Summary of the deliverable D1.1 : “Interface Tracking”
provided by ESR 1, Ms Ogloblina Daria, under the guidance of Prof. Nikolaus A. Adams, Technische Universität München, August 2016

The bubbles may contain pure vapor, pure gas, or mixtures of both. The effects of wall shear forces and high instantaneous loads due to impinging jets and shock waves are of particular importance. Therefore, suitable numerical models and computational approaches have to be developed or adopted. By comparison of advantages and disadvantages of two entirely different numerical approaches it is concluded that both can be suitable to fulfill the main task of the research activity. The approaches are called “two-fluid model” and “single-fluid model”. Based on profound experiences with both models within the research group at TUM AER, it is decided to focus on the “single-fluid model” for further activities within this project. Since both methods have been published in several papers, this report contains a summary of physical and mathematical ideas of both methods without reproducing every detail.

Collapsing bubbles and bubble clusters are known to be an important source of cavitation erosion. Several parameters can have an effect on possible material damage, in this report, the stand-off distance is selected as a parameter, while other quantities are kept constant. We investigate three-dimensional collapse events of vapor bubbles in the vicinity of a solid wall under high ambient-pressure conditions. Detached and attached bubbles are taken into account. The investigation was performed by means of the “single-fluid model” or thermodynamic-equilibrium approach. With this approach, the density and the internal energy are the only quantities necessary for specifying the mixture of liquid and vapor in a computational cell. Compressibility of all phases enables full resolution of collapse-induced pressure wave dynamics. The instantaneous pressure and density fields were obtained and compare well with reference solutions provided in the literature. The deformed shapes of the bubbles are represented with iso-surfaces of vapor ratio 0.05 and feature all relevant details.

It is shown that the single-fluid approach including the thermodynamic equilibrium model enables high quality computations of collapsing bubbles. In particular, rebound processes can be predicted which are supposed to be an important aspect for erosive loads close to a wall. Our recent results are validated against previous results obtained with the “two-fluid model” including thermal non-equilibrium processes.

We show that the “single-fluid cavitation model” performs as an efficient sharp-interface method, provided that the grid resolution is sufficiently high. Excellent agreement with the results obtained by the more costly “two-fluid model”, as well as the reduction of unknown model parameters, lets us conclude that the “single-fluid model” is a very promising basis for further activities and for fulfilling the milestones and requirements of the project. Moreover, the method allows for much better comparison of results and for (nearly) 1-to-1 data exchange with the project partners. We consider it to be very important to have strong interaction of as much ESRs as possible, which is perfectly ensured by the chosen model. By providing a suitable technique for simulation of collapsing bubbles the milestone and the deliverable is sufficiently fulfilled.