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Spray algorithm without interface construction

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ABSTRACT

This research is aimed to create a new and robust family of convective schemes to capture the interface between the dispersed and the carrier phases in a spray without the need to build up the interface boundary. The selection of the Weighted Average Flux (WAF) scheme is due to this scheme being designed to deal with random flux scheme which is second-order accurate in space and time. The convective flux in each cell face utilizes the WAF scheme blended with Switching Technique for Advection and Capturing of Surfaces (STACS) scheme for high resolution flux limiters. In the next step, the high resolution scheme is blended with the WAF scheme to provide the sharpness and boundedness of the interface by using switching strategy. In this work, the Eulerian–Eulerian framework of non-reactive turbulent spray is set in terms of theoretical proposed methodology namely spray moments of drop size distribution, presented by Beck and Watkins [1]. The computational spray model avoids the need to segregate the local droplet number distribution into parcels of identical droplets. The proposed scheme is tested on capturing the spray edges in modelling hollow cone sprays without need to reconstruct two-phase interface. A test is made on simple comparison between TVD scheme and WAF scheme using the same flux limiter on convective flow hollow cone spray. Results show the WAF scheme gives a better prediction than TVD scheme. The only way to check the accuracy of the presented models is by evaluating the spray sheet thickness.

1. Introduction

Sprays enter in different applications in several fields according to its use in for example power generation and spray cooling. Concerning the physical model for liquid fuel sprays, modelling relating to the two-phase nature of the flow is believed to constitute an important field. Many researchers over years have made their work and exhibited wide range of investigation for physical phenomena under the main field named as spray modelling. Approaches have been used to predict the flow properties in different situations where the liquid phase is considered as a spray injected into a gas field.

The approach used here is known as the Eulerian–Eulerian approach where the analogy to the continuum approach of single phase flow is considered for both phases. Here, the two-phase flow is treated as interacting and interpenetrating continuums. Therefore, each phase can be described by a set of transport equations for mass, momentum and energy where the interphase exchange source terms are included. From this point, the computational method used allows both phases to be discretized using the same method. Klose et al. [2] solved two-phase equations by using Eulerian–Eulerian framework combined with combustion models and showed the solution is numerically stable for the behaviour of the aero engine combustor. A comprehensive numerical model for spray combustion has been reported by Guo et al. [3] who applied an Eulerian

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