Abstract

In 2006, the Quicksilver Caucus, a coalition of State government agencies and standards organizations, requested that United States government agencies and standards organizations collaborate together to reduce the industrial and laboratory use of Hg thermometers.
- ASTM International found over 850 standards with references to Hg thermometers.
- NIST and the EPA are providing science-based support for the transition of ASTM standards to allow for the use of alternative thermometers.

As part of that support, the EPA and NIST completed a pilot study to phase out the use of Hg thermometers in petroleum field activities.
- A NIST developed protocol to compare Hg and alternative thermometers was implemented at two petroleum product distribution terminals.
- Observations from these tests provided valuable information for understanding measurement differences encountered in the field.

Outcomes from the EPA and NIST work

Web-based user-friendly guidelines
- Replacement of Mercury Thermometers
- Selecting Alternatives to Mercury-Filled Thermometers
- Verification Methods to Alternatives to Mercury-Filled Thermometers, Including Research on Ice and Steam Points
- Non-Mercury Thermometers for Validating Autoclave Operating Temperatures
- What is Traceability?

Web-based videos
- Alternative Thermometers
- Ice Melting Point
- Steam Point
- Traceability

Alternative thermometer testing
- Intrinsically-safe alternative thermometers field tested at two Refined Product Terminals (RTPs)

Phase I: Alternative Thermometers

<table>
<thead>
<tr>
<th>Thermometer Type</th>
<th>Thermometer Designation</th>
<th>Range and Graduation/Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hg</td>
<td>59F-1, 59F-2</td>
<td>0 F to 180 F in 1 F</td>
</tr>
<tr>
<td>Hg</td>
<td>12F-1, 12F-2</td>
<td>-5 F to 215 F in 1 F</td>
</tr>
<tr>
<td>Hg</td>
<td>63F-1, 63F-2</td>
<td>8 F to 89 F in 0.2 F</td>
</tr>
<tr>
<td>Organic</td>
<td>S59F-1, S59F-2</td>
<td>0 F to 180 F in 1 F</td>
</tr>
<tr>
<td>Digital</td>
<td>DT1-1</td>
<td>-10 C to 188 C in 0.1 C</td>
</tr>
<tr>
<td>Digital</td>
<td>DT1-2</td>
<td>-40 C to 204 C in 0.1 C</td>
</tr>
<tr>
<td>Digital</td>
<td>DT1-3</td>
<td>-10 C to 188 C in 0.1 C</td>
</tr>
<tr>
<td>Digital</td>
<td>DT1-4</td>
<td>-40 C to 204 C in 0.1 C</td>
</tr>
<tr>
<td>Digital</td>
<td>DT2-1, DT2-2</td>
<td>-50 F to 400 F in 0.1 F</td>
</tr>
</tbody>
</table>

Repeatability testing protocol performed at NIST

- Thermometers cycled through full calibration cycle 3 times
- Measurements performed by two NIST metrologists
- Temperature range of –21 C to 99 C

Phase II: Field Testing of Protocol and Thermometers

Protocol to field-test thermometers at RTPs
- Measurement instructions and data-collection worksheets
- 8 measurement sets performed once per week
- Feasibility of different technicians measuring several thermometers
- Survivability of transfer standards (e.g., thermometers)
- Different measurement conditions
  - Time of day / night
  - Gasoline and Ethanol
  - Weather conditions

Thermometers Tested at RTPs
- Organic
- Digital

Notes From the Field

Thermometer field measurements needs improvement
- Analog Thermometers
  - RPT-1: ±0.6 C field measurement resolution
  - RPT-2: Drain time only 5 minutes for Organics
- Digital Thermometers
  - RPT-1: results reflect staff training issues
  - RPT-2: results reflect NIST & EPA metrologists capabilities

Digital thermometer manufacturers need to solve various issues
- Ergonomics, EMI, Training tutorials – online videos