# Cavitation Modelling

Y. Meslem† , S. Honnet‡, W. Schwarz*, J. Reveillon† and F.X. Demoulin†

†UMR6614-CORIA, Technopole du Madrillet, BP 12, Avenue de l'Universite, 76801 Saint-Etienne-du-Rouvray Cedex, France
‡PSA Peugeot Citroen, Centre Technique de Velizy, Route de Gisy 78943 Velizy-Villacoublay, France
* AVL France, 2-4 rue Hans List F-78290 Croissy sur Seine, France

### Abstract

## Introduction

During the last decade, the combustion efficiency in Diesel engines has risen by the improvement of injection systems. The increase of injection pressure has been one of the main strategy to reach that goal. Nevertheless, strong local pressure drops have been observed in many Diesel injectors and as a result, cavitation occurs. According to He and Ruiz [2] the dense zone of the spray is influenced by the in-injector flow and particularly by the cavitation phenomenon. Some studies show that the occurrence of cavitation modifies basic characteristics of the spray, which play a major role in the Diesel combustion.

## Computational methods

A cavitation model has been developed. As surface density and liquid and gas fractions are the solved variables in the model, this model is able to deal with non spherical gaseous structures, like huge gaseous cavities in Diesel injectors. In case of large gas cavities, a modelling proposal has been suggested, close to the term using Rayleigh-Plesset equation. Only driving pressure term is kept. Indeed, the other terms are linked to bubble sphericity assumption and lose their sense in case of larger gaseous structure or are hard to estimate. Another distinctive feature of the model is to transport interface velocity in order to keep second order time derivative of the bubble radius in the Rayleigh-Plesset equation so as to improve accuracy. Reference conditions issue for cavitation nuclei, that is to say estimation of residual gas pressure and radius of the nuclei, has been raised and a procedure has been proposed. The first step is to identify two zones, "pre-cavitating zone" and cavitating zone, on a first calculation without cavitation modelling. The "pre-cavitating zone" is the zone usptream the cavitating zone and the zone where nuclei are considered to exist. Reference conditions are chosen according to comparisons between critical values identified by Franc [1] and order of magnitude of pressure for the two zones.

## Results and Discussion

First results of the model have been presented. Calculations are based on pressure history extracted from a 3D calculation with the CFD solver AVL Fire along a bubble streamline. Response to the pressure drop from gas volume fraction and surface density looks reasonably good. Results are hopeful but will have to be confirmed with 3D reference calculations with an implemented version of the model in the solver AVL Fire.

## References

[1] J.P. Franc. The rayleigh-plesset equation: a simple and powerful tool to understand various aspects of cavitation. *In Fluid Dynamics of Cavitation and Cavitating Turbopumps, CISM Courses and Lectures*, 496, 2007.

[2] Lu He and Francisco Ruiz. Effect of cavitation on flow and turbulence in plain orifices for high-speed atomization. *Atomization and Sprays*, 5(6):569–584, 1995.

*Corresponding author: yann.meslem@coria.fr