

Temperature and Thermal Equilibrium

Dave Anderson

Asphalt Binder ETG

Bozeman, MT

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What are the issues?

- ❑ How do we define and measure thermal equilibrium?
- ❑ How can we ensure that we have reached the target test temperature at low temperatures?
 - ✓ Do we have adequate measurement techniques?



Some givens

- ❑ We need to control temperature to $\pm 0.1^\circ\text{C}$ and report temperature to the nearest 0.01°C
 - ✓ Modern equipment can easily meet these requirements
- ❑ We need a better method for measuring specimen temperature
 - ✓ An 8 mm silicone wafer with an embedded transducer is not satisfactory for low-temperature 4 mm geometry
 - ✓ A satisfactory solution should be available to all instrument manufacturers as an off-the-shelf item
 - ✓ *Action item* – Resume this pursuit, particularly for the 4 mm plate at low temperatures, and coordinate with rheometer manufacturers



Temperature control at low temperatures

- ❑ Pending results to the contrary, it can be assumed that for low temperature measurements Peltier plates alone give insufficient temperature control and must be accompanied by a controlled temperature “oven”
 - ✓ Further work with low-temperature measurements should be limited to instruments that meet the above criterion
 - ✓ *Action item* – Combine existing material on sample preparation and fixture compliance with additional information on instrument requirements to provide short-term guidance “White Paper” to the asphalt community



Thermal equilibrium

- ❑ Detailed procedure for determining time when complex modulus changes minimally with time has been developed as “Determination of Thermal Equilibrium Time”
 - ✓ Assumes all changes with time of the result of thermal equilibrium
 - ✓ More detailed evaluation of available data shows that this may not be the case
 - ✓ Existing and new data needs to be revisited with respect to the design of temperature control systems



Thermal Equilibrium, cont'd

- ❑ Initial work implied time to thermal equilibrium occurs much sooner than the current 10-12 minute wait time
 - ✓ More recent studies contradict this finding
 - Work conducted by Pavel Kris as part of ETG study
 - ✓ Additional data is also now available for 4 mm low temperature measurements
 - ✓ *Action item* –
 1. Task Force needs to reevaluate available data and recommended procedure for determining thermal equilibrium



That's all folks



