METER
ENVIRONMENT

A QUICK PRIMER FOR MEASURING THERMAL PROPERTIES IN FLUIDS

With all sample types, it is necessary to allow the sensor needle to equilibrate with the sample and the surrounding environment. Temperature differences between the sensor, sample, and surroundings could give erroneous readings.

SENSOR RECOMMENDATIONS

For fluids, METER recommends using the KS-3 sensor for measuring thermal conductivity and thermal resistivity. While the KS-3 was designed for measuring fluid samples, measuring the thermal properties of liquids is difficult, and great care must be taken to obtain accurate and repeatable results. We do not currently have a sensor that is suitable for measuring specific heat or diffusivity of a liquid sample.

SAMPLE SIZE

Best practices for solid samples suggest that a sample with a 2 cm radius of sample material around the sensor needle is sufficient for samples with thermal conductivities around .5 W/mK. For fluid samples, however, the minimum sample size is approximately 50 mL, though more conductive samples may need to be larger.

Convection or bulk movement caused by temperature changes and vibrations in the testing area can occur easily in a liquid sample. Because our thermal properties instruments measure conduction, or the movement of heat through molecules, it is important that there is no convection in the sample. If convection or bulk movement occurs in a sample during testing, the resulting measurements are useless. The two types of convection that can occur are forced convection and free convection.

FORCED CONVECTION

To avoid forced convection, the sample should be free from vibration. Even minor vibrations from a computer fan, an HVAC system, or people walking through the testing space are enough to disturb a sample. Fluids should be measured with the sensor needle oriented vertically in the sample with no air bubbles around the sensor. It is important that the sensor needle is still in relation to the sample as it is measuring. If the sample needle moves, this will stir the sample, causing sample disturbance.

FREE CONVECTION

To avoid free convection or the bulk fluid flow due to a temperature gradient, temperature and sample viscosity need to be taken into account. Long read times, which will add more heat to a sample, will cause free convection and sample mixing. As a general rule, anything less viscous than water at 50 °C should not be measured unless it is stabilized. If a sample is less viscous than water and has not been stabilized, then it will be problematic to take a measurement with the TEMPOS.

SAMPLE STABILIZATION

Liquid samples can be effectively measured if they are stabilized with agar powder. The effect on thermal conductivity is negligible, and the more solid structure will prevent both free and forced convection. We recommend using 5 g of agar powder for every 1 L of water or aqueous solution. It is possible that stabilizing a sample in this way could interfere with the function of micro and nanoparticles, however.

For a more detailed exploration of this topic, read "Using TEMPOS to measure thermal properties in fluids"

For additional questions about testing a liquid sample, please contact METER directly.