Faculty of Engineering- Fayoum University

Mechanical Engineering Department

كلية الهندسة- جامعة الفيوم

قسم الهندسة الميكانيكية

Summary of the M. Sc. Thesis

"Experimental and Numerical Study of Spoiler Effect on Ship Balance"

This thesis discusses the effect of hull-mounted cavitating spoilers system on ship balance. Three-dimensional flow field around spoiler was simulated experimentally and computationally with injection of air or exhaust gas behind spoiler. The bow spoilers consist of an even number of sections arranged port and starboard forward of the center of mass of the ship. The stern spoilers consist of an even number of sections arranged port and starboard attached to the ship transom or transom plate. Injecting exhaust gas stabilizes cavities behind spoilers. The forces and moments acting on the ship bottom depend on spoilers inclination, rise of ship floor and air injection positions. The two-phase flow field around a ship spoiler with the free surface simulation in Piecewise Linear Interface Construction method is modeled numerically using a three-dimensional Navier-Stokes code. The governing equations are discretized on a structured grid using an Upwind Difference scheme. For different conditions, the bubbles shape, the three-dimensional flow field around the spoiler body and the pressure variation on the wake of the spoiler body are computed.

Furthermore, the spoiler system was applied experimentally to understand the parameters affecting the flow field and bubble formation around ship spoiler and their influences on the hydrodynamic forces which acting on the spoiler body. These parameters are the spoiler inclination angle, ship floor angle and injected air position. The images of bubble formation and flow filed variation are recorded with scientific video camera and compared with the computed flow field at different conditions and time sequence.

The experimental results are compared with the numerical ones at different conditions and time sequence. This comparison display a good agreement between the experimental and numerical simulation of bubble formation in the cases of spoiler with 60° and 90° inclination angles except the computational bubble shape has small dissimilarity and not flatted at bubble tail, and the computational bubble shape has slowly splitting and not attached to ship body in the case of spoiler with 30° inclination angle. This may be contributed to the laminar flow computation without including turbulence effects. The spoiler inclination angle had clear effect on the moment value around the spoiler fixation line. The effect of spoiler inclination angle θ has the more prominent effect on ship balance than the other two parameters of floor angle and injection position. The high moment values were produced in case of 90° spoiler inclination angle and the small values were produced in case of 30° after 1 second. Therefore, changing spoiler inclination angle, ship floor angle and position relative to injection holes produces different bubble shapes and consequently different forces are introduced to control the roll, pitch motion and speed of the ship leading to ship balance.