TA Instruments

Thermal Analysis & Rheology

RHEOLOGY SOLUTIONS

TAILORING KETCHUP FLOW PROPERTIES FOR SPECIFIC CONTAINERS

PROBLEM

Food sauces such as ketchup are commonly sold to consumers in a variety of different containers including the traditional glass bottle and cheaper, more convenient, plastic squeeze dispensers. The sauces used to fill these different types of containers need to be similar in taste, color, and final texture when applied, but they also need to be different in their dispensing properties. When used in a glass bottle, the sauce is not expected to flow freely until the bottle is "shocked" with a firm tap on the base. In the plastic bottle, on the other hand, the sauce should flow when a gentle squeeze (pressure) is applied for several seconds.

SOLUTION

Rheology which measures the deformation and flow of materials under an applied force (stress) is ideal for evaluating the flow properties of food sauces. Figures 1-3 illustrate several sets of comparative rheological curves obtained on commercial ketchups from the same supplier. Material A has been formulated for glass bottles while material B is for use in plastic dispensers. Figure 1 shows the viscosity versus shear rate data (under both increasing and decreasing stress). Both A & B exhibit shear thinning behavior. That is, their viscosity decreases with increasing shear. Hence, both should be easy to dispense when pressure is applied. As expected, ketchup A has a higher initial viscosity (apparent thickness).

Figure 1. FLOW COMPARISON - COMMERCIAL KETCHUPS

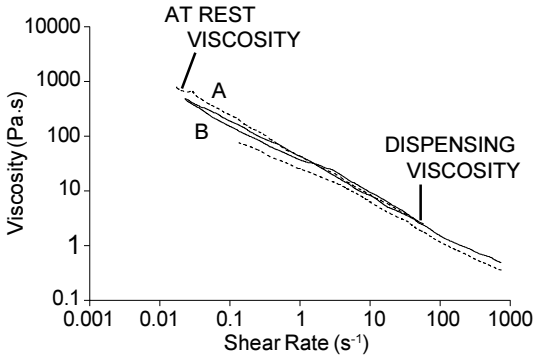


Figure 2. STRESS & RECOVERY - COMMERCIAL KETCHUPS

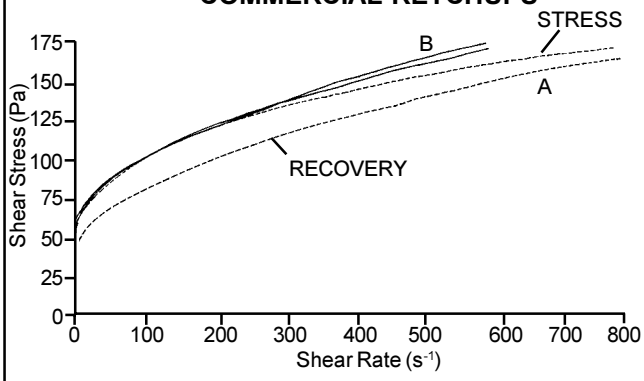
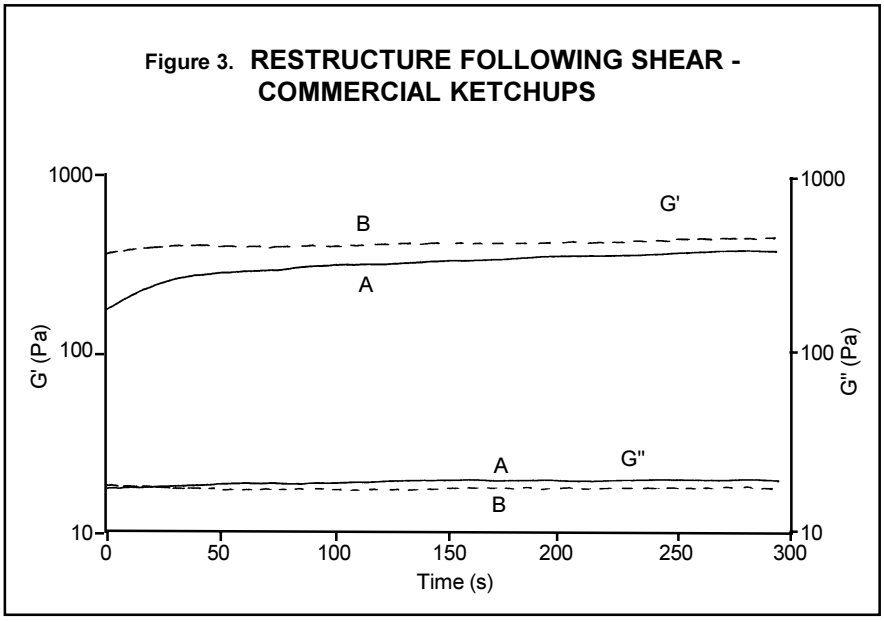


Figure 2 shows the response of A & B to the application of increasing stress and decreasing stress. As in Figure 1, the increasing stress represents behavior during dispersing. The decreasing stress, however, represents the "recovery" behavior (how the ketchup appears on the plate) once it's dispensed. Ideally, ketchup should exhibit rapid recovery from the shear thinning (structure breaking) behavior exhibited during dispensing. This "ideal" behavior which would result in a direct overlay of the increasing and decreasing stress curves in Figure 2 is essentially exhibited by ketchup B. Ketchup A, on the other hand, is thixotropic. That is, recovery of structure after dispensing is slower (more time dependent). This "non-ideal" behavior is offset, however, by the higher initial viscosity of ketchup A, and hence both have good appearance on the plate.

Figure 3 reflects the results from an oscillation experiment with a preshear designed to examine recovery of the ketchup following its being squirted/shocked onto the plate. The curves show that following the shear of dispensing, ketchup B has a higher level of structure, but that ketchup A rapidly builds a structure similar to B. This result reconfirms the conclusion from Figure 2 that although A and B dispense differently, their final appearance on the plate is comparable.

Figure 3. RESTRUCTURE FOLLOWING SHEAR - COMMERCIAL KETCHUPS



ACKNOWLEDGEMENT: This brief is based on studies by Steve Robinson, Technical Representative, TA Instruments, Ltd (UK)

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