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"Tomorrow's Instruments... Today"™

Development & Advancement of the Brookfield Viscosity (ASTM D2983) Test

The Brookfield Viscosity test was first developed at General Motors in 1954 using an air bath technique to determine viscosities of automatic transmission fluids (ATF), gear oils and hydraulic fluids at low temperatures. Published first in the early 1960s as CRC L-45, the low temperature, 16-hour test procedure became ASTM D2983 in the early 1970s.

The use of a temperature-controlled, cold-box was first chosen for use because commercial liquid baths were not available for overnight temperature control. Serious limitations of cold-box viscometry were characterized by the frequently erroneous results caused by sample heating on removal from the cold-box. Various techniques such as the balsa-block sample carriers were efforts to work around the temperature-control problems. Replicate samples and averaging were a necessity. Moreover, temperature control of a cold-box was erratic as it was opened and closed to access the samples for analysis.

One improvement was the use of a temperature-controlled, liquid bath in which the samples were replaced from the air cabinet for the final 30 minutes of the 16 hour soak period. This approach was introduced in the 1970s and allowed the viscometer to be connected to the spindle and viscosity taken while the sample remained in the liquid bath at temperature.

Later, it was thought that if the more precise temperature control of liquid baths could reproduce air-bath cooling curves, the results should be acceptable. However, the reasoning was flawed because a cold liquid bath medium removes heat from the sample much more rapidly than air. Thus it was really necessary to reproduce the heat removal rate of the sample exposed to the circulating air in the cold box. This problem was overcome relatively recently by a simple approach based on a deeper understanding of the dynamics of liquid cooling and viscosity measurement.

The Simulated Air Bath

The approach was to eliminate the need for a relatively large programmed liquid bath to imitate the cooling curve of the air bath. This was done by a precise method of insulating the test fluid from the bath medium held at the desired temperature of analysis. This precise insulation uses a limited amount of gas in a glass Dewar chamber composing the stator test cell for the test fluid. Thus, the cooling rate and the heat-transfer rate are the same as in the cold-box. With this development, the precision of the constant temperature liquid bath is applicable and the test samples – now cooled at the same rate as the cold-box – can be measured in place. Rotors made to the correct dimensions using an insulating material completes the new approach to D 2983. (See SimAir® Stator and insulated #4 Rotor at right.)



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As a unique consequence of this approach, the samples can be inserted and removed from the liquid bath at any time without affecting the nearby samples. Replicate test samples are not necessary and productivity is enhanced.

This new approach developed by Ted Selby (original developer of the Brookfield test in 1954) is now known as the SimAir[®] Test Cell with a patented test cell design. As noted, without using any cooling program, the SimAir[®] cell modifies heat transfer to the sample and closely simulates the cooling influence of the air bath permitting the sample to develop the same viscometric characteristics as in the cold-box.

The SimAir[®] approach is being recognized as the best possible approach to measuring low-temperature viscosities of ATF and gear oils for a single-point method. (Just as the Scanning Brookfield Technique is for multi-point determinations and the generation of the *Gelation Index*.)

As a result, ASTM Round Robin testing on the SimAir[®] approach is currently underway in the D2983 Task Group. The study is expected to fully incorporate the SimAir[®] technique into the method and identify any biases between the various instrument types and test procedures being used for this test in the industry.

The SimAir[®] Test Cell has been licensed exclusively for use in the Tannas Scanning Brookfield PlusTwo (SB+2) and King Brookfield Liquid Bath (BLB) manufactured by King Refrigeration, Inc., also located in Midland, Michigan. Contact us for details.

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