Continuous, In-Line Measurement

BY CHARLIE WESLEY

Continuous, in-line measurement of asphalt-rubber (A-R) viscosity provides a window into the A-R process. This measurement can assure the binder is not under- or over-reacted, that dosing is precise, and that the processing system is performing to specification. In automatic blending control systems, viscosity measurement can be used as the process variable around which temperature, heating time, mixing time and the addition of additives can be controlled.

Current Laboratory Practice

The most commonly specified method for determining A-R binder viscosity is AASHTO T316, which in turn requires conformance to ASTM D-4402, "Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermosel Apparatus" (Figure 1). Properly following the ASTM procedure and using the specified bench-top viscometer with its integrated temperature control module results in a precise and repeatable measurement of A-R binder viscosity at useful application temperatures, e.g. 135°C or 170°C.

However, there are practical problems when trying to adapt the AASHTO procedures to process measurements. The system needs time to achieve equilibrium temperature. The procedure itself requires several steps that must be followed for each measurement. Some states require a trained and experienced technician.

The laboratory measurement's timeframe does not coincide with what is going on in the process. Also, the A-R process is dynamic. Fluid is being pumped and mixed, flow rates and temperatures are changing and it is all going on in real time. An off-line measurement can not capture events in time to respond to system upsets nor can it provide a continuous record of process viscosity.

Current Field Practice

In lieu of the AASHTO and ASTM standards, some states use a procedure that specifies the use of a hand-held, rotational apparatus that can be correlated to the Brookfield viscometer. But meaningful data sets between the lab and the field device are difficult to achieve, and unacceptable non-repeatability and non-reproducibility errors are common.

Nevertheless these devices are attractive because they claim less time is needed to reach temperature equilibrium and are relatively inexpensive. However, it is still a multi-step, operator-dependent procedure with plenty of room for error. It does not measure process viscosity in real time, nor is temperature integrated into the measurement.

The devices have very limited features (e.g. not explosion proof, no means to correct for temperature effect on viscosity, etc.), and the devices bear no relationship other than rotation to the measurement technologies employed in the governing ASTM standard.

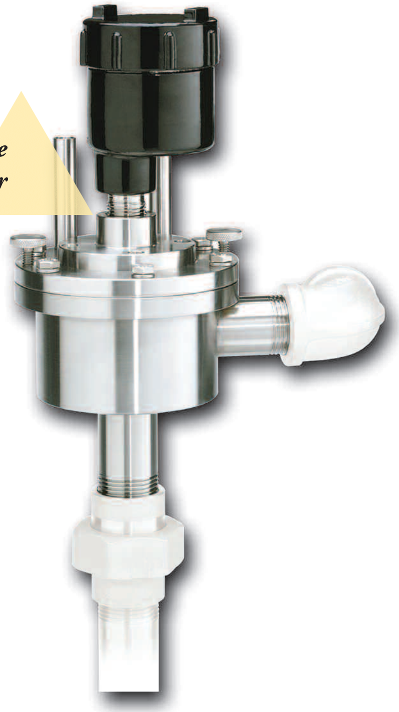
Using this type of device, while expedient, leaves the measurement open to interpretation causing frustration, lost time on the job, and considerable additional expense.

In-Line Process Viscometers

For bitumen and asphalt cement, AASHTO T201 specifies ASTM D-2170 in place of the rotational viscometer in AASHTO T316. The assumption is that the viscosity of asphalt is not affected by changes in shear rate caused by mixing or pumping the fluid, changes in pressure, etc.

Vibrating, probe-type process viscometers (Figure 2) can be used to measure kinematic viscosity and are sometimes used for process viscosity measures of asphalt. However, these devices do not have a defined shear rate and should not be used

OF ASPHALT-RUBBER BINDER VISCOSITY



Vibrating, probe-type viscometer

In-line, rotational viscometer

Laboratory viscometer

to meet the AASHTO or ASTM requirements for asphalt-rubber binder.

In-line, rotational, process viscometers are available that continuously and accurately measure A-R viscosity, while being pumped through the system, at process temperatures, in real time. At the same time, they provide a compatible technology to the bench-top viscometer required in the ASTM and AASHTO specifications.

These are rheologically correct devices that measure shear-induced stress at a precisely defined and programmable rate (Figure 3). While very sensitive to changes in viscosity, they are insensitive to changes in flow rate and mechanically induced process vibrations. They are designed to operate in harsh and hazardous process environments and are suitable for mounting on over-the-road vehicles. However, if recurring and substantial shock loads are expected, isolation mounts are recommended.

Installation Details

The viscometer is typically installed between the blender and mixer using ANSI-type flange connections. Flow rate through the viscometer does not have to be tightly controlled but must be kept below 75 liters per minute (20 GPM). The viscometer's measurement surfaces will tolerate particle sizes up to 1.8 mm. If larger particle sizes are expected, a 12 mesh screen is recommended. An optional heat jacket assures the temperature of the A-R binder is the same at the viscometer site as it is in the circulation loop. Temperature sensitive motor interlocks protect the viscometers measurement systems should the binder heating system shut down.

Installation and calibration of the viscometer is accomplished without special tools. Reproducibility of one process viscometer to another can be made better than ± 1 percent of calibrated value. Cleaning of measurement-sensitive, wetted surfaces is accomplished without removing the viscometer from service.

Process under Control

A suitable, in-line, rotating, process viscometer to measure and control A-R binder viscosity allows time to correct for process upsets before material, time and money are lost. A properly designed, installed and maintained process viscometer establishes a more controlled and efficient process, provides accurate measurements to fulfill ASTM 4402 requirements and will provide years of reliable service.

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