Numerical study on submarine nose shape for drag reduction

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The configuration of submarine, is often divided into a central body that is cylindrical and terminates with a nose at the bow and a tail at the aft. A defence submarine must be able to perform its duties in a wider variety of water depths. In order to conduct reconnaissance, a submarine frequently needs to manoeuvre and snorkel at shallow depths while remaining hidden when diving to a greater depth. Submarines are utilised in combat, research and underwater rescue operations. To validate the ideal geometric configuration of the submarine drag must be studied. The present article describes the numerical analysis of several nose forms to find the best submarine hull for diving. The hull envelope equation was initially used to generate a reference hull, referred to as the base model. To standardise the computational parameters, the findings of the reference model were first compared with a model from the literature that had dimensions similar to those of the reference model. STARCCM+, a commercial CFD tool, was then used to compare the reference hull to various geometric configurations of the nose profiles. Since it affected the flow entrance, the bluntness parameter was defined to allow changes in the nose shape. The configuration is further analysed by incorporating changes to the submarine's nose section, using additional parametric equations were used to optimise the submarine design. For the sake of numerical examination, the parameters such as speed, L/D ratio and operating region were held constant. It was found that there was about a 0.8% reduction in drag with a change in the nose shape of the considered vessel.

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enclosure. For submarines, the hydrodynamic shape is provided by the outer hull. The housing area, weaponry, control system, communication apparatus, battery banks and primary and auxiliary machinery are all housed in the inner pressure hull[1]. At a designated depth, the pressure hull aids in withstanding the external hydrostatic and hydrodynamic forces. Frictional resistance around the exterior hull is a significant issue for a specific depth of operation. For optimal power usage and other operational needs, it is crucial to reduce the frictional component.

Although a submarine is typically assumed to operate underwater, there are times when it may function at snorkelling depths[2]. The submarines typically spend at least some time hovering at shallower depths to avoid being picked up by opposing radar. The objective of the present study was to use computational fluid dynamics (CFD) to numerically examine the impact of various forms on the submarine hull and provide lower drag in submerged or normal operating conditions. Figure 2 shows a reference hull that was identified as the chosen base model. The reference hull was selected because experimental data on frictional drag for a model with a similar set of dimensions could be found in the literature[3]. Table 1 provides the dimensions of the model. The results from the CFD solver were first compared with the experimental values to confirm the