also if the fluid presents a permittivity stratification - due, e.g. to a temperature gradient. The DEP-force influences the flow of the fluid, and, hence, also affects the heat transfer between the inner and outer cylinders. This effect has been shown in various experiments. Our experiments focus on the investigation of thermal convection in a dielectric liquid inside a vertical annular cavity under the influence of a DEP-force which is radially oriented. The Earth's gravity inhibits a pure central force field in these experiments since the Archimedean buoyancy and the thermoelectric buoyancy are superimposed. Therefore, the experiment is performed under parabolic flight conditions. A dedicated experimental set-up for thermo-electrohydrodynamic (TEHD) - experiments in parabolic flight campaigns and laboratory investigations has been designed. A modular design allows the application of different measurement techniques and experimental configurations. Various experiment cells with aspect ratios of 6 and 20 (and 60 for laboratory experiments, only) either for Particle Image Velocimetry or for Shadowgraph/ Schlieren techniques have been constructed. The challenges of the design and performance of these TEHD-experiments are the implications of the high electric potential – up to 2kV/mm - and the measurement techniques. Non-invasive measurement techniques which do not need the positioning of sensors inside the electric filed are preferred. Also the choice of the dielectric working fluid is restricted to liquids with very low electric conductivities, high flashover-limits and, due to the safety requirements for parabolic flights, high flammability limits and low toxicity. The main objective is to gain better understanding of flow processes in a dielectric fluid subjected to a DEP force. This can increase the efficiency and reliability of tube heat exchangers. Further, the DEP-force allows the development of devices with an active control of heat transfer, only depending on the electric potential amplitude.