"Sprays with heat and mass transfer and combustion"

Fernando Luiz Sacomano Filho
(Universidade de São Paulo, Escola Politécnica da USP)

Abstract

Heat and mass transfer are key mechanisms on the calculation of real spray systems. Both exchange phenomena are able to interfere with various processes related to spray flow dynamics, for instance droplets dispersion and gaseous mixture formation. The large disparity of scales involving both exchange phenomena and the domain in which the spray flows in makes droplet evaporation a sub grid process. Therefore, the computation of these exchange mechanisms is a matter of modeling.

The existence of combustion reactions makes the importance of the correct computation of both mechanisms pretty well pronounced. Indeed, combustion and evaporation are strongly coupled phenomena in general systems where spray and flame interacts. Namely, combustion processes fed by liquid fuels as well as those in which a non flammable liquid stream is purged into combustion reactions. The heat transfer as well as the injection of vapor into the gas flow determine the mixture arriving the reaction zone, which influence on flame characteristics. Consequently, the combustion reaction delivers the heat and may consume or produce the vapor species interfering therefore on the evaporation process.

Recent studies conducted in the Universidade de São Paulo (Brazil) in cooperation with the Technische Universiteit Eindhoven (Netherlands) and the Technische Universität Darmstadt (Germany) indicate how coupled are heat and mass transfer with combustion reactions. The studies have been conducted in a numerical framework including detailed chemistry information for flames propagating in droplet mists. Results clearly show that detailed chemistry information is important for the calculation of droplet evaporation as well as that evaporation models and different assumptions are able to interfere with flame characteristics.

It is the purpose of this lecture to present an overview about the main aspects associated with heat and mass transfer of sprays focusing on combustion processes. Special attention is given to the relevance of properties estimation and typical simplification assumptions regarding both mechanisms. The lecture follows a structure that allows the assessment of each analyzed simplification and converges to an optimal combination of the presented methods.