

# Manage Reaction End Points In Real Time Using An In-Line Process Viscometer

By Robert G. McGregor



**Figure 1**  
**Brookfield DV-II+ Pro Benchtop**  
**Viscometer with Rotating Spindle**

An important objective of any process optimization effort is to maximize the efficiency of determining the reaction endpoint. Doing this well increases productivity, reduces waste, and increases profitability.

Formulations in the pharmaceutical industry are full of relevant examples: cough syrups, rubbing ointments, eye drops, to name a few. Customer acceptance of these products depends not only on their therapeutic performance, but also how they feel when being applied or consumed. The “right” feel

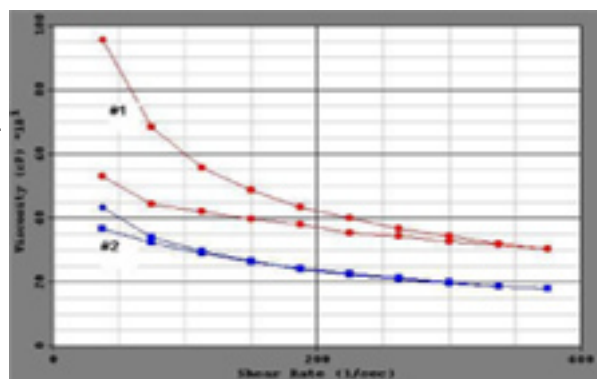
implies that the product’s flow behavior has been properly characterized using the measurement of viscosity as a qualifying parameter.

A common method for determination of a reaction’s endpoint is to measure the fluid’s viscosity. This viscosity measurement is usually expressed as; “x” viscosity at “y” shear rate and “z” temperature (most fluids in pharmaceutical processes are shear thinning

so this is the only accurate method to express the fluid’s viscosity). Typically, the measurement is made using a rotating spindle type, bench top viscometer under laboratory conditions. **See Figure 1.** A multi-speed rotational viscometer is used so viscosity measurements can be made under different conditions of fluid shearing. This feature provides the means to create a viscosity vs. shear rate curve showing the shear thinning (usually Power Law) behavior of the fluid. **See Figure 2.**

A bench top measurement is, in and of itself, reliable and ac-

curate. However, there are issues: the actual taking of the measurement can be a painstaking process, it requires a skilled operator, and some period of time does take place between the time the sample is drawn and the actual taking of the laboratory measurement. If the measurement is made before the reaction is complete, more downstream energy will be required to finish the process or worse, the product could be lost and production delayed. If the measurement is taken some time after the endpoint is reached, again energy is wasted, the product may have to be rejected, and production is delayed. In addition, even though the bench top measurements are accurate under the conditions in which they are made, those conditions are different from actual process conditions. This leads to possible questions about the relevance of the measurement.



**Figure 2 / Viscosity Flow Curve Shows Shear-thinning**  
**Behavior of Typical Pharmaceutical Formulations**

A better method is to make a continuous viscosity measurement, in real time, using an in-line type of process viscometer. However, since most companies' base line viscosity data was acquired using a bench top viscometer, a requirement for the process viscometer must be that it show a close correlation between its readings and the lab viscometer's readings, even though the two readings are made under differing circumstances of temperature, pressure, and flow.

It has been demonstrated at a major pharmaceutical company, under process conditions, that for shear thinning, suspension type fluids, Brookfield's STT100 sanitary, in-line process viscometer is a reliable and accurate device that correlates very well to bench top rotational viscometers.



**Figure 3 / Brookfield STT-100 In-line Process Viscometer**

**See Figure 3.** The STT100 is designed to conform to 3A

standards, stands up to tough process environments including vigorous CIP & SIP systems, and most importantly, provides accurate viscosity measurements at specific shear rates that allow for precise, real-time determination of reaction endpoints.

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