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Numerical Modelling of Hydrodynamic Drag and Supercavitation Parameters for Supercavitating Torpedoes

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Abstract : In this paper, supercavitationphenomena, and parameters are explained, and hydrodynamic design approaches are investigated for supercavitating torpedoes. In addition, drag force calculation methods ofsupercavitatingvehicles are obtained. Basically, conventional heavyweight torpedoes reach up to ~50 knots by classic hydrodynamic techniques, on the other hand super cavitating torpedoes may reach up to ~200 knots, theoretically. However, in order to reachhigh speeds, hydrodynamic viscous forces have to be reduced or eliminated completely. This necessity is revived the supercavitation phenomena that is implemented to conventional torpedoes. Supercavitation is a type of cavitation, after all, it is more stable and continuous than other cavitation types. The general principle of supercavitation is to separate the underwater vehicle from water phase by surrounding the vehicle with cavitation bubbles. This situation allows the torpedo to operate at high speeds through the water being fully developed cavitation. Conventional torpedoes are entitled as supercavitating torpedoes when the torpedo moves in a cavity envelope due to cavitator in the nose section and solid fuel rocket engine in the rear section. There are two types of supercavitation phase, these are natural and artificial cavitation phases. In this study, natural cavitation is investigated on the disk cavitators based on numerical methods. Once the supercavitation characteristics and drag reduction of natural cavitationare studied on CFD platform, results are verified with the empirical equations. As supercavitation parameters cavitation number (□), pressure distribution along axial axes, drag coefficient (C_?) and drag force (D), cavity wall velocity (U_?) and dimensionless cavity shape parameters, which are cavity length (L_?/d_?), cavity diameter(d_m/d_?) and cavity fineness ratio (□L_?/d□_m) are investigated and compared with empirical results. This paper has the characteristics of feasibility study to carry out numerical solutions of the supercavitation phenomena comparing with empirical equations.

Keywords : CFD, cavity envelope, high speed underwater vehicles, supercavitating flows, supercavitation, drag reduction, supercavitation parameters
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