Simulation of bubbles dynamics in beer tumblers

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Abstract

Tumblers for the brewery market represent a growing part of volumes produced by ARC. We propose our customers not only aesthetic articles thanks to continuously innovative designs and outstanding quality decoration but also a real functionality through bubble nucleation. Brewers attach more and more importance to bubbles movement in the glass and foam creation, as one of our customers says "you drink with your eyes". That's why, in addition to the experimental research approach conducted by ARC, we decided develop a new numerical approach to improve our knowledge concerning the way to control effervescence and bubble nucleation. Indeed, even if the dynamics of bubbles are now well understood, there is a lack of data in the study of induced flow patterns in carbonated beverages. It was demonstrated that ascending bubbles generated at chosen nucleation locations act like many swirling motion generators in glasses. Because there is strong relationship between fluid mixing phenomena and aromas exhalation process, the knowledge of the liquid phase hydrodynamic behavior seems to be a key parameter in the beer science. It is the reason why a numerical Lagrangian-Eulerian modeling of flow dynamics induced by the effervescence in a glass of beer has been carried out for the first time using the finite volume method by CFD (Computational Fluid Dynamics). In order to define source terms for flow regime and to reproduce accurately the nucleation process at the origin of effervescence, specific subroutines for the gaseous phase have been added to the main numerical model. These subroutines allow the modeling of bubbles behavior based on semi-empirical formulas relating to bubble diameter and velocity or mass transfer evolutions. Numerical results show how the beer glass shapes and also location and density of nucleation sites can affect the flow patterns and vortical structures induced by the columns of ascending bubbles.

Keywords: Tumblers, Flow simulations, Bubbles

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