18f Foam Formation in a Continuous Mechanical Whipper

Linda Indrawati, Zebin Wang, and Ganesan Narsimhan

Foam formation by mechanical whipping is important in many applications. A continuous mechanical whipper was designed to make protein stabilized foams. Three different impellers (four blade straight, six blade straight and six blade curved) were employed to make foams stabilized by sodium caseinate and whey proteins. The inlet flow rate of protein solution was varied in the range of 5 to 15 ml/s, the whipper speed in the range of 2500 to 15000 rpm, the viscosity of protein solution was varied by the addition of xanthan gum in the concentration range of 0 to 0.1 weight % and temperature in the range of 25 to 80 C. The effects of whipper speed, flow rate, viscosity of protein solution and temperature on foamability, foam stability, power input and bubble size distribution of foams were investigated. The relative foam density was lower at higher whipper speeds because of more incorporation of air, lower at higher viscosity due to slower liquid drainage during foam formation and was insensitive to flow rate. The power input was found to be highest for largest liquid flow rate, highest whipper speed and was insensitive to xanthan gum concentrations. 6 blade curved impeller produced more foam than the other two impellers. Six straight blade impeller was found to produce foams with smallest bubble size. Higher temperature resulted in better foam stability for foams formed with whey proteins possibly due to partial denaturation leading to lower surface tension. On the other hand, higher temperature had detrimental effect on foam stability for foams formed with sodium caseinate. Based on breakage and coalescence rates of bubbles in the whipping chamber, a simple model for the prediction of average bubble size was proposed. The amount of air incorporation for different whipper speeds and types of whippers was measured and fitted to a simple expression based on mechanical energy balance. A correlation for bubble size was developed in terms of whipper speed and flow rate based on the above models which was shown to describe the experimental data reasonably well for different whippers.