Can you help to make the perfect milk foam?

1. Company information

With annual revenue of 11.6 billion euros, FrieslandCampina is one of the world's largest dairy companies. FrieslandCampina employs 23,769 people. Its central office is located in Amersfoort, the Netherlands. The activities are divided into four market-oriented business groups: FrieslandCampina Consumer Dairy, FrieslandCampina Specialised Nutrition, FrieslandCampina Dairy Essentials, and FrieslandCampina Ingredients. FrieslandCampina produces and sells consumer products in over 100 countries around the world. Examples are infant nutrition, cheese and desserts. In addition, ingredients and (semi-)finished products are supplied to manufacturers and professional customers.

2. Problem

All around the world beverages with foamed milk are gaining in popularity. Probably one of the most famous examples is cappuccino – an espresso topped with foamed milk (see Figure 1). In addition, completely new types of foamed milk beverages are conquering the world. Examples being BABYccino, chocolate milk latte or earl grey tea latte.

At home milk foams are generally prepared by whisking milk to generate a milk foam. A milk foam or froth is made of a large number of gas bubbles in a 3D-arrangement. The gas bubbles are stabilized against coalescence or other physical destabilization mechanisms by emulsifiers and/or proteins. The perfect foam consists of uniform gas bubbles small enough to be physically stable and large enough to guarantee a creamy mouthfeel.

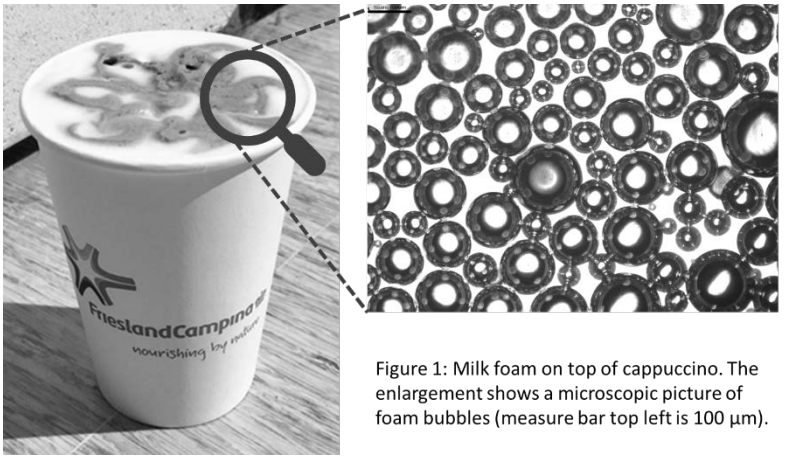

Figure 1: Milk foam on top of cappuccino. The enlargement shows a microscopic picture of foam bubbles (measure bar top left is 100 µm).

In coffee bars direct steam injection is the traditional method to generate a milk foam. Air and water vapor are forced into the milk to simultaneously form micro-foam bubbles and heat the milk. Drawbacks of this method is that it requires experience and time to generate a milk foam with good foam quality. With foam quality being of the uttermost importance to us as a customer it is logical that coffee bars look for alternatives.

Lattiz® is a commercial milk foaming system, developed by FrieslandCampina, including patented membrane technology. In bio science and material science generating foam bubbles with membranes is common, but in dairy industry this is a relatively new concept. In addition, due to the sensitivity to spoilage and the complex composition of milk it is a big challenge to foam milk in a controlled way at a commercial level.

To make the perfect dairy foam FrieslandCampina is looking for support to endeavour the physical processes occurring during cross-flow membrane foaming (see Figure 2). Relevant questions are: Which physical processes occur? What process parameters determine foam quality? What is the ideal membrane for good quality foam? These insights have to lead to the critical parameters in cross-flow membrane foaming technology with the ultimate goal to choose the optimal membrane design and process parameters to prepare the perfect dairy foam.

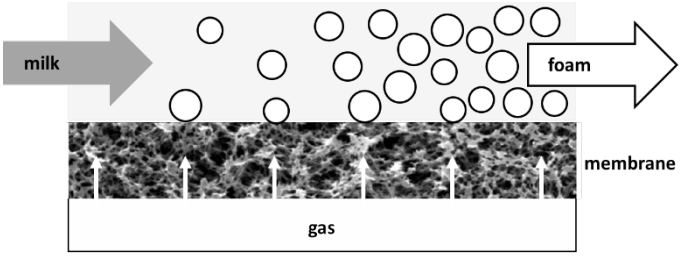

Figure 2: Outline of cross-flow membrane foaming technology for milk.

Aim: Identify the key membrane design and process parameters in cross-flow membrane foaming technology for foaming of traditional consumer dairy products as milk and cream with the ultimate goal to make a dairy foam with perfect foam quality at minimal process time.

Willing to help? The physics community could help FrieslandCampina in modelling the various physical processes occurring during cross-flow membrane foaming by building a quantitative physical model. The ultimate goal would be to identify the critical parameters for foam quality. Based on a positive outcome FrieslandCampina will start an internal project to prepare milk foams at lab scale at the conditions identified in the Physics with Industry case.

Key words: physical chemistry, flow dynamics, compressibility, gas flow, mass transfer, membranes, foam, modelling, mathematics, milk, dairy, cream