Exponential Business and Technologies Company

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Temperature Dependance of Peanut Butter Viscosity and Spreadability

Figure 1. Peanut butter stored in a plastic jar

How much effort is required to spread peanut butter across a piece of bread? Does peanut butter have the same viscosity or thickness when you chew it as when you spread it at room temperature? These are the types of product questions you can get answers for from rheological measurements, as rheology is the study of how viscous materials deform and flow. By design, peanut butter should be stable and appear solid in the container, but still spread easily and cling to the bread that you apply it to. These design specifications, characteristics and performances of the peanut butter products can often be tested and verified using laboratory rheology studies.

The Ebatco newly acquired MCR302e Rheometer (manufactured by Anton Paar) is an excellent choice for characterizing deformation and flow properties of a variety of fluids and viscoelastic solids including peanut butters. MCR302e is capable of performing both rotational rheometry and oscillatory rheometry, using a wide range of shear stresses and shear rates in order to test viscoelastic behaviors of materials used in broad real-world applications. MCR302e with its heating and cooling stages can also allow explorations of the effects of temperatures on viscoelastic properties of materials from -150 °C to 400 °C.

In this application note, two commercial peanut butter products were evaluated on the MCR302e rheometer using a 25 mm parallel plate measuring system at 15 °C, 25 °C, and 35 °C so as to determine the effects of temperature on the viscous properties. These temperatures represent cold storage, room temperature, and the temperature when food is chewed, respectively. Each peanut butter was subjected to a logarithmic shear rate ramp from 0.01 s^{-1} to 10 s^{-1} to generate a viscosity flow curve. We were able to study the differences not only in viscosity at the

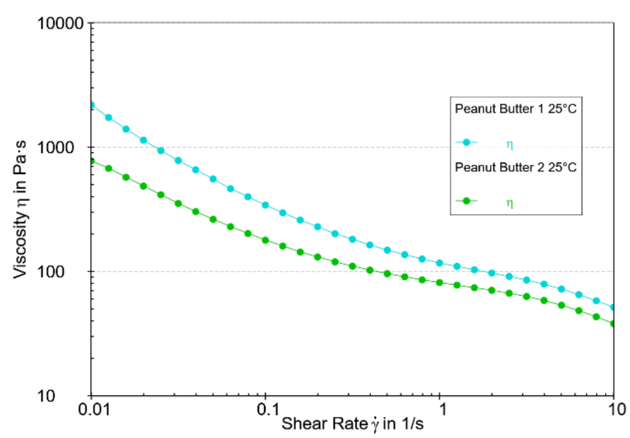

Figure 2. Viscosity comparison between two peanut butters.

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selected temperatures between samples, but also in the yield point, the stress required to make the peanut butter flow.

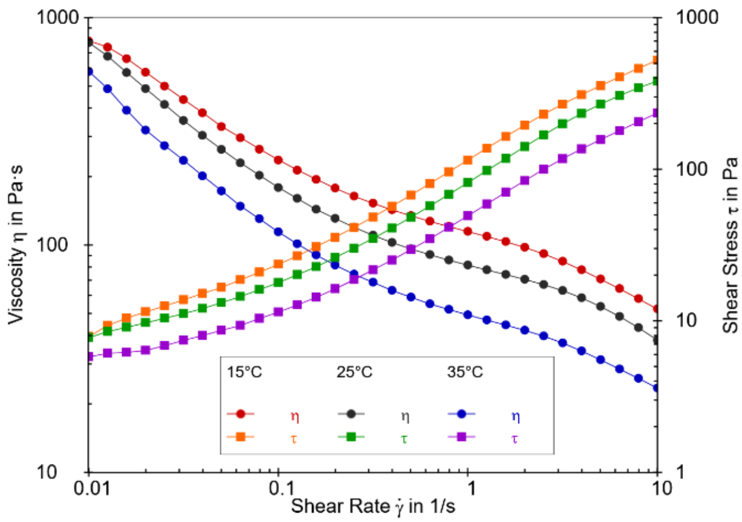

Figure 3. The effect of temperature on shear stress (τ) and viscosity (η) for Peanut Butter 2.

The viscosity curves of both peanut butters at room temperature, as shown in Figure 2, are significantly different, possibly due to variations in their formulations. Peanut Butter 1 has higher viscosities for all shear rates than Peanut Butter 2 at room temperature. Thus, Peanut Butter 1 was determined to be harder to spread than Peanut Butter 2, which exhibited more of a whipped consistency.

Both peanut butters were further evaluated to determine the influence of temperature on the initial yield point, the minimum shear stress required to generate flow. Yield points can be extrapolated several ways but for these experiments it was simply taken as the y-intercept from the plot of shear stress vs. shear rate at the lowest shear rate (Figure 3). The results determined this way for both peanut butters are listed in Table 1. As expected, increasing the temperature of Peanut Butter 2 reduced the yield point. It can be inferred that increasing the temperature of Peanut Butter 2 also increases the spreadability, as the peanut butter will not spread until the yield point has been met. On the other hand, Peanut Butter 1 exhibited higher yield point at all temperatures than Peanut Butter 2 and had slight increase in yield point from 15 °C to 25 °C before it had a significant drop in yield point at 35 °C.

Table 1. Yield Point Versus Temperature

Temperature	**Yield Point (Pa)**	
	Peanut Butter 1	Peanut Butter 2
15°C	17.6	7.9
25°C	21.9	7.8
35°C	9.5	5.8

Rheometry can help to answer questions such as how the flow behavior of a product changes with temperature or with the addition of stabilizing additives, especially those that prevent phase separation. Useful rheometry data provides valuable feedback to the formulation team, thereby affording the team the ability to adjust the recipe proactively, reduce waste, and save time and money.