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A numerical solver for fully resolved simulations of droplets combustion

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Numerical methods for interface resolved simulations of droplet vaporization [1,2] are of significant interest in many configurations for which accurate investigations on micro-scale phenomena are required to improve our insight on local physics. This is especially true in the context of droplets combustion for which some recent works have been published in [3] for instance. We present in this work, numerical developments to account accurately for combustion phenomena in the framework of a droplet vaporization solver based on an interface capturing method [2]. Accurate validations of our solver (DIVA solver) against experimental data on the temporal evolution of the droplet square diameter of a static burning droplet will be presented in a first time.

Next, numerical simulations on the combustion of a droplet in a flow have been performed. In particular, we will show the strong impact of the incident flow on the flame structure as it can be observed in Fig. (1), where three types of flames can be visualized, that is, an envelope flame for lower Reynolds, a side flame for intermediate Reynolds and a wake flame for higher values of the Reynolds number. By analyzing the Nusselt number of the droplet obtained from the simulations in Fig. (2), we will show the strong impact of the flame shape on the vaporization heat flux and so on the overall combustion mechanism. In particular, a non-monotonic variation of the Nusselt number is observed for increasing Reynolds number.

As the developed numerical solver allows also to perform numerical simulations in 3D configurations involving both several droplets and an incident turbulent flow, we will present some preliminary results of the combustion of several droplets interacting with a turbulent flow.

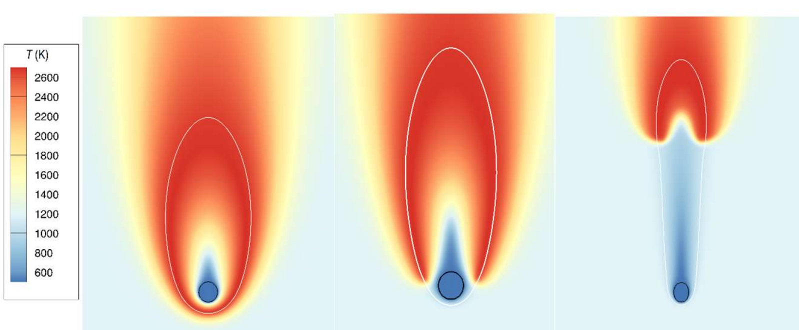

Fig. (1) : Snasphots of the interface shape and thermal field for the combustion of a droplet in a flow. Left an envelope flame (Re=5), middle a side flame (Re=15), right a wake flame (Re=20)

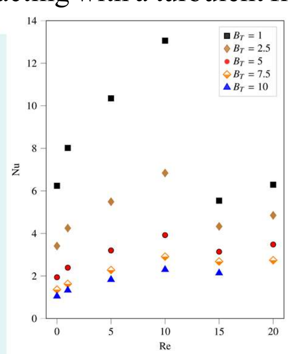

Fig. (2) : Evolution of Nusselt number with Reynolds for different Spalding numbers

References

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