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The effects of long-chain polymers on tip vortex flow and cavitation inception QUAN ZHANG, CHAO-TSUNG HSIAO, GEORGES L. CHAHINE, Dynaflow, Inc — Experiments have shown that propeller/hydrofoil tip vortex cavitation can be suppressed by properly injecting dilute polymer solutions at the tip. However, the mechanisms for this phenomenon are not well understood yet. To understand better the underlying flow physics the tip vortex flow generated by a rotating propeller in water and a dilute polymer solution (FENE-P model) was numerically simulated. It is found that the vortex flow structure is changed by the non-Newtonian features of polymers. Phenomenally the vortical rotation in a polymer solution is slower and the vortex center pressure is higher than in water. The non-Newtonian stress is much stronger than the Newtonian stresses in water. To further understand the non-Newtonian stresses contribution, the FENE-P model is also applied to a simplified quasi-cylindrical vortex. It is found analytically that in addition to the three normal stresses that are expected to be quadratic in the shear rate, one of the shear components is also quadratic. We also studied polymer effects on the dynamics of a bubble nucleus in the tip vortex. The bubble was found to grow to an elongated large cavity in water while it collapses in the polymer solution for the same cavitation number. This work was supported by the Office of Naval Research, Contract N00014-04-C-0110, monitored by Dr. Ki-Han Kim.

Quan Zhang
Dynaflow, Inc

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