Some Measurements of Gap-Dependent Viscosity of Mayonnaise Using a Parallel Plate Geometry

Sarah L. Mason, Nancy Kjøbæk, and Alan Friis

Food Process Engineering Group, Biocentrum-DTU, Technical University of Denmark, DK-2800, Lyngby, Denmark

EXTENDED ABSTRACT

Viscosity measurements of commercial mayonnaise at different gap settings in a parallel plate rheometer are reported in this poster. Measurements that represent a true material behaviour are required to support our studies of emulsion structure.

Various phenomena can occur when attempting to measure the viscosity of products, such as emulsions, which consist of one phase present as particles dispersed in a second, continuous phase. The calculation of a correct value for the viscosity requires that the boundary conditions be known on either side of the gap which contains the fluid. At the stationary surface, the material within the gap must not move, while at the rotating surface the material must move at the same velocity as the surface. This assumption is no longer true if a layered flow forms in the material in the gap. As described by Barnes[1], a slip, or wall depletion effect, is common in dispersions. A layer of continuous phase may form at the metal boundary. The viscosity calculated using the no-slip boundary conditions will not be correct if the sample is not homogeneous during the measurement.

Plucinski et. al[2] describe factors affecting the wall slip of mayonnaise in viscometers; in their experience, mayonnaise always slips during such tests. Sanchez et. al[3] found that flow curves for oil-in-water emulsions are highly reproducible and accurate when geometries with rough surfaces are used to make the measurements.

We report some measurements of the viscosity of Kraft® mayonnaise. The product contains vegetable oil, water, vinegar, wheat starch, sugar, salt, pasteurised egg yolks, sour regulator lactic acid, spices, flavor and colour (beta carotene and paprika extract). The label indicates that 100 mL of this mayonnaise contains 0.3 grams protein, 50.0 grams of fat, and 6.4 grams of carbohydrate, which means an approximate composition of 71% vegetable oil, and 29% water phase (the other ingredients including the egg yolks) by volume. Thus, this is a highly concentrated emulsion of oil droplets.

Viscosity measurements were carried out on a StressTech (Rheologica Instruments AB) unit at 5°C with the shear stress controlled, and using a parallel plate (40 mm) geometry. The sample was left undisturbed for five minutes after loading to allow for temperature and structure equilibration. The mayonnaise viscosity depended on the time of shearing so fresh samples were measured at a constant shear stress of 250 Pa for five minutes. Sample heights (gap heights) of 1, 2, and 3 mm were tested. When setting the gap, the height of the mayonnaise on the lower plate was measured. The upper plate was then lowered to 1 mm above the sample. Thus, the upper plate always began its descent into contact the sample from the same height above the sample.

At a gap height of 3 mm, the mayonnaise began to flow in the rotational flow field and was thrown from the gap. The viscosity results at 1 and 2 mm were inconclusive as to

the direction of the effect of gap height; our next step is to make the measurements using a serrated-surface rather than a smooth-surface measuring geometry.

ACKNOWLEDGMENTS
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