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Experimental and theoretical investigation of spray drying: What can happen in single droplets

Pavol Rajniak

*Slovak Technical University, Faculty of Chemical and Food Engineering, Department of
Chemical and Environmental Engineering*

Radlinskeho 9, 81237 Bratislava, Slovakia

e-mail: pavol.rajniak@stuba.sk

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Spray drying is an important unit operation in pharmaceutical industry to produce solid amorphous dispersions which are frequently used to improve the solubility and thus the bioavailability of poorly soluble active pharmaceutical ingredients. The process can be studied at different levels: droplets, dryers, processes.

Goal of the presentation is to focus on heat and mass transfer phenomena during drying of single droplets. Interesting videos from laboratory ultrasonic levitator showing shrinking, ballooning and exploding of droplets and particles are shown first. Then a detailed distributed parameter model developed for simulation of a single droplet drying is presented. The model describes heat and mass transfer inside the droplet/particle, shrinking of the particle, the skin formation followed by skin thickening, crust formation and the final drying of non-shrinking particle. The model also calculates exchange of heat and mass between the particle and external drying gas and the decreasing particle density. An extension of the model for ballooning and exploding particles is also presented. The models are compared with droplet drying experiments from an ultrasonic levitator.