Modelling Strategies and Implementation Challenges of Moment Methods for the Simulation of Polydisperse Two-Phase Flows

P. Dems[1], W. Polifke[1]

In the Eulerian/Lagrangian formulation for polydisperse two-phase flows, the particle properties such as position, velocity, size, temperature, etc. are tracked explicitely by ("representative") particles. This approach is conceptually rather straighforward, thus it is no surprise that the method is frequently employed for the simulation of multi-phase flows such as fuel sprays or bubble columns. An Eulerian/Eulerian approach, on the other hand, may be advantageous in circumstances where particle densities are large, or particle-particle interactions are important, or else, where a high-level parallelization is needed to reduce the computing times, etc. For the situations where the size-dependence of particle properties sigificantly influences the inter-phase momentum exchange, evaporation, coalescence and breakup, agglomeration, combustion, etc., so-called "moment methods" are frequently used. In this approach, the particle size distribution is described approximately by a few of its moments. The first few moments can be related to the properties of the particle distribution that are of immediate interest: particle number, size, area, volume, etc. Several variants of moment methods have been proposed, varying in the concept of how the moments are transported through the computational domain and how the size distribution is reconstructed from the moments.

At the Lehrstuhl für Thermodynamik at the Technische Universität München, moment methods have been in development for a number of years and have been used to simulate bubbly flows, spray distribution, evaporation and combustion as well as the meteorological phenomena. The closure is achieved by assuming a functional form of the size distribution function. It is a unique feature of our approach that for the convective transport of moments, approximate individual moment transport velocities are computed by a fast Eulerian relaxation approach. This allows to consider effects like size-dependent particle velocities and segregation in an efficient manner. The talk provides an overview of the characteristics of the method, its implementation in OpenFOAM for laminar as well as turbulent flow cases, and the numerical challenges associated with the moments' transport. The LES Results of validation studies, and examples taken from the scope of applications mentioned before are presented.

[1]Lehrstuhl für Thermodynamik, TU München, D-85747 Garching, Germany