Atomization behavior of plant based dairy alternatives

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The global trend of plant-based products has led to a demand for plant based dairy milk alternatives. These products contain large amounts of vegetable proteins that behave differently from milk proteins. Skim milk concentrate and whole milk concentrate can be spray dried at total solids contents up to 50%, sometimes more. Whey protein concentrates or isolates still have a reasonable concentration of roughly 45 to 30 % when being spray dried. With reducing dry matter (DM) the energy demand of the spray drying operation strongly increases.
Therefore, it is of high interest to understand the relationship between protein content, total solids of the feed solution and atomizing behavior. With rising protein content, the viscosity of the feed solution at constant water level will strongly increase. Two-phase nozzles are typically capable of operating at higher viscosities than pressure nozzles. As protein solutions are shear thinning, a relevant shear rate is required to characterize the feed solutions.
The aim of this study is to answer the question of the limit of DM in spray drying plant based milk alternatives and to investigate the impact of shear thinning behavior in pressure nozzle and two-phase nozzle atomization. For that purpose, whey protein as a reference and pea protein and soy protein as typical plant based proteins were used in model milk alternatives with fat as well as directly. Each system was varied in DM and high-pressure homogenization was applied to emulsify the oil fraction. The pre-treatment was kept constant also for the pure protein solution to allow comparison. The solutions were atomized using a pressure nozzle ex spraying systems as well as a two-phase nozzle from Düsen-Schlick GmbH. For all systems, the droplet size distribution of the atomized feed was determined by means of a Spraytec (Malvern Panalytical GmbH) as well as the cone angle and pressure drop vs. volumetric flow rate. The curves were modelled and model parameter related to the varied parameter, i.e. water content, type of protein and viscosity.