

Mechanical Engineering Doctoral Defense

Integration of Theory to Computations of Spray and Turbulent Flows

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Abstract

Theoretical analyses of liquid atomization (bulk to droplet conversion) and turbulence have potential to advance the computability of these flows. Instead of relying on full computations or models, fundamental conservation equations can be manipulated to generate partial or full solutions. For example, integral form of the mass and energy for spray flows leads to an explicit relationship between the drop size and liquid velocities. This is an ideal form to integrate with existing computational fluid dynamic (CFD), which is well developed to solve for the liquid velocities, i.e., the momentum equation(s). Theoretical adaption to CFD has been performed for various injection geometries, with results that compare quite well with experimental data. Since the drop size is provided analytically, computational time/cost for simulating spray flows with liquid atomization is no more than single-phase flows. Some advances have also been made on turbulent flows, by using a new set of perspectives on transport, scaling and energy distributions. Conservation equations for turbulence momentum and kinetic energy have been derived in a coordinate frame moving with the local mean velocities, which produce the Reynolds stress components, without modeling. Scaling of the Reynolds stress is also found at the first- and second-gradient levels. Finally, maximum-entropy principle has been used to derive the energy spectra in turbulent flows.



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Zoom Link: <https://asu.zoom.us/j/86249287191>