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SPECIAL ISSUE

CAVITATION BUBBLES, DROPLETS AND JETS

Guest Editors

Guillermo Aguilar

PREFACE

As the title of this special issue suggests, "Cavitation bubbles, droplets and jets," this issue is motivated by an effort to bring diversity to the readers of *Atomization and Sprays*. With the more and more complex problems all research communities currently face, it is only natural that we reach out to other researchers who not only appreciate and benefit from the advances that the community has made over the years, but who can also contribute with their expertise and perspective to help us solve similar or related problems. Therefore the diversity sought for this issue was twofold. First, I pursued the participation of contributors who are well respected in their research fields, investigate fascinating fluid phenomena, but do not normally publish their work in this venue because it is only peripherally connected with the themes typically covered by *Atomization and Sprays*. Second, I pursued international diversity—two contributions come from research institutions in Mexico, one from India, one from the USA, and one from the UK.

The paper by Devia et al. introduces a novel direct-light transmission technique referred to as spatial transmission modulation (STM). This technique consists of a nearly collimated and continuous laser beam passing through a reservoir where a cavitation bubble is formed by a pulsed laser. The presence of the cavitation bubble and its size change as it grows and collapses, modifying the intensity of the light transmission, which is detected by a photodiode with microsecond resolution. Furthermore, they complement and correlate these measurements with those obtained with a 1-megapixel high-speed video camera, which simultaneously records the cavitation event at 75,000 frames per second. Their results show that a computational spatial energetic analysis from the continuous laser beam is a valid method to directly obtain the cavitation bubble evolution induced by a single laser pulse.

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The contribution of Padilla-Martinez et al. also delves into the cavitation phenomenon, except that in their case the bubbles studied are formed by a continuous wave laser as opposed to a pulsed one. This kind of bubble is achieved by using a saturated solution of copper nitrate ($CuNO_4$) dissolved in water as a highly absorbing media and tightly focusing the laser beam into it. Due to the explosive boiling that gives place to this type of cavitation, the phenomenon is termed "thermocavitation." Padilla-Martinez et al. use the implosion of the thermocavitation bubble near a solid surface to generate liquid columns that extend far beyond the usual onset of Rayleigh-plateau instability. Using a high-speed video camera, they acquired images at 105,000 fps and use these images to follow the column dynamics. They propose a simple model based on the propagation of the pressure wavefront emitted after the bubble collapse. With this model, they show that it is possible to control the aspect ratio of the liquid column by adjusting (1) laser power to regulate the cavitation bubble size, (2) beam focus position, and (3) initial droplet volume.

Rayapati et al. present a numerical study. They propose a population balance model wherein droplet atomization and evaporation processes are handled simultaneously. The model is implemented in a Eulerian–Eulerian multiphase framework, which allows the drop phase itself to be modeled as multiple continua and to incorporate a stress field which naturally arises in a collision-dominated dense spray. The utility of the model is first demonstrated on a uniform flow evaporator. The mean droplet surface area is shown to exhibit a similarity scaling in terms of a nondimensional parameter that characterizes the competition between atomization and evaporation. Then the model is generalized to a computational fluid dynamics (CFD) situation for a plug flow atomizer/evaporator. The continuous variation of Sauter mean diameter (SMD) in the flow is shown to decrease during the atomization processes, while it locally increases during evaporation.

The paper contributed by Bank et al. leads to a better understanding of the splashing and spreading dynamics upon drop–film impact. They recognize that while some efforts have been made in this arena, not many have aimed at separating the effects of drop fluid properties from those of the film. In their study, they use various fluids to cover a wide range of viscosity (4×10^{-7} – 6.5×10^{-4} m^2/s), thus allowing for Weber and Reynolds numbers to vary between 20–3000 and 20–14,000, respectively. Puzzling but at the same time revealing results are found. For instance, crown formation (with no splashing) appears to relate more strongly to the film's properties, whereas the onset of crown splashing shows more dependence on the drop properties. This phenomenological study adds to the evidence that this group has published previously, wherein viscosity plays a dual role in the dynamics of drop impacts—not only as an inhibitor, but also as a promoter beyond certain Weber and Reynolds number threshold values.

Finally, Castrejon-Pita and co-workers present a review paper from the perspective of the opportunities and challenges of inkjet technologies. As this community well knows, inkjet printing relies on the formation of small liquid droplets to deliver precise amounts of material to a substrate under digital control. Inkjet technology has become a relatively mature technology and is of great industrial interest due to its flexibility for graphical printing and its potential use in less conventional applications such as additive manufacturing and the production of printed electronics and other functional devices. Thus this contribution is also an invitation to the community to acknowledge and help tackle the newest challenges in modern inkjet printing so that it can soon become mainstream technology in emerging applications such as additive manufacturing (3D printing). This review article also points out specific examples of the barriers, limitations, and challenges faced by inkjet technology in both graphical printing and manufacturing.

Finally, I want to extend my sincere thanks to all the contributors of this special issue and to encourage the atomization and sprays community to read with interest these outstanding papers. Just like the problems we face and the world we live in today, they are diverse in many ways. Enjoy!

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