chamber 520 reaches one selected temperature point, the liquid bath assembly 502 stops heating for few minutes and temperature values and resistances values (Ti and Ri) are recorded simultaneously for the reference thermometer 504 and the to-be-calibrated thermistors 506 inserted in the inner chamber 510 during this period. After that, the liquid bath assembly 502 continues to heat the liquid 522 in the outer chamber 520 to the next selected temperature point until the liquid temperature reaches 40°C. Least Square Algorithm, as an example, which is faster in computing and higher in accuracy for nonlinear fitting of multiple points may be built in the master processor 580 for Steinhart-hart coefficients identification.

[0076] FIG. 10 shows a graph 1001 illustrating a comparison between the temperature difference at two locations in the liquid bath with only the outer chamber, and that in the liquid bath assembly 502 with both two chambers (the inner chamber 510 and the outer chamber 520) and the stirrer 542 when the temperature varies from 25°C to 30°C during calibration. It can be seen that, with the two chambers and the stirrer 542 configuration, the temperature uniformity can be reduced from -0.035°C ~0.045°C to -0.004°C~0.01°C during heating process, and be reduced from -0.015°C ~0.015°C to -0.004°C ~0.005°C during heat holding process.

[0077] FIG. 11 shows a graph 1101 illustrating a comparison of the errors of temperature calculated by traditional three-points calibration and the multi-points calibration following the procedure shown in FIG. 9. The results demonstrate that the deviation between temperature calculated by the calibrated coefficients obtained from the multi-point calibration according to various embodiments and temperature calculated by original coefficients is less than 0.005°C. The error of the multi-point calibration is also less than the error of traditional three-point calibration.

[0078] FIG. 12 shows a table 1201 illustrating a comparison between original coefficients of the thermistor, coefficients calculated by traditional three-point calibration method, and coefficients calculated by multi-point least square algorithm according to various embodiments. As shown, the coefficient calculated by multi-point least square algorithm is closer to the original coefficients of the thermistor as compared to the coefficients calculated by traditional three-point calibration method.

Claims

1. A temperature sensor calibrator, comprising:

a first chamber configured to receive a temperature sensor in a liquid;

a second chamber separate from the first chamber, the second chamber surrounding the first chamber;

a temperature-regulating component configured to adjust a temperature of a liquid received in the second chamber; and

a temperature-homogenizing component disposed in the second chamber, the temperature-homogenizing component configured to enhance temperature uniformity of the liquid in the second chamber,

wherein the temperature homogenizing component further comprises a plurality of inlets and a plurality of outlets distributed along a height of the second chamber.

2. The calibrator as claimed in claim 1, wherein the temperature-homogenizing component comprises an agitator.

3. The calibrator as claimed in claim 2, wherein the agitator is disposed in the second chamber, and configured to circle around the first chamber.

4. The calibrator as claimed in claim 2 or 3, further comprising a motor connected to the agitator, and wherein the motor is configured to drive the agitator.

5. The calibrator as claimed in any one of claims 1 to 4, wherein the first chamber comprises heat conducting fins.

6. The calibrator as claimed in any one of claims 1 to 5, wherein the first chamber is defined by a cavity within a container, and wherein the container is made of thermal conductivity materials.

7. The calibrator as claimed in claim 6, where the cavity comprises a plurality of elongated cavities, an annular cavity, or a plurality of flabellate cavities.

8. The calibrator as claimed in any one of claims 1 to 7, wherein the second chamber is surrounded by thermal isolation layer.

9. The calibrator as claimed in any one of claims 1 to 8, further comprising a lid and a rubber plug, wherein the rubber plug is configured to be fitted into a through hole in the lid for coupling the temperature sensor to the lid.

10. The calibrator as claimed in any one of claims 1 to 9, wherein the temperature-regulating component is separate from the second chamber, and wherein the temperature-regulating component is connected to the second chamber via conduits.

11. The calibrator as claimed in any one of claims 1 to 10, further comprising a built-in electronic module.

12. The calibrator as claimed in claim 11, wherein the electronic module comprises a user interface.

13. The calibrator as claimed in claim 11 or 12, wherein the electronic module comprises a plurality of input channels.

14. The calibrator as claimed in claim 13, wherein each of the plurality of input channels comprises a microprocessor and a memory.

15. The calibrator as claimed in claim 13 or 14, wherein the electronic module comprises a data acquisition unit configured to acquire data from the plurality of input channels.

16. The calibrator as claimed in claim 15, wherein the data acquisition unit is configured to synchronously sample data from the plurality of input channels.

17. The calibrator as claimed in any one of claims 11 to 16, wherein the electronic module comprises a master processor configured to identify Steinhart-hart coefficients.

18. The calibrator as claimed in any one of claims 11 to 17, wherein the electronic module comprises a controller configured to control the temperature-regulating component and the temperature-homogenizing component.

19. The calibrator as claimed in any one of claims 11 to 18, wherein the electronic module comprises an electronic port configured to be connectable with external processor.

20. A method of manufacturing a temperature sensor calibrator, the method comprising:

providing a first chamber configured to receive a temperature sensor in a liquid;

providing a second chamber to surround the first chamber, wherein the second chamber is separate from the first chamber;

providing a temperature-regulating component configured to adjust a temperature of a liquid received in the second chamber; and

providing a temperature-homogenizing component in the second chamber, wherein the temperature-homogenizing component is configured to enhance temperature uniformity of the liquid in the second chamber,

wherein the temperature homogenizing component further comprises a plurality of inlets and a plurality of outlets distributed along a height of the second chamber.

21. A method of calibrating a temperature sensor, the method comprising:

inserting the temperature sensor into a liquid in a first chamber;

adjusting a temperature of a liquid in a second chamber surrounding the first chamber to regulate a temperature of the liquid in the first chamber, wherein the second chamber is separate from the first chamber;

mixing the liquid in the second chamber to enhance temperature uniformity of the liquid in the second chamber;

measuring the temperature of the liquid in the first chamber by means of the temperature sensor; and

calibrating the temperature sensor based on a measurement result,

wherein mixing the liquid in the second chamber comprises circulating the liquid in the second chamber through a plurality of inlets and a plurality of outlets disposed along a height of the second chamber.

22. The method as claimed in claim 21, wherein mixing the liquid in the second chamber comprises mixing with an agitator.

23. The method as claimed in claim 21 or 22, wherein measuring a temperature of the liquid in the first chamber comprises simultaneously measuring a liquid reference temperature of a reference temperature sensor inserted in the first chamber and a resistance of a to-be-calibrated temperature sensor inserted in the first chamber.

24. The method as claimed in claim 23, wherein simultaneously measuring comprises synchronized sampling of reference temperature data of the reference temperature sensor and resistance data of the to-be-calibrated temperature sensor with an electronic module having a data acquisition unit and a plurality of input channels.

25. The method as claimed in claim 23 or 24, wherein simultaneous measuring is performed at more than three temperature points.

26. The method as claimed in claim 25, wherein calibrating the temperature sensor comprises determining Steinhart-hart coefficient based on a multi-point fitting algorithm.

27. The method as claimed in claim 26, wherein the multi-point fitting algorithm comprises multi-point least square algorithm.

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