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EDITORIAL

Facilitating drying R&D via critical review papers

Over the last decade, this journal has initiated publication of invited and contributed critical and evaluative reviews on topics of contemporary interest as well as research areas that provide opportunities for further research. The goal is to encourage young researchers and academics to become familiar with the sub-fields of their interest and identify specific areas to which they can make original contribution. Indeed, as these articles are written by recognized experts in the fields, one can save significant time and effort typically required to initiate research in any area by careful study of expert reviews. Note that the explosive growth in technical literature in drying science and technology makes it a really challenging task to identify research needs. In order to facilitate access to review articles that have appeared in this journal in recent years, we have devoted two Guest Editorials in the past [1, 2], which cover articles published during 2016 through 2018. Here, we will summarize the review articles which appeared during 2019 with brief outlines of their content. As can be surmised from the list of references [3–12], the review articles cover a broad range of topics that should interest academia as we as industry.

Emerging food drying technologies: microwave-assisted, infrared-assisted, solar-assisted and similar hybrid drying methods have noted as emerging food drying technologies with energy-saving characteristics. Further research to produce a dried product without substantial losses of color, flavor, taste, appearance, and chemical components is still nevertheless recommended [3].

Heat and mass transfer modeling within the grain storage ecosystem: conduction heat transfer between particle-particle and particle-wall is found to be well predicted through the discrete approach of modeling (DEM) rather than finite element modeling. Detailed simulation analysis in stored grain is possible with increasing computational power and with incorporation of graphical processing unit (GPU) [5].

Spray and freeze drying: spray drying and freeze drying have noted to be efficient tools to design "controlled release delivery systems." However, designing a controlled delivery system with physiochemical stability to gently release entrapped core in the gastrointestinal tract is the main challenge of encapsulation [7]. Freeze drying has significant advantages in the preparation of high-quality new energy ultrafine powder materials with excellent physical and chemical characteristics [8]. The effect of different types of freeze drying processes has also been reported by Harguindeguy and Fissore (2020) who found that vacuum freeze drying gives the best results for retention of vitamin C [10]. From a hurdle technology perspective, multiple combinations of novel freezing and several other drying-assisted technologies need to be investigated in the future. Freeze drying continues to remain a research-intensive area in view of its massive scale application in drying of pharmaceuticals, nutraceuticals, biologics and more recently in high value foodstuffs as well.

Dielectric properties of fruits and vegetables: moisture content, temperature and frequency are found to be crucial factors in the controlling and designing of a dielectric heating system, which offers rapid heating capability than conventional heating systems; the former also typically delivers better dehydrated products with reduced cost of treatments [12].

Drying of biomass: scale-up of an integrated drying process based on techno-economic and environmental evaluation, utilization of advanced computational methods, investigation of commercial biomass based on biomass characteristics and exploitation of novel strategies based on energy/exergy analysis as well as life cycle assessment are recommended for highly efficient drying systems for biomass [4].

Drying of paper: achievement of right quality and an even quality across the width and the length of a paper roll has been found to be the biggest issue for the paper producing companies. Incorporation of new materials such as microfibrillar cellulose in the stock has been reported as challenge for the existing paper dryers [6]. This is an area that attracted much R&D attention several decades ago; there is a need to revisit this theme to enhance the current papermaking as well as converting technologies. Since papermaking is a massively energy-intensive dewatering operation, in view of the global consumption of paper and allied products, the economic significance and climate change potential of paper drying cannot be overemphasized.

Integration of evaporative dryers: waste heat from power plant can be utilized to dry lignite with increased efficiency by integrating evaporative dryers; this approach has noted to be technologically feasible [9].

Sewage sludge bio-drying: bio-drying process has been affirmed as a significant alternative process for the sewage sludge treatment to transform sludge into value-added product in agriculture or in energy generation [11]. Drying of sludge of various origins is a critically

important area that has potential implications in circular economy as well.

During 2018–2019, *Drying Technology* published a wide assortment of significant critical reviews covering diverse areas where thermal drying plays a critical role in energy conservation, enhanced quality and technoeconomics. We fervently hope that these articles will help to facilitate and promote further applications and innovation in drying operations.

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