Drying by desorption: a method to determine and optimize the spray drying parameters of food and dairy products regarding to the water availability

Pierre Schuck, Anne Dolivet, Serge Mejean, Romain Jeantet

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P. Schuck*, A. Dolivet, S. Méjean, R. Jeantet

INRA, UMR 1253, 65, rue de Saint Brieuc, Rennes Cedex, F-35042, France
Agrocampus Ouest, UMR 1253, 65, rue de Saint Brieuc, Rennes Cedex, F-35042, France
**pierre.schuck@rennes.inra.fr*

The main aim of this study was to develop a method to simulate the transfer conditions (energy and water) of spray-drying. Typical curves were registered with the water activity meter on water, dairy and food concentrates (Fig 1.) [1]. These curves showed that the relative humidity (RH) from the pressure sensor as a function of time can be represented by a sigmoid equation. Two phases can be identified on the curves obtained for pure water and milk concentrates: Initially, at the beginning of desorption, there was a constant RH (ie rate of drying) phase. This constant phase corresponds to free water evaporation. The second phase was the falling rate period, which was very short for pure water and much longer for milk concentrates, whatever the total solid content. We assumed that this corresponded to the evaporation of bound water, which involves extra energy (EE) in order to overcome binding (indirectly the bound strength of water). The area under the curve of each part thus represents the amounts of free and bound water desorbed, respectively. EE is calculated as a function of the drying kinetics according to the desorption curves (Fig 1.). When the drying kinetic of a concentrate is similar to the drying kinetic of pure water, no EE is required. If the drying kinetic is two slower, energy requirement is two higher than for pure water. The difference with the latent heat of evaporation required for pure water determines EE.
The calculation method to determine EE was computerized to obtain new software (SD2P®, Spray Drying Parameter Simulation & Determination). From the desorption curve, the software SD2P® (Spray Drying Parameters Simulation & Determination) is a way, among others, to predict the value of these parameters when they are not known [2, 3]. The combined results provide more precise determination of spray-drying parameters (including inlet/outlet air temperature, mass/powder flow rate, powder temperature, etc.), powder state during spray-drying (stickiness) and the cost of spray-drying with respect to weather conditions (Fig 2). Several cases will be presented to show the interest of this strategy in order to anticipate the spray-drying parameters and the powder behavior.

[1] Schuck, P et al. Drying Technology 16 (2008), 1371-1393.
[2] Schuck, P. et al. J. Food Eng. 94 (2009), 199–204.
[3] Zhu, P et al. Dairy Sci Technol. 93 (2013), 347-355.

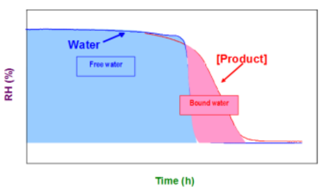

Fig. 1 – Kinetics of drying by desorption

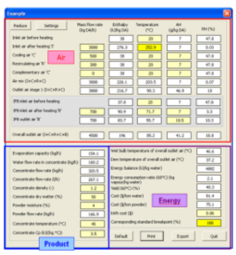

Fig. 2 – Synthesis page