



D I A L

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Shear Ultrasound Reflection Viscometer (SURV)

Application: On-line viscosity and temperature monitoring of molten substances/materials at very high temperatures.

Utility: Shear Ultrasound Reflection Viscometer (SURV) is an on-line, in situ and noninvasive process monitoring device. This device measures viscosity and temperature of molten substances/materials in real time. The probe can be made out of various refractory materials chosen to match specific operating conditions and can be mounted at the location where the viscosity information is required. The material being monitored can be either flowing or static. It can also monitor the material as it is being melted. The device provides useful information for quality assurance and process control.

Principle: The principle of SURV is based on the reflection of shear waves from a solid-viscous liquid interface. Shear waves are ultrasonic waves in which the particle motion is perpendicular to the direction of propagation of the wave. These waves impart a “shearing” motion at the interface. Viscosity is the physical property of the liquid which describes its resistance to shear. Thus, the amplitude of the reflected shear wave from a solid-liquid interface depends on, among other things, the viscosity of the liquid. In addition, the ambient temperature of the melt can be inferred from the arrival time of the reflected shear wave.

Technology Description: SURV is illustrated in Figure 1. This device incorporates an ultrasonic buffer rod made of appropriate high temperature material (such as magnesium oxide, alumina, silicon carbide). One end of the probe (surface A) is flush with the melter wall, where it is in contact with the melt. A piezoelectric transducer is attached to the other end (surface B) which

extends into the melter wall. Ultrasonic shear waves are generated by the transducer and reflect off the end of the probe which is in contact with the melt. The reflected waves travel back through the probe and are detected by the transducer. The transducer converts the reflected waves to voltage signals, which are amplified and digitized. The signals are averaged to obtain a good signal to noise ratio. The digitized signals are transferred to a laptop computer which continually processes them to extract the melt viscosity and temperature. Measurements can be made at rates from a few milliseconds to a couple of seconds depending on the instrument repetition rate and averaging.

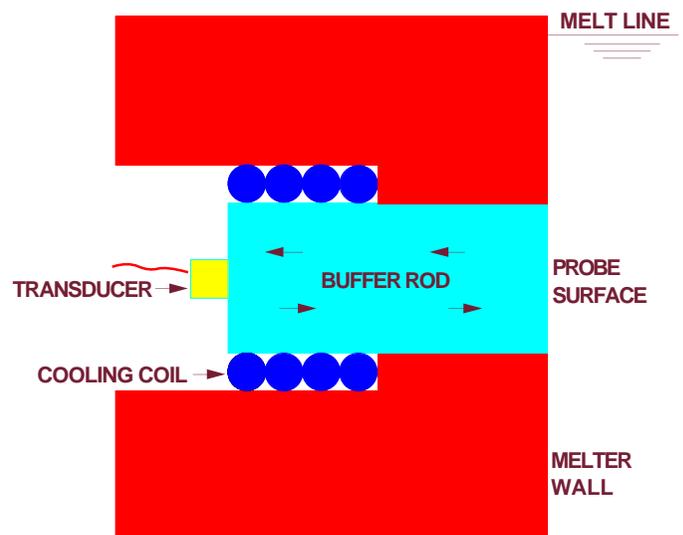


Figure 1. Schematic of shear ultrasound reflection viscometer.

Advantages: SURV has many distinct advantages such as the absence of moving parts, high operating temperatures, large dynamic range (from close to 0 P to over 500 P), real time monitoring.

Requirements: There are two essential requirements for SURV. The SURV probe requires a port in the melter where it can be fixed flush with the melter wall and be completely wetted by the melt. In some applications the probe will have to be made from a suitable corrosion resistant material. The buffer rod must be cooled to protect the transducer from extreme temperatures. Presently, this is accomplished by simply passing water through copper coils wrapped around the buffer rod.

Calibration: SURV is currently being calibrated using NIST traceable standard glasses and other glasses of known viscosity. The viscosities of these glasses have been measured using rotary viscometers in glass measurement laboratories.

Software: The software for SURV is a platform portable graphical software designed in LabWindows CVI and ANSI C. This software may be used to continuously monitor the viscosity data. If desired, TTL signals may be sent to the interface system, whenever a desired viscosity is achieved and certain gates need to be triggered. The software has an automatic self-test to check the

integrity of the probe. An alarm will be generated if the probe is damaged. The software will be modified to suit particular applications.

Costs: DIAL will provide the instrumentation, software, system integration, calibration procedure, technical training, continued support and upgrades as the development warrants. This system along with others developed and under development by DIAL will be provided to the DOE user at cost. Inquiries from industrial users or commercial instrument companies are also welcome.

Additional information about SURV can be obtained by contacting:

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