MODELING OF MULTI-COMPONENT SPRAY IMPINGEMENT AND WALL FILM DEVELOPMENT IN CROSS FLOW CONDITIONS

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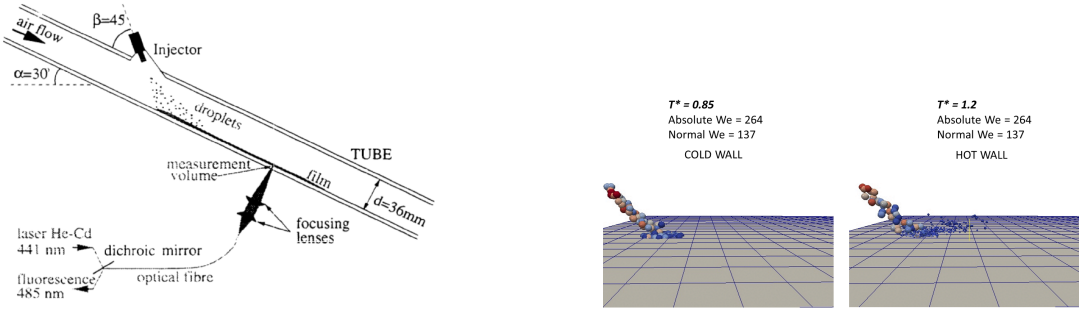
Injection of multi-component liquid is a key phenomenon in several industrial fields, from engine after-treatment systems to gas turbine combustors. An reliable description of the interaction among the gaseous flow, the injected liquid and the system walls is mandatory to optimize the reactant dosing and the resulting preparation of a well distributed mixture in a confined environment.
For these reason the multi-dimensional simulation of liquid spray dynamics acts as powerful support in predicting the entrainment and accurately evaluate the impingement phenomena over a wide range of thermal and kinetic cross flow conditions. In particular the lagrangian-eulerian approach, in which the liquid phase is tracked through the domain, is an industrially consolidated tool and is the framework in which the proposed work takes place.
A detailed characterization of the drop impingement regimes based on a kinetic and on a thermal parameter has been implemented [1], including the heat directly exchanged between the spray and the solid wall [2].
The capability to handle the interaction with multi-component liquids has been added to the liquid film library, involving the transport of chemical species inside the film and its coupling with the momentum and the energy equations including evaporation and boiling.
The thin film assumption is kept valid and the single layer region is used as the base for the development.
This approach allows to simulate the two main conditions occurring in quasi-steady spray systems, where the liquid injection law is constant enough to drive the system to a always-dry impingement regime under the drop Leidenfrost condition or to permanent wall wetting.
The spray impact model has been validated over a wide range of drop-wall conditions [1], and the wall film formation and evolution has been compared to experiment proposed by [3] and reported in (Fig. 1(a)), which involves injection of fuel on an inclined cylindrical plate.
As a future development, the application of the conjugate heat transfer with the wall including the solution of the solid energy balance, is chosen as the main focus to be able to handle the whole spray induced thermal transient through the wetting and drying phenomena.



(a) (b)

Figure 1: Liquid film development test case [3] (a); Example of thermal conditioning of the spray-wall impact under the same kinetic conditions (b).

References

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