Development of Computer Program for Submarine Concept Design and Verification of the Empirical Formulae by CFD

Te Chih Chen* and Jiahn-Horng Chen*

* Department of Systems Engineering and Naval Architecture
National Taiwan Ocean University
2 Pei-Ning Road, Keelung 20224, Taiwan
e-mail: jhchen202@gmail.com

ABSTRACT

At the stage of diesel submarine concept design, various possibilities must be considered and iteration is needed to meet the optimum design goal. To accelerate the concept design process, we developed a computer program based many empirical design formulae available in the literature, *e.g.* [1-2], to reduce the laborious iteration and, then, to save time at this stage. Following the requirements of owner, we can use the program to estimate the required submarine volume, weight, and power based on the Albacore hull form. The iterations will be terminated when the buoyancy of the submarine is equal to the total weight. Then the results can be used as input for design software. The same hull form obtained in the empirical-formula approach was also developed and its resistance and required power estimated by the other available design software. It is interesting to find that the deviation of resistances (or the required power) obtained by these two approaches are significant.

To justify the accuracy of these two approaches, we used CFD tool to compute the flow field and estimate the resistance for verification purposes. In particular, the ANASYIS Fluent was employed and the Reynolds-averaged Navier-Stokes equations were solved with the k-ε turbulence model available in the commercial code. The results show that the estimated resistance by the empirical formulae is usually overestimated, compared to the CFD solutions. This indicates that the use of empirical formulae in the concept design should be carefully justified. Such an overestimation might lead to a heavier power system, larger propulsion system, and less permissible payload.

In addition, we also found that the resistance obtained by the software was usually much closer to the CFD results. The formulae provided by the software is more accurate as far as our test cases are concerned. The bow forms somewhat deviated from the Albacore hull form were also developed and their resistance computed by the two approaches. These forms we developed are those typical to modern diesel submarine bow forms. Similar conclusions as above were obtained after the series of study.

REFERENCES

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