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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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DEVELOPMENT STRATEGY TOWARDS AN MAGNETIC SURFACE STRESS PUMP FOR MICROGRAVITY CONDITIONS

Abstract

Magnetic surface stress pumps are a promising class of microfluidic devices. The pump utilises the interaction between asymmetric boundary conditions and magnetic stress. When the magnetic field lines exit the paramagnetic fluid, the sudden drop in magnetisation induces stress. This can be used to pump the fluid into a desired direction. For example, the fluid flow in an open channel will result in a Couette flow with the highest velocity at the free surface, reducing linear to the bottom of the channel. The asymmetry is caused by the no slip boundary condition of the walls and bottom while the free surface can be assumed to have a slip condition due to the low viscosity of the air above. These pumps have a very high reliability and lifetime because no moving parts are used. The development of the Couette flow allows a simple scaling over the channel height. The magnetic bond number which describes the ratio between the magnetic volume force and the surface tension force defines the minimal flow condition. Additional maintaining the free surface in microgravity is a challenge for the magnetic field design. Further the electronic system of signal, amplifier, coil setup and paramagnetic liquid results in its specific time constant and holds another limiting factor. We show our approach for the development of a pumping technology based on these principles. Furthermore, preliminary experimental results of a first drop tower campaign to test pumping properties in microgravity are discussed.