Chapter 10

Concluding remarks

The aim of this study is to obtain more knowledge of physical phenomena that occur in aerated systems. The results of the research, which mainly focused on the baking process and aerosol ice cream, have helped to give a wider insight into the physics of bubble evolution (bubble expansion, coalescence and collapse) and into the rheological characteristics necessary to obtain a good final product in line with customer preferences.

In this thesis two aerated materials were studied, only apparently different, but that are both constituted of a matrix, either elastic-viscous or visco-elastic, and air bubbles entrapped during the first production steps. Both materials can be included in a bigger class of aerated system, like beer, cake, metallic foams and so on, that can be studied with a unified approach. In fact, these systems are constituted of a gas phase, the bubble micro-system, and a continuous phase, the macro-system, which hides the heterogeneity in the parameters coming from the bubble system evolution.

As a matter of fact, the classes of aerated foods are very wide and each type of alimentary foam has specific problems, but it is possible to classify alimentary foams into three types, depending on the bulk rheological properties and/or interfacial elastic parameters:

- *Aeration of Newtonian liquids for which the interfacial characteristics are important*;
- *Aeration of elastic-viscous materials for which the stability is mainly controlled by bulk elastic properties;*
- *Aeration of intermediate viscosity systems or visco-elastic material, which are stabilised by both bulk and interfacial rheological properties.*

Excluding the first class, in this work the stabilization of cellular materials for products like *whipped cream* and like *doughs* was described, taking into account the evolution of the heterogeneous phase and the phenomena that occur with time, like bubble expansion and coalescence.

The problem of height evolution of biscuits during the baking period, fits in a broader project of industrial optimization of production rejects and consequently maximization of earnings. Therefore the final characteristics of biscuits are a huge problem for production and from this point of view stack height and coalescence time, and weight loss and temperature profiles were also studied, obtaining very good results in terms of final height.

Instead, the study on *soft ice cream* forms part of the research and optimization of the industrial recipe for the launching of a new product. Moreover, the research addressed the study of better design for a nozzle and valve necessary for instant extrusion. The results obtained from the numerical model are in very good agreement with the experiments. The final recipe has optimal rheological and industrial properties, good for assuring the final texture and flavour in line with customers expectations.

Finally, this thesis has thoroughly analysed the physical problems inherent in the phenomena involved in two typical industrial situations, allowing contact with two large industries in the sector, specifically United Biscuits in the UK and the CoDap in Italy, thereby permitting practical industrial experience in the factory in order to validate the results and to give a more technological aspect to the entire research.

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