ME – PhD Thesis defence

Secondary atomization of a droplet in diverse Interaction settings

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ABSTRACT

Secondary atomization is a critical process that occurs after primary atomization, where liquid droplets are further atomized into smaller droplets. This study investigates the secondary atomization of a single droplet in three different interaction settings: shock waves, vortices, and porous surfaces.

In the first setting of shock-droplet interaction, two modes of droplet breakup are observed, shear-induced entrainment and Rayleigh-Taylor piercing, and a criterion for transitioning between the two modes is discussed. The authors also enhanced a technique for measuring drop sizes during shock-drop interactions to improve estimates of spatial size distribution and number concentration. Additionally, the study explores the secondary atomization of liquid metal droplets and how surface oxidation plays a role in regulating atomization dynamics.

In the second setting of vortex-droplet interaction, the authors focus on both droplet and vortex dynamics and identify different regimes of interaction, including deformation, stretching and engulfment, and droplet breakup. They compare the interaction's effect on various characteristics of the vortex rings.

In the third setting of porous-surface (facemask) droplet interaction, the authors show that high-momentum cough droplets can penetrate mask material to a significant extent and atomize into smaller droplets. The study highlights the importance of considering secondary atomization in determining mask efficacy and compares theoretical models for droplet penetration, breakup time, and droplet size prediction with experimental data.

Lastly, the authors examine a periodic interaction between a vortex ring and a droplet at a low Weber number, where secondary atomization does not occur. The study reveals that the droplets' evaporation characteristics depend on the strength of the vortex, while the crystallization dynamics remain independent of it.

Overall, this study provides valuable insights into the complex phenomenon of secondary atomization and its importance in various industrial and natural processes. The findings can help optimize these processes and improve our understanding of them.

Area of research topic: Fluid Mechanics

Field of investigation: Droplets, Spray and Atomization, Optical diagnosis, and fluid dynamics relevant to droplet-based disease transmission.

ABOUT THE SPEAKER

Shubham Sharma is a Ph.D. student in Mechanical Engineering at IISc Bangalore. His research is supervised by Professor Saptarshi Basu and focuses on the secondary atomization of a droplet in diverse interaction settings. He is interested in understanding the mechanisms of droplet atomization, the transmission of infectious diseases through droplets, compressible flow interactions, and optical diagnosis for fluid flow problems. Before joining IISc in 2018, he completed his M.Tech in Thermal Sciences (Gold medallist) at NIT Calicut, where his thesis focused on convective heat transfer from an array of heated cylinders. He received his B. Tech in Mechanical Engineering from JNGEC Sundernagar in 2016.