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Three-dimensional flow fields and forces on revolving flat plates[1]
MUSTAFA PERCIN, BAS W. VAN OUDHEUSDEN, Delft University of Technology — The evolution of three-dimensional flow structures of revolving low-aspect-ratio plates in the Reynolds number range of 10,000 to 20,000 was studied, combining Tomographic Particle Image Velocimetry with force measurements. Two motion kinematics were considered: (1) a revolving surge motion where the wing accelerates to a terminal velocity with a constant acceleration at a fixed angle of attack and then remains to revolve at a constant rate; (2) a revolving pitch motion which is initiated by a constant acceleration from rest to a terminal velocity at zero angle of attack, followed by a pitch-up motion at a constant pitch rate and revolution at a constant rate. In the experiments, the terminal velocity, acceleration, angle of attack and pitch rate were varied to study their effect on the resultant flow fields and forces. In general, a vortex system that consists of a leading edge vortex, a tip vortex and a trailing edge vortex is observed. The vortex system bursts into substructures as the motion progresses, which does not lead to a decrease in the forces. The evolution of spanwise flow and the effects of centrifugal acceleration and spanwise pressure gradient are discussed.

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