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A NUMERICAL COMPARISON OF A HYDRAULIC CAVITATION BUBBLE AND A LASER-INDUCED BUBBLE

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1 Introduction

Cavitation is the formation of gas bubbles in a liquid when the pressure drops below the vapor pressure level. They grow and collapse into the fluid in a small period of time, generating high magnitudes of pressure, velocity and temperature [4]. Investigations have been focused on the detailed study of the life cycle of a single cavitation bubble immersed in a fluid: its inception, growth, collapse and rebound[3]. These last two stages of the cavitation bubble are responsible for the damage on the nearby solid surfaces [1]. In this case, it is of particular interest the formation of a water jet in the implosion and rebound stages of the cavitation bubble. they can be artificialy produced by laser pulse focused in the liquid. The focus of this work is to simulate hydraulic cavitation and Laser-induced bubbles and compare the results with experimental data.

2 Methodology

An analytical model of the dynamic of a cavitation bubbles using spherical bubble (1D) of incompressible fluid was proposed by Rayleigh and later expanded by Plesset[2] to consider surface tension an viscosity. Recently works focus in describe the non symmetry behavior on the interface of the hydraulic bubble under different situation [6],[7].

The present study compares the behavior of a hydraulic cavitation bubble and the Laser-induced bubble by solving the conservation of energy equation and a multiphase model of separated flows using the individual phase momentum equation (IPME) of two incompressible fluid [5].

$$\frac{\partial}{\partial t}\left(\rho_N \alpha_N u_{Nk}\right) + \frac{\partial}{\partial x_i}\left(\rho_N \alpha_N u_{Nk}\right) = \rho_N \alpha_N g_k + F_{Nk} - \delta_N \left\{ \frac{\partial P}{\partial x_k} - \frac{\partial \sigma^D_{Cki}}{\partial x_i} \right\} \tag{1}$$

where $N = 0$ is gas component and $N = 1$ is water. The conservation of energy equation is just applied to the Laser-induced bubble model in order to replicate the thermal effect of the gas into the bubble. Water jet of Both bubbles models are qualitative and quantitative compared under different situation such hydrostatic pressure variation and rigid wall proximity.

3 Results

Hydraulic cavitation and Laser-induced bubble problems are solve numerically, then behavior, shape and form of interface the bubbles are compare (Figure 1).

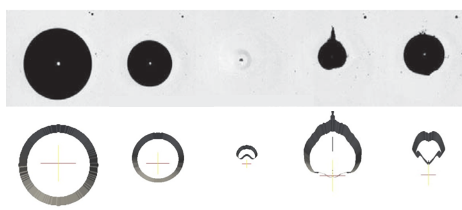

Figure 1: Experimental study with Laser-induced bubble (Up) by [3]. Numerical simulation of hydraulic cavitation bubble (down). Hydrostatic pressure of one gravity

Numerical results of Laser-induced bubble are validated by experimental study of this way of generation bubble [3]. The comparison between the two different cases of bubble generation (hydraulic and Laser), shows the distinction between Water jet and interface form of the two bubbles, it is given by influence of the gas content and its density. The numerical simulation of a cavitation bubble generated by laser shows good agreement with experimental results of Laser-induced bubble given by [3].

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