AASHTO re:source (formerly AMRL) In Focus

Why Don't You Just Tell Me Which Thermometer to Buy?
And Other Frequently Asked Thermometer Questions

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We get a lot of questions from laboratories that are looking for a thermometer that they can use to replace their mercury thermometers. Unfortunately, there is no simple answer to that question, and folks tend to get a little frustrated when we don't have the straightforward response they were looking for. Okay, okay, so I've never run into a customer quite as grumpy as this little green fella' here, but I do understand peoples' frustration. Why don't we just get to the point already?

It's just not that simple…
The best answer that I can provide to this oft-asked question is that there is no one size fits all solution to temperature measurement. Alternatives to mercury thermometers all have limitations, and the circumstances in which they are used will determine which type of device is the best fit. For more information on the pros and cons of the different types of digital thermometers that are on the market today, check out this diagram.

And to further complicate things…
Generally, once I provide the above explanation, people follow-up with a list of the tests that they run, and ask me to suggest a device that can be used in each individual test scenario. Unfortunately, this isn't really practical either. Let me explain.

As you may know, several AASHTO and ASTM standards solely specify the use of mercury thermometers for testing. As initiatives to reduce the use of mercury continue to gain momentum, this has become a critical issue for standards developers as they insert language regarding other types of thermometers into standards. Experts have to consider how the use of a digital alternative in place of a mercury thermometer will affect the meaning and precision of the test results. Changes will be made to AASHTO and ASTM standards as conclusions on the best types of alternatives are reached.

What's taking so long?
Replacing or specifying alternatives to mercury is not an easy task. Several standards specify that a liquid-in-glass thermometer be immersed to a point other than what it was designed for. This complicates things, since digital thermometers do not have the same immersion-point issues that are intrinsic to the use of liquid-in-glass thermometers. The issue becomes even more complex for test methods that specify a particular rate of rise in temperature over an interval of time. The temperature response time of digital thermometers can vary by make, model, and configuration. These issues have to be carefully considered when writing language regarding digital alternatives to mercury.

In several cases, research will need to be done to determine if the test results are affected by the use of a different type of thermometer. Experts are working toward developing research plans and interlaboratory studies to address these issues. Unfortunately, this type of research takes time to implement and complete. It may be a few more years before we see the results of these efforts in AASHTO and ASTM standards.

So, when we get asked to recommend a digital thermometer that can be used to replace a mercury thermometer in a specific test, sometimes the most truthful answer is "we don't know yet."

What I am supposed to do until then?
We do realize that some states have severely restricted the use of mercury, and it may be difficult or impossible to get your hands on the mercury thermometers that are still required by test standards. Sitting around and waiting a couple of years for the methods to get updated simply isn't an option.

While there is no guarantee that the device that you choose will meet the requirements of the standard once the experts have updated them, these general guidelines may assist you in selecting a suitable alternative in the meantime. When selecting an alternative to a mercury thermometer, consider the following:

Accuracy of the Device
Not all digital thermometers are created equally, and some are more accurate than others. Avoid thermocouples unless measurement uncertainty greater than 2°C is acceptable, or if temperature has little effect on the test results. Infrared thermometers are known to have serious accuracy problems, and are probably not suitable for most laboratory tests. When choosing an industrial platinum resistance thermometer (IPRT), choose one with a 3- or 4-wire configuration. Be sure to check the manufacturer's specifications for accuracy information that is specific to the device that you are considering for purchase.

Range of Use
Consider the range of temperatures in which you expect the thermometer will be used. In general, it is best to choose a device that has the narrowest range of use that is actually necessary for your application. Note that thermistors only provide a very narrow range of suitable temperatures, and should not be used for measurements above 90°C. Again, be sure to check the manufacturers' specifications for a recommended range of suitable temperatures for a particular device.

Test Medium and Location
Avoid exposed or bare sensing elements for measuring the temperature of liquids, as these types of devices may be prone to contamination or damage by the liquid medium. Bare sensing elements are best for temperature measurement in gaseous environments where the device will be placed in a permanently fixed location. Avoid thermocouples with grounded junctions if they might make contact with metal while in use.

Immersion Depth
Particularly with IPRTs, it is important to check the manufacturer's recommendations for the minimum immersion depth of the sensing element. Before purchasing an IPRT, make sure that your testing medium will provide at least the minimum recommended depth of immersion. In general, experts recommend choosing a device where the overall sheath length of the IPRT is at least 2 inches greater than the immersion depth.

Vibrations and Shock
If it is possible that the thermometer could be subjected to shock or vibration during use, avoid using an IPRT. IPRT's are more fragile than the other types of thermometers available and should be handled with extreme care.

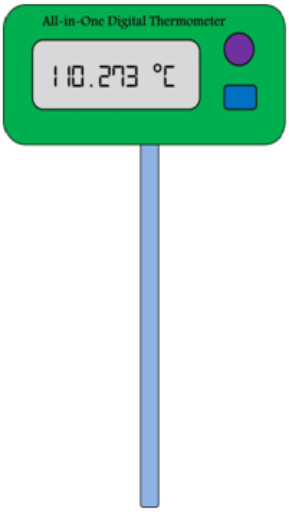
Thermal Response Time
Thermal response time can vary by type of digital thermometer, as well as make, model, and several other factors. Choosing a digital alternative where rate of rise is an important part of the test procedure can be very challenging. Until more research is done by standards developers to address these issues, you may wish to perform your own comparison between an IPRT and the mercury thermometer specified in the test standard to ensure that your test results conform to the in-laboratory precision statements.

The use of mercury thermometers is prohibited in our laboratory. Will our AASHTO accreditation be affected?
Most likely not. If the laboratory is restricted in their use of mercury, the use of an appropriate alternative to liquid-in-glass will not be noted in the laboratory's assessment report, even if an alternative to liquid-in-glass is not specified in the test method. As AASHTO and ASTM standards "catch up" and add alternatives to mercury thermometers, we will begin to evaluate digital thermometers that are used based on the requirements that are in the standards.

What is AASHTO re:source doing in its own laboratories?
I get this question a lot too. I am proud to announce that AASHTO re:source has been "mercury free" for almost a year now. Before that, we were still using mercury thermometers to calibrate the thermometers that we use in our laboratory assessment kits. So what kind of device did we end up buying? We chose to go with an all-in-one IPRT. That is, a device in which the central processing unit (CPU) and the sensing element are an integral, portable unit.

The device that we purchased is marketed specifically as a "liquid-in-glass replacement." We chose this device for its ease of operation - no fancy software and recording features, just a few simple buttons. Because the features of the device are limited to only those that we really need, we were able to keep costs down. In addition, since the probe and CPU are one integral unit, we don't need to worry about mix-ups regarding which probe was calibrated with the device.

All-in-one digital thermometers are quickly growing in popularity, and there are several different varieties available on the market today that come in thermocouple, thermistor, and IPRT configurations. Since they are intended to be used much in the same way liquid-in-glass thermometers are used, they may be a suitable choice for many laboratory applications. Of course, this type of device, while it works well for our needs, may not be suitable in all situations. Use the criteria mentioned earlier in this article to determine the device that best meets your needs. Keep in mind that you may need to purchase more than one type of device to meet the demands of all of the different test methods that your laboratory performs.



All-in-one Digital Thermometer: ***The CPU and sensing element are one integral unit.***

If you would like additional information on this topic, please contact me.