Summary of the Deliverable D4.7: Development of three-phase LES model

provided by ESR 15, Mr Mithun Murali Girija, under the supervision of Prof. Manolis Gavaises and Dr. Phoevos Koukouvinis, CITY University of London, Jan 2018

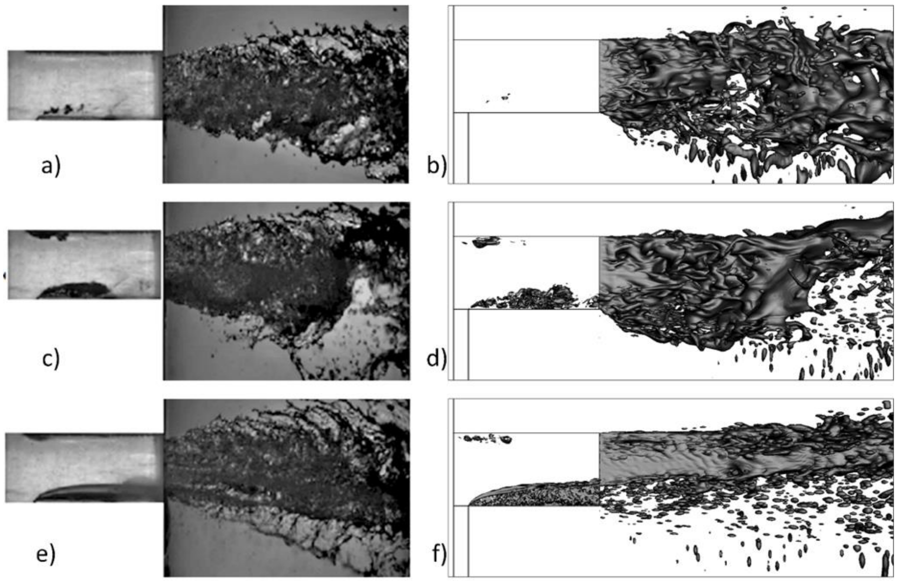

Figure 1. Comparison of in-nozzle cavitation and near-exit spray formation between experimental results from (1) *and current numerical study. (a, b) 2 bar (c, d) 3 bar (e, f) 5 bar inlet pressure. Iso-surfaces of mixture density at 100 kg/m^3 shown at a random time instant.*

Computational methods have been popular for studying complex flow phenomena occurring in complex geometries where experimental evaluations are limited or challenging. A validated computational fluid dynamic model offers much greater flexibility and greater insights into the flow dynamics. This study presents a new fully compressible three-phase cavitation model which considers the presence of three phases; liquid, vapor and gas is presented along with the application of Large Eddy Simulation for resolving turbulence. A The three-phase model consists of a cavitation model which is based of barotropic equations of state which is then combined with the state equation of compressible isentropic gas either using a diffused interface 'mixture' model or using a sharp interface 'VoF' model to close the three-phase system.

Two test cases are presented, showing the applicability of the three-phase model. The model employing mixture approach with a RANS model for turbulence is used to study the effect of dissolved gas on cavitation for a case of flow over hydrofoil (2). This study shows that with an increase in the amount of non-condensable gas, the intensity and spread of cavitation decreases. The validation of the three-phase model with the sharp interface VoF is presented in Figure 1. The model identified a cyclic phenomenon of gas entrainment during developing cavitation resulting in increased flow atomization. The study also shows two other regimes of cavitation, namely; inception and hydraulic flip.

References

1. Abderrezzak B, Huang Y. A contribution to the understanding of cavitation effects on droplet formation through a quantitative observation on breakup of liquid jet. Int J Hyd. Energy. 2016; 41:15821–8.

2. Dular M, Coutier-Delgosha O. Numerical modelling of cavitation erosion. Int J Nume Meth. Fl. 2009; 61:1388–410.