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Verification of the Supercavitation Phenomena: Investigation of the Cavity Parameters and Drag Coefficients for Different Types of Cavitator

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Abstract : Supercavitation is a pressure dependent process which gives opportunity to eliminate the wetted surface effects on the underwater vehicle due to the differences of viscosity and velocity effects between liquid (freestream) and gas phase. Cavitation process occurs depending on rapid pressure drop or temperature rising in liquid phase. In this paper, pressure based cavitation is investigated due to the fact that is encountered in the underwater world, generally. Basically, this vapor-filled pressure based cavities are unstable and harmful for any underwater vehicle because these cavities (bubbles or voids) lead to intense shock waves while collapsing. On the other hand, supercavitation is a desired and stabilized phenomena than general pressure based cavitation. Supercavitation phenomena offers the idea of minimizing form drag, and thus supercavitating vehicles are revived. When proper circumstances are set up, which are either increasing the operating speed of the underwater vehicle or decreasing the pressure difference between free stream and artificial pressure, the continuity of the supercavitation is obtainable. There are 2 types of supercavitation to obtain stable and continuous supercavitation, and these are called as natural and artificial supercavitation. In order to generate natural supercavitation, various mechanical structures are discovered, which are called as cavitators. In literature, a lot of cavitator types are studied either experimentally or numerically on a CFD platforms with intent to observe natural supercavitation since the 1900s. In this paper, firstly, experimental results are obtained, and trend lines are generated based on supercavitation parameters in terms of cavitation number (□), form drag coefficientC_D, dimensionless cavity diameter (d_m/d_c), and length (L_c/d_c). After that, natural cavitation verification studies are carried out for disk and cone shape cavitators. In addition, supercavitation parameters are numerically analyzed at different operating conditions, and CFD results are fitted into trend lines of experimental results. The aims of this paper are to generate one generally accepted drag coefficient equation for disk and cone cavitators at different cavitator half angle and investigation of the supercavitation parameters with respect to cavitation number. Moreover, 165 CFD analysis are performed at different cavitation numbers on FLUENT version 21R2. Five different cavitator types are modeled on SCDM with respect tocavitator’s half angles. After that, CFD database is generated depending on numerical results, and new trend lines are generated based on supercavitation parameters. These trend lines are compared with experimental results. Finally, the generally accepted drag coefficient equation and equations of supercavitation parameters are generated.

Keywords : cavity envelope, CFD, high speed underwater vehicles, supercavitation, supercavitating flows, supercavitation parameters, drag reduction, viscous force elimination, natural cavitation verification
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