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Kommission für Technologie und Innovation KTI

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Analysis of the flow conditions in a high-speed micro-turbine for NMR-MAS applications using CFD

Initial conditions and Goals

Nuclear Magnetic Resonance (NMR) spectroscopy is a popular analysis technique for research on chemical substances and tissues. Samples are spun in a strong, static magnetic field and exposed to high-frequency pulses. A gas-powered micro-turbine 1.3 mm or less in diameter generates this rotation. The high frequencies of up to 100 kHz, which are key in this process, cause lossy flow effects such as recirculation, separations and compression shock. Maximising the speed at a defined system pressure requires optimising the turbine geometry and the housing. The goal of this project was to investigate the flow conditions at different operating speeds to derive approaches for increasing the efficiency of the turbine.

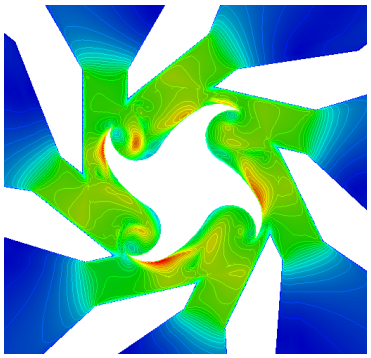

Fig. 1: Contour plot of the flow rates around the micro-turbine

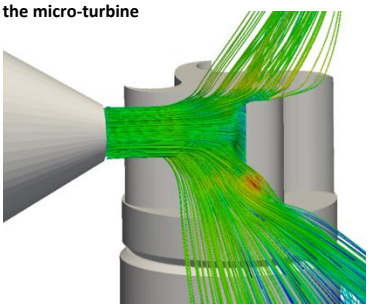

Fig. 2: Flow curve for a drive nozzle

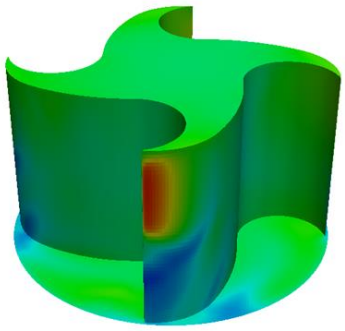

Fig. 3: Pressure distribution on the micro-turbine

Findings

The results of the simulation show excellent conformance with the measurement series. The simulations showed that with this system configuration’s periodic pressure peaks will occur on the convex sides of the vanes, inducing a section modulus. The findings further show that the 7 drive nozzles affect each other negatively. This provided initial approaches for optimisation whilst adhering to the available production options.

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