Abstract:

Rotorcraft in hover, descent, and low-speed forward flight operate close to the vortices trailed from their rotors. Consequently, blade vortex interactions occur, which can result in large transient loads on the blades, high noise levels, and vibrations. Furthermore, the trailed vortices can persist far downstream in the rotor wake, where they may produce dust or snow clouds when the rotorcraft operates close to the ground. Therefore, in the present research work one possible passive solution to the aforementioned problems, a centrifugal pumping rotor blade design, was investigated numerically by means of CFD. It was found that the vortex formation process at the blade tip was altered in comparison to a baseline design, and a reduction of the vortex coherence and strength was achieved. The numerical simulations were correlated to experimental data, and it was shown that the experimentally determined flow features in the rotor wake were predicted well. Furthermore, the numerical study revealed flow details in the internal channel and close to the blade tips that cannot be visualized or measured using experiments. Further insight was provided into the effects of
varying mass flow rates and flow distributions on the vortex formation process at the blade tip. Therefore, the present research work not only improves the understanding of the modified vortex formation process, but it will also allow to improve the centrifugal pumping blade design by giving further insight into the internal channel flow, the complex aerodynamic interactions at the blade tip, the modified tip vortices, and the modified rotor wake.

Stichworte: applied aerodynamics, rotorcraft aerodynamics, CFD, flow control, vortex flows

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