
The effect of dasher design on residence time and microstructure of frozen desserts produced with a continuous scraped surface freezer

GALLAGHER L. (1), RANKIN S. (1), ALVAREZ G. (2), HARTEL R. (1)

¹ University of Wisconsin-Madison, Madison, United States

² French National Institute for Agriculture, Food, and Environment (INRAE), Antony Cedex, France

Most frozen desserts produced for retail sale are manufactured using continuous scraped surface freezers (SSFs). SSFs contain a dasher assembly which includes a dasher, knives, and sometimes a beater. The purpose of the dasher assembly is to mix the working fluid, scrape ice off the freezer wall as it forms, and whip air into the product as it is dynamically frozen. These processes occur simultaneously and impact the structure of the frozen dessert. Equipment manufacturers of SSFs employ a variety of dasher assembly designs based on desired product attributes; however, to date these assemblies have largely been constructed based on proprietary findings, and trial and error. Very little is known about how the dasher assembly impacts product structures, quality, and fluid behavior in the freezer. To improve the understanding of SSF operation, a continuous freezer was used in a series of pilot scale experimental studies encompassing 5 commercially available dasher assemblies with varying geometries and ranging from 11 to 57% volume displacement. Residence time distribution (RTD) profiles and microstructural attributes (ice crystal, air cell, and fat globule size distributions) were characterized for sorbet and ice cream made under constant processing conditions, while varying dasher assembly. For selected dashers, we also investigated how processing parameters, (including product throughput, dasher rotational speed, and overrun), interact with dasher design to influence RTD and microstructural attributes. Generally, increased volume displacement of the dasher assembly resulted in a shorter RTD in sorbet. There was a small effect of dasher design on ice crystal size in sorbet, with dashers delivering a shorter RTD generally producing smaller ice crystals. In ice cream, dasher design played a larger role in structure formation as its microstructural components are more strongly affected by the shear each dasher generates. This study furthers our understanding of how dasher design influences heat transfer and shear forces in SSFs and will enable frozen dessert manufacturers to select a dasher based on desired structural characteristics.