Mechanical Engineering Thesis Defense

Numerical simulation of the interaction between floating objects and a gravity driven flow

School for Engineering of Matter, Transport and Energy

Sai Chaitanya Mangavelli

Advisor: Dr. Huei-Ping Huang

abstract

The study presented in this paper focuses on studying and documenting the interaction between the floating objects and a air-water medium driven by gravity. The floating objects are called storage trays since the analysis was formulated as a virtual transportation system to study the interactions in terms of its oscillatory behavior. The solution involves solving the Navier-Stokes equation along with K-Omega turbulence model in ANSYS fluent package to simulate the 2-D, two phase flow in a rectangular domain. The implicit Volume Of fraction solver is utilized for simulating the multi phase model. The present work utilizes dynamic mesh setting with a user defined function to monitor the motion of the storage tray. The range of operating values that include inlet velocity of water, depth of water, shape and density of the storage tray within which the numerical simulation would represent an actual experimental setup and yield a relatively stable solution are formulated. The interactions are studied with the help of rotational and vertical oscillatory motion of the storage tray while traversing in the moving fluid. These parameters are significantly affected by the density of the storage tray and initial velocity of water. However, they are relatively less affected by the depth of water within the operating range. The optimum conditions for a single storage tray are $\rho=700kg/m^3$, inlet velocity of water of at $0.9m/s$ and initial depth of water at $0.36m$. These are utilized to set the operating conditions for the multiple storage tray cases. The relation between motion of the multiple storage trays and their spacing is established. Finally, the non-uniform shaped storage trays with $\rho=850kg/m^3$ are analyzed with $10\%-35\%$ reduction in cross-sectional area. Recommendations for a 3-D numerical analysis of the above system are made in the future applications.

April 6, 2018; 1 PM; ECG 317