D 1.10/ Summary of the deliverable: "Implementation of a fluid solver taking into account thermochemical effects"

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The goal of this study is to simulate the bubble collapse with a special focus on thermal effects. In this deliverable, a fully compressible CFD diffuse interface method [1], [2] known as the six-equation method, is developed. In this approach, each phase is modelled as an independent material. This model is derived from a seven-equation approach [3]. In contrast to some other developed models such as [4], [5], this multiphase method retains mechanical, thermal, and chemical non-equilibrium effects while it assumes instantaneous velocity equilibrium [6]. The method has several advantages over the other multiphase methods including volume fraction positivity preservation as well as the correct treatment of shock wave due to the monotonic sound speed versus the volume fraction [2]. The results show that the current implementation has been successful in the simulation of an air-water shock tube case with high pressure and density ratios. Moreover, two collapse cases with low and high pressure ratios have been simulated, which are in good agreement with the available data as well as the Keller-Miksis model. Also, the very high temperature during the collapse has been depicted. It is worth mentioning that the current implementation assumes the bubble interior contains perfect gas. However, the bubble thermodynamics becomes more complex during the collapse. Experimental determinations of the bubble temperature have been made in some research [7]–[10]. By fitting the experimentally recorded single bubble sonoluminescence spectra, temperatures in the range of 5000 – 20,000 K have been estimated [8]. At such extreme condition, the perfect gas assumption is insufficient. Therefore, real gas thermodynamics is of the main interests in the present study. In this regard, tabulated thermodynamics data have been utilised. Moreover, the code can deal with the multiphase cases using an Adaptive Mesh Refinement. This allows the code to capture various spatial scales with a good resolution, especially at the interface.

In addition, the very high temperature inside the bubble causes chemical effects by forming highly reactive free radicals as a result of thermal dissociations of the bubble vapour or gas content [11].

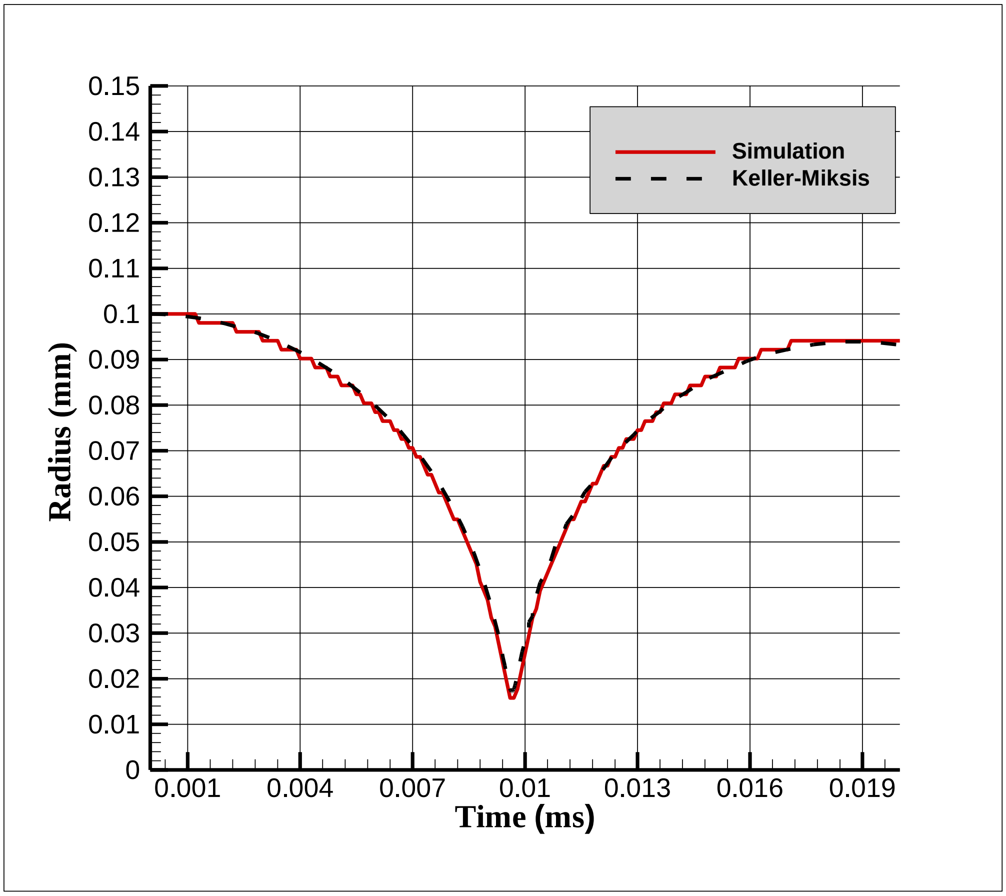

Figure 1. Radius evolution over time compared with the Keller-Miksis model [12]

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