Influence of gas absorption on evaporation of acoustically levitated slurry droplet

Yehonatan David Pour[1], Boris Krasovitov[1], Andrew Fominykh[1], Ziba Hashemloo[2], Abdolreza Kharaghani[2], Evangelos Tsotsas[2], Avi Levy[1]

[1]*Department of Mechanical Engineering, The Pearlstone Center for Aeronautical Engineering Studies, Ben-Gurion University of the Negev, P. O. B. 653, 8410501, Israel*
[2]*Chair of Thermal Process Engineering, Otto von Guericke University Magdeburg, 39106 Magdeburg, Germany*

Abstract

In this study, we developed a model of convective heat and mass transfer of an acoustically levitated slurry droplet that evaporates in an atmosphere of air, water vapor, and soluble gas. The advanced model considered the effects of acoustic streaming, forced convection, and non-isothermal gas absorption on the evaporation rate of a liquid droplet containing small solid particles.[1,2]. A model of highly soluble gas absorption was developed through the approximation of the finite absorbate concentration level in the absorbent. It is shown that the time of porous shell formation decreases with the increase of sound pressure level (SPL) and increases with the increase in frequency. Adding soluble gas to the gaseous phase shortens the time required for porous shell formation during slurry droplet drying. As shown by numerical calculations, in a gas mixture containing air with an ammonia content of 30%, at a temperature of 293 K and a humidity of 50%, with an acoustic field frequency of 2π·45 kHz and an SPL of 140 dB, the time of porous shell formation of a silica-water slurry droplet with the initial radius of 250 μm is about half shorter than that in a gas mixture not containing an active gas. The prediction of the developed model was in good agreement with the experimental results available in literature.

Keywords: Slurry droplet, acoustic levitation, droplet evaporation, gas absorption, heat and mass transfer, acoustic streaming.

References

[1] Pour, Y. D.; Fominykh, A.; Krasovitov B.; Levy, A. Effects of Gas Absorption with Chemical Dissociation Reaction on Single Slurry Droplet Drying. *Dry. Technol*. **2020**, 38, 663-675.

[2] Pour, Y. D.; Krasovitov, B.; Fominykh, A.; Hashemloo, Z.; Kharaghani, A.; Tsotsas, E.; Levy, A. Intensification of Spray Drying Granulation Process by Gas Absorption Accompanied by Chemical Dissociation Reactions. *Chem. Eng. J*. **2022**, 433, 133566.