Influence of Collapse of Cavitation Bubble Cloud on Erosion of Solid Surface in Hydraulic Machinery

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ABSTRACT

Construction machinery employs various types of hydraulic equipment for transmitting power by fluid. Cavitation is inevitable in hydraulic equipment where high-pressurised fluid flows through a narrow channel to low pressure region. Although cavitation itself does not disturb the work of construction machinery, cavitation noise and erosion due to the collapse of cavitation bubbles are problems to be solved. Cavitation noise in a hydraulic relief valve causes the discomfort of construction machine operators, and cavitation erosion in the control valve developing in long term operation of construction machinery decreases the controllability of flow in the valve. Especially, the quantitative prediction of cavitation erosion is desired in design phase by a numerical simulation. Thus, the development of the numerical simulation to investigate these problems is required.

Cavitation bubble cloud is generated by a high-speed flow like a jet in hydraulic machines and collapses violently on a solid surface. The periodic collapse of bubble cloud causes the erosion of the solid. To represent such cavitation behaviours, the dynamics of cavitation bubble and cloud should be considered. Additionally, the mass transfer of incondensable gas through bubble interface is important role in the growth and collapse of cavitation bubbles. The motion of bubble is strongly coupled with surrounding fluid, and the bubbly mixture phase is also coupled with solid phase based on the previous work [2] to investigate the influences of the impulsive stress due to the violent collapse of cavitation bubble cloud on the erosion of solid.

In the present study, the simulation results for the macroscopic cavitating flows in a hydraulic valve by means of a homogeneous cavitation model and for the microscopic behaviour of the cavitation bubble cloud interacting on solid by using the above-mentioned two fluid model will be presented. In addition, the influence of the distribution of the cavitation bubble and the impact of the collapse of the bubble cloud on the solid surface will be discussed.

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