Research Report（April, 2020- March, 2021）

Enrollment from April 2020 | Department of Applied Mechanics and Aerospace Engineering | Takahiro USHIOKU

I. List of Papers

[1] Takahiro Ushioku, Hiroaki Yoshimura, Numerical study of unsteady behavior of cloud cavitation by smoothed particle hydrodynamics, Proc. ASME 2020 Fluids Engineering Division Summer Meeting, Paper No: FEDSM2020-20117, V002T04A005; 7 pages.

II. List of Talks

[1] Takahiro Ushioku, Hiroaki Yoshimura, Numerical study of unsteady behavior of cloud cavitation by smoothed particle hydrodynamics, ASME 2020 Fluids Engineering Division Summer Meeting, No. 20117, Orland, USA. FEDSM2020, July 3, 2020.

[2] Takahiro Ushioku and Hiroaki Yoshimura, Multiphase flow analysis of unsteady behavior of cloud cavitation by the smoothed particle hydrodynamics method, International Workshop on Multiphase Flows: Analysis, Modeling and Numerics, Dec.3, 2020.

[3] T. Ushioku and H. Yoshimura, Unsteady Behavior of Cloud Cavitation and Vortex Flow Structure Based on Mixture Model of Liquid and Gas, JSIAM Annual Meeting 2020, Ehime University, September, 2020 (in Japanese).

[4] T. Ushioku and H. Yoshimura, Numerical Analysis of Unsteady Phenomena of Cloud Cavitation by the Two-dimensional Smoothed Particle Hydrodynamics Method, JSME Annual Meeting 2020, Nagoya University, September, 2020 (in Japanese).

III. Research Results in AY2020

An aggregate of cavitation bubbles is called a cloud cavitation and shows a collective unsteady motion repeating the process of growth and collapse. In particular, it is considered that a high-pressure shock wave is generated associated with the collapse of the cloud, however its mechanism has not been precisely understood. In this study, we have investigated the unsteady behavior of the cloud in a submerged water-jet injection into still water and the shock wave phenomenon by an experimental observation and a numerical analysis using the two-dimensional Smoothed Particle Hydrodynamics (SPH) method. Specifically, as a result of the numerical investigation, we have found that the growth, shrink and collapse behavior of the cloud is synchronized with the motion of twin vortices moving along the interface of the cloud. This knowledge is considered to be important for building a macroscopic model of the cloud.

IV. Research Plan for AY2021

In AY2021, to obtain numerical results that match the experimental results qualitatively and quantitatively, we will plan to make a numerical analysis based on the model considering surface tension and precipitation of dissolved gas. Moreover, we will try to clarify the relation between the twin vortices moving along the interface of the cloud and the shock wave phenomenon. And also, we will plan to observe three-dimensional shape of the cloud by two high-speed cameras. In particular, investigating the shape of the cloud before and after the collapse may be considered to be important in elucidating the mechanism of the shock wave phenomenon.