Improved Characterization of Starches Using a Starch Pasting Rheometer and Starch Pasting Cells

by Aly Franck

Starches are natural products used most extensively as thickening agents in the food industry, but are also widely employed in the adhesives, paper coatings, wood, packaging, and pharmaceutical industries. A fundamental rheological measurement conducted routinely on starches is the evaluation of the gelatinization process. This is accomplished by measuring the viscosity of the starch suspension, while heating and cooling under specific testing conditions. The resultant curve, referred to as the pasting curve, yields important starch performance parameters, including the pasting temperature, peak viscosity, holding strength, and final viscosity.

The traditional viscometric test geometries, such as cone and plate, parallel plate, and concentric cylinders, are not well suited for starch characterization because these dispersions require continuous mixing during the measurement to prevent sedimentation of the starch granules. For this reason, the instruments that have been used for characterizing starch (for example, the amylograph and the Rapid Viscosity Analyzer [RVA]) measure the torque of the mixing element in a mixing chamber to follow the changes during gelatinization.

To enhance the quality of starch measurements, the mixing chamber has been redesigned to minimize moisture loss (which is also of concern during measurements) and is mounted onto the AR series rheometers (TA Instruments, New Castle, DE), allowing for systemic analysis and rheological characterization. Standard rheological methods based on steady, transient, and oscillatory measurements are offered to evaluate starch during the gelatinization process as well as in the final product.

Figure 1 Cross-section of pasting cell with impeller in place.

The Starch Pasting Rheometer (SPR) (TA Instruments) is a standalone instrument based on AR1000 technology (TA Instruments). Combined with Rheology Navigator scripted software (TA Instruments), the rheometer is an effective solution for the enhanced routine quality control evaluation of starches. Complementing this is the Starch Pasting Cell (SPC) (TA Instruments), a Smart Swap™ option for the research-grade AR2000 rheometer (TA Instruments).

Figure 1 shows a cross-section of the pasting cell with the impeller in place. Heating is through resistive elements placed concentrically to the cup; cooling is through water carried in a helical conduit in close proximity to the cup's outer walls. Flow is controlled through relays placed upstream of the cup. The maximum temperature ramp heating rate is 15 ˚C per min, and the cooling rate is 30 ˚C per min. The temperature is read by a Pt 100 probe in close thermal contact with the cup bottom.

The starch cell uses a nonstandard testing geometry (mixer element) to measure the rheological parameter such as viscosity and modulus in transient and oscillatory testing modes. A special evaluation of the geometry coefficients provides a data analysis in terms of correct shear rate and stress for this nonviscometric flow geometry.

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