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Theoretical and Experimental Investigation of Subcritical and Supercritical Vortex Flows MARTIN BRUSCHEWSKI, HEINZ-PETER SCHIFFER, SVEN GRUNDMANN, Tech Univ Darmstadt, Germany — The presented work deals with the subcritical and supercritical behavior of vortex flows. A vortex filament method is proposed for the simulation of these two flow states. The flow is modeled by a continuous distribution of vortex filaments in which the axial velocity component is induced by a helical winding of the filaments. By this method, the three-dimensional steady and incompressible vortex flow in a circular channel with different exit orifices is computed. The reference velocity fields are obtained experimentally by Magnetic Resonance Imaging. As the main outcome it was found that there are two conjugate solutions for every investigated case. The first solution requires all vortex filaments to terminate at the fluid boundaries. It does not depend on the downstream geometry and it therefore represents the supercritical state. For the conjugate solution, some regions contain ring-shaped vortex filaments instead of terminated filaments. The manifestation of these vortex rings depends on the downstream geometry. Hence, the occurrence of vortex rings is considered as an indicator for the subcritical state. The results in terms of the velocity field are in very good agreement to the measured subcritical and supercritical vortex flows.

Martin Bruschewski
Tech Univ Darmstadt, Germany

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