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Discontinuity of lift on a Hydrofoil in Reversed Flow for Tidal Turbine Application

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Abstract

This work presents an experimental investigation of a hydrofoil in reversed flow configuration in the context of marine current turbine development. Experiments consist in hydrodynamic force measurements and PIV flow observations on a NACA 0015 hydrofoil, at 5×10^5 Reynolds number. The hydrofoil in reversed flow produces a higher lift than in the classical forward flow for very low angles of attack and proved to be relatively efficient for an angle of attack lower than 10°, despite a much higher drag than the same foil in direct flow. Moreover, the lift coefficient shows a discontinuity with an hysteresis effect when the angle of attack is varied up and down around zero-degree. It is shown that the sharp leading edge generates an early Leading Edge Separation Bubble on one side (suction side) even for vanishing angles of attack. This separation bubble triggers the transition to turbulence of the boundary layer on the suction side while the pressure side boundary layer remains laminar. As a consequence, separation on the rounded trailing edge occurs farther downstream on the (turbulent) suction side compared to the (laminar) pressure side. The Leading Edge Separation Bubble and the inherent up-down asymmetry in the boundary layer regime are responsible for the lift singularity.

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