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Vortical structures responsible for delayed stall in an idealized humpback whale flipper model[1] HEESU KIM, Seoul National University, JOOHA KIM, UNIST, HAECHEON CHOI, Seoul National University — In this study, we investigate how the tubercles on the leading edge of an idealized humpback whale flipper model delay the stall. Oil-surface visualization is performed to see the surface flow pattern on the suction surface, and PIV is conducted in several streamwise and crossflow planes at different attack angles (α). Without tubercles, leading edge separation first occurs near the tip region and progresses inboard with increasing α. With tubercles, however, two types of vortical motions are observed at the mid-span. The first is streamwise vortex arrays which are dominant at $\alpha \leq 9^\circ$, and they are observed downstream of small separation bubbles near the leading edge. The second is asymmetric counter-rotating streamwise vortex pairs that become dominant at $\alpha > 9^\circ$, and these structures appear near the trailing edge. These two types of vortical motions delay flow separation at the peak regions of the mid-span, eliminating the spanwise stall progression and resulting in delayed stall. At $\alpha = 16^\circ$ at which the tubercle model stalls, a large-scale streamwise vortex is originated from flow separation near the root region. This structure delays flow separation at the mid-span, leading to higher lift coefficient.

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