Understanding Thermal Drift

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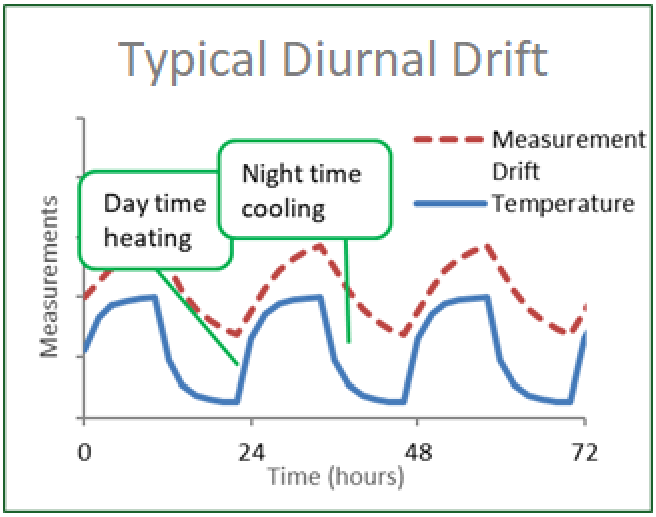
Overview

Measurement drift is a phenomenon common to all extensometers, as well as other types of sensors and electronic devices generally. There are several common sources of drift that affect strain measurement, *warmup drift, thermal drift*, and *cyclic drift* being the most common. This article addresses *thermal drift.*

> *Note that this term is specifically applied to the case of* ***nominally steady*** *temperature conditions which exhibit small unintended variations over time. Large intentional shifts in temperature require special consideration: see* [Epsilon TechNote – Dynamic Temperature Applications]

Thermal Drift



When using load cells, extensometers, or other sensor systems, small variations in temperature over time typically produce a small offset in the reading which changes over time – thus it is called drift. The relationship is often nonlinear and is related to the rate of change.

In many applications the most significant contributor to thermal drift is diurnal room temperature variation, which is controlled by the HVAC system of the test environment (image right).

Similar effects may also occur over a shorter timescale (*5-50 minute cycles due to HVAC cycling*), or at multiple time scales.

When performing tests of short duration (a few seconds to minutes), thermal drift is usually negligible. When performing longer tests which may last several hours or more, it may become more significant. This is especially true in the case of creep testing, where test duration may be quite long and the strain range may be quite low.

Identifying Thermal Drift

Thermal Drift is distinguished from other sources of measurement drift by the fact that it never stabilizes, and correlates directly – if not linearly – to variation in room or test temperature. Thermal drift is not correlated to the test profile and may occur in some cases even with an extensometer mounted onto a stable unloaded specimen.

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Several factors make identifying measurement errors due to thermal drift difficult. In many cases thermal drift is not actually a measurement error, but an indication of true (but undesirable) strains. This can be caused by thermal drift error in a load cell, deformation of the test machine, specimen or load train, specimen bending strains, etc. These contributors can all generate real but undesirable strains that vary with temperature, and are typically quite difficult to distinguish.

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Mitigating Thermal Drift

Thermal drift effects may be mitigated by one or both of:

1. Improving temperature control, and/or
2. Reducing the system's sensitivity to temperature variation,

Improving control

Improving temperature control is often the easiest solution. This might mean:

- Control variables (*e.g.*, use window shades, avoid opening doors to uncontrolled areas, etc.)
- Adjust HVAC and chamber settings (*e.g.,* maintain the daytime thermostat setting at night, use tighter limits on thermostat control, improve control of any specimen-heating system)
- Utilize a local environmental control (*i.e.,* temperature-controlled enclosure for extensometer, test frame, or laboratory space)

Reducing sensitivity to temperature variation

Mechanisms for reducing the system's sensitivity to temperature variation vary according to the root cause, which can be difficult to identify. In elevated temperature testing, both the room temperature and the test temperature control may be relevant. Some common sources of sensitivity which could be relevant are:

- Loadcell, extensometer and data acquisition system sensitivity effects
- CTE elongation of the specimen (CTE x ΔT)
- Test frame and load train deformation, warping and related effects *
- Specimen bending effects *

** Temperature-related deviations in indicated elongation exceeding the predictions of CTE do not necessarily indicate a measurement error. Undesirable but real deformations caused by temperature variation of the testing apparatus are common.*

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