JL-P2.0 - Boiling Bath Procedure

This procedure will produce a water boiling point close to 100°C (212°F). The exact temperature depends on the atmospheric pressure. The procedure is based on ASTM XXXXXXXXX (does not exist ? see NIST printed pdf about steam point). This point is also referred as Steam Point. This document presents the procedure used to calibrate each TDL system as part of a three-point calibration. It can be replicated by the user to verify the calibration of the system over time. This method can achieve an uncertainty of 0.1 °C (0.2 °F) at a 95 % confidence level.

Warning: This procedure uses boiling water and generates hot steam. Protect yourself from burns and scaldings. Jericho Laboratory Inc. is not responsible for damage or safety if you attempt to reproduce this procedure.

Required material:

- Stainless steel pot (minimum dimensions: 20 cm dia. x 20 cm (8 x 8 inches))
- One aluminum plate (minimum bottom dimension: 18 cm diameter (7 inches)
- Scissors
- Tap water
- Clean thermistor probe with wire
- Plastic stick
- Third-hand or clothes clamp
- Hot plate (heat source)

Procedure:

1. Wash the pot and the probe with soapy water and rinse three times with tap water.
2. Attach the probe on the plastic stick and hold the plastic stick with the third-hand.
3. Using the scissors create a hole in the aluminum plate, large enough for the stick.
4. Fill the pot with 10 cm (4 in.) of clean tap water.
5. Put the aluminum lid on and bring water to a strong boil.
6. Once the water boils, lower the heat. Boiling should remain strong during measurements.
7. Insert the probe into the water. The probe should be 5 cm below the water level. (NIST says above the water, others say below the water).
8. Determine the atmospheric pressure (barometric pressure) at your position. Be as precise as possible (ex: 1013 hPa). The weather station should be as close as possible from your location and be less than one (1) hour old. The weather station in Montreal (airport) is 13 km from the Jericho facility.
9. Probe must be exposed to five (5) minutes of rolling boil before taking measurements (NIST recommendation).
10. Measure data every second for 30 seconds. See Figure X for a typical curve.
11. It is possible to test more than one probe at the same time.
12. Data treatment: Calculate the atmospheric pressure and average the 30 data points.

13. NIST: The uncertainty of the elevation limits the uncertainty of the steam point. Using the steampoint calculator, you can achieve an uncertainty of 0.1 °C (0.2 °F) at a 95 % confidence level.

Steam point equation is given by the NIST excel sheet. Pressure must be between 97.0 and 104.0 kPa for the equation to be valid.

Frequent values as per the NIST Excel sheet

Atmospheric pressure (kPa)	Temperature (°C)
100.1	99.63
100.2	99.66
100.3	99.69
100.4	99.72
100.5	99.74

(ADD A DIAGRAM OF THE APPARATUS)

Comments:

1. The lid is necessary to get accurate results. The steam accumulates within the pot and creates a slight positive pressure. This way no air enters the pot.
2. The NIST recommends using a pot that is at least 8 inch deep.
3. Be careful that no bare metal from the probe is exposed to the steam. It could cause a measurement error by electrical conductivity.
4. Our data comes from the Montreal Airport, which is at the same altitude as the laboratory. There is therefore no need to correct for altitude. If you reproduce this procedure, you might have to account for elevation (ex: United States Geological Survey website). The building height is taken into account (see calibration certificate for an example).
5. You might need a few tries to figure out what level of heat will maintain a rolling boil. Do not remove the lid during the measurements.
6. There is no need to use distilled water. The steam produced is in itself a small distillation process. For the same reason, gloves are not necessary.
7. To find recent atmospheric pressure data near you, we suggest the National Weather Service website (USA) or Environment Canada. NIST recommends using data that is at maximum one hour old.
8. When using a thermistor probe, the Joule effect bias is reduced by taking a 1 mS measurement every 1 second.
9. The resistance value is recorded for 30 seconds and averaged. The resistance value is not with a TDL device, but with a similar device with higher precision, that incorporates an Arduino Mkr Zero. If you reproduce this experiment at home with the TDL device, the exact resulting value might differ slightly since the accuracy of the device is lower than the calibration device used at Jericho.

References:

- Natural Ressources Canada (weather): https://weather.gc.ca/past_conditions/index_e.html?station=yul
- National Weather Service : https://www.weather.gov/
- NIST Procedure for steam point: https://www.nist.gov/pml/mercury-thermometer-alternatives-verification-methods-alternative-thermometers (videos do not work anymore)