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NUMERICAL SIMULATION OF A BUBBLE ATTACHED AND SLIDING ON A CYLINDER

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When a vehicle moves forwards in a liquid, such as water, it will encounter much larger drag than it does in the air, because the former has much larger density. Therefore there is always a strong desire to reduce the drag through introducing bubbles or air cavity over the body surface [1-4]. Numerical simulation for fluid flow over a rigid body with a deformable bubble attached is analyzed based on the velocity potential theory together with the boundary element method (BEM). The bubble surface is treated as a well defined air-liquid interface and tracked using the time stepping technique with a mixed Eulerian-Lagrangian method. The variation of the bubble pressure with its volume is taken into account. Fully nonlinear dynamic and kinematic conditions are imposed on the bubble surface. The points of intersection between the bubble and body are treated specially in the numerical procedure. The auxiliary function method is adopted to calculate the pressure on the body surface and in the flow field. The convergence study has been undertaken to assess the developed numerical method and the computation code. Some case studies are undertaken in which the interactions between the bubble, body and the incoming flow field are simulated. The effects of various physical parameters on the interactions are investigated, such as initial pressure inside the bubble, surface tension and its initial location on the body. It is aimed that the results from this paper would provide some insight into the drag reduction on marine vehicles through using bubbles and air cavity.

REFERENCES

[1] M.S. Plesset and A. Prosperetti, Bubble Dynamics and Cavitation. *Annual Review of Fluid Mechanics*, 1977. 9: p. 145-85.
[2] H. Oguz, and A. Prosperetti, Dynamics of bubble growth and detachment from a needle. *Journal of Fluid Mechanics*, 257, 111–145, 1993
[3] S. L. Ceccio, Friction drag reduction of external flows with bubble and gas injection. *Annual Review Fluid Mechanics*, 42, 183–203, 2010
[4] J. K. Choi and G. L. Chahine, Numerical study on the behavior of air layers used for drag reduction. *28th Symposium on Naval Hydrodynamics*, Pasadena, 2010