

# Duplicating the Formulation

## The Viscosity Challenge

Ketchup is sometimes described as “too thick” or “too thin”. The former relates either to the problem users have getting the ketchup out of the bottle or to spreading it once applied. The latter pertains to the failure of the ketchup to stay on the food item.

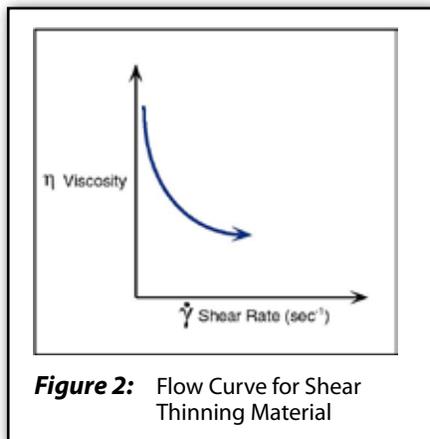
The most successful brands of ketchup have rheological properties which overcome these difficulties. Thickening agents, which give body to the product, must also permit easy flow when necessary. This means that the ketchup has a tendency to remain in place when at rest (for example, on a French fry), but move easily when a force is applied (squeezing the bottle).

Rotational viscometers provide a quick and easy way to characterize the flow behavior of ketchup. (See Figure 1). The disc spindle is immersed into a beaker of ketchup and rotated at various speeds to simulate the shearing action that the ketchup experiences.

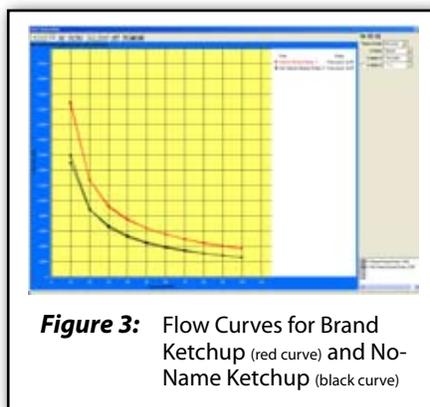


**Figure 1:** Rotational Viscometer with Disc Spindle

Flow curves, a measurement of viscosity vs. shear rate (See Figure 2), clearly show the difference between a “name” brand ketchup and a “no name” brand. (See Figure 3) The latter oftentimes has a lower viscosity and exhibits a “runny” behavior, which can cause customers to complain.



**Figure 2:** Flow Curve for Shear Thinning Material



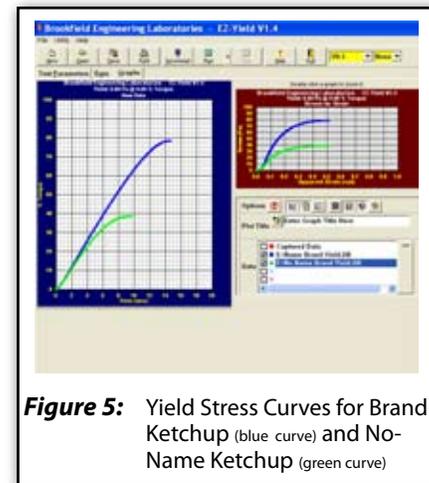
**Figure 3:** Flow Curves for Brand Ketchup (red curve) and No-Name Ketchup (black curve)

A second test practiced by some manufacturers looks at the yield stress of the ketchup. This is the amount of force that it takes to start the ketchup moving (how hard you have to squeeze the bottle). An inexpensive yield stress rheometer (see Figure 4) can quickly show the difference between the two ketchups by measuring the force required to start the vane spindle



**Figure 4:** Yield Stress Rheometer with Vane Spindle

rotating once immersed in the ketchup. (See Figure 5) The “no name” brand will oftentimes have a lower yield stress value.



**Figure 5:** Yield Stress Curves for Brand Ketchup (blue curve) and No-Name Ketchup (green curve)

Successful formulations for ketchup require a working knowledge of the intended flow behavior. This can only happen when target values are specified for both the flow curve and the yield stress.