

Research Article

The Study of Drag Reduction on Ships Inspired by Simplified Shark Skin Imitation

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The skin of a fast swimming shark reveals riblet structures that help reduce the shark's skin friction drag, enhancing its efficiency and speed while moving in the water. Inspired by the structure of the shark skin denticles, our team has carried out a study as an effort in improving the hydrodynamic design of marine vessels through hull design modification which was inspired by this riblet structure of shark skin denticle. Our study covers on macroscaled design modification. This is an attempt to propose an alternative for a better economical and practical modification to obtain a more optimum cruising characteristics for marine vessels. The models used for this study are constructed using computer-aided design (CAD) software, and computational fluid dynamic (CFD) simulations are then carried out to predict the effectiveness of the hydrodynamic effects of the biomimetic shark skins on those models. Interestingly, the numerical calculated results obtained show that the presence of biomimetic shark skin implemented on the vessels give about 3.75% reduction of drag coefficient as well as reducing up to 3.89% in drag force experienced by the vessels. Theoretically, as force drag can be reduced, it can lead to a more efficient vessel with a better cruising speed. This will give better impact to shipping or marine industries around the world. However, it can be suggested that an experimental procedure is best to be conducted to verify the numerical result that has been obtained for further improvement on this research.

1. Introduction

Shipping industry has been a thriving industry, since the start of the industrial revolution, and now, it is categorized as one of the large scale economies [1]. Liner ship is facing an unexpected development on the size of the vessels as it has increase endlessly year after year. The escalation in vessel size decreases both fuel and capital cost per cubic capacity required by it [1, 2]. Flow over bodies, either air or fluid, is commonly encountered in practice, and it is normally responsible for numerous physical phenomenon such as hydrodynamic drag especially for immersed transportations like ships [3]. Reducing this resistance may help in improving cruising speed and reduce fuel consumption as well [3, 4]. Scientists today have come up with numerous studies attempting to overcome this the problem, which includes the study of shark skin for drag reduction, self-cleaning super

hydrophobic surface originated from the uniqueness of water repellency properties of lotus leaves, and drag reduction through micro bubble injection on ships [5, 6].

Our focus in this study is on hull form design modification through biomimetic riblet structure of shark skin denticle as an attempt of improving the hydrodynamic design of marine vessels. However, in this present paper, we described our approach by focusing on wall shear, velocity profile, and turbulence kinetic energy (TKE) produced by the modified and unmodified hull form through CFD activity. Macroscaled biomimetic riblet shark skin is applied on the frontal and rear vicinity of the container ship with the intention of improving the fluid flow around the ship which will provide better flow separation control especially at the ship hull surface area. Endless studies have been carried out recently as an effort upon improving performance of systems such as ship performance, duct or pump efficiency, and energy