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# The Effect of Different Liquid on Temperature Uniformity and Stability in Microbath 7102

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**Abstract**

Microbath Fluke Type 7102 is used for thermometer calibration. In the calibration process, Microbath uses liquid media as heat conductor. Liquid media in Microbath during the calibration process there is a value of uniformity and temperature stability. The value of temperature uniformity and stability is an influential component in determining the value of measurement uncertainty ($U_{95}$). The smaller the $U_{95}$ value, the better the calibration results. This is a factor in this study to analyse the uniformity and temperature stability of liquid types of Water, Methanol and Glycol. The uniformity test method is carried out using 5 (five) point measurements, where the reference point is in the middle. The stability test method uses the measurement of one reference point. Uniformity and stability values are connected to determine the uncertainty of measurement value using the GUM (Guide to the expression of Uncertainty in Measurement) method. The analysis showed that Methanol is more homogeneous than Glycol and Water, with values of 0.0855 ºC < 0.0942 ºC < 0.1030 ºC. Water is more stable than Methanol and Glycol, with values of 0.0021 ºC < 0.0027 ºC < 0.0028 ºC. The time to stabilise Methanol is better than Water and Glycol. Methanol can be stabilised with ± 35 - 40 minutes, Water needs ± 38 - 40 minutes and Glycol needs ± 48 - 50 minutes. The relationship between uniformity and temperature stability is that the smaller the uniformity and stability values, the smaller the $U_{95}$ of a calibration result. The $U_{95}$ value of Methanol 0.11 ºC, Glycol 0.12 ºC and Water is 0.13 ºC.

**Keywords:** Uniformity, Stability, Uncertainty of Measurement ($U_{95}$), Microbath 7102

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## INTRODUCTION

Thermometers are one of the main sensors for temperature measurement in weather observation parameters. The Meteorology, Climatology and Geophysics Agency (BMKG) has thousands of temperature sensors from analog to digital types that are used for maritime meteorological measurements, synoptic to upper air observations. According to UU No. 31/2009, weather observation equipment within BMKG must be calibrated regularly once a year to obtain accurate and valid data. This refers to the World Meteorological Organization (WMO) standard in WMO No.18 of 2021 (WMO, 2021). To support these programs, BMKG has 5 Calibration Laboratories accredited by KAN for the implementation of ISO/IEC 17025:

2017 in Indonesia, one of which is the calibration laboratory of the Center for Meteorology, Climatology and Geophysics (BBMKG) Region I Medan.

The calibration laboratory of the Center for Meteorology Climatology and Geophysics Region I Medan calibrates thermometers, one of which is the Fluke Type 7102 Microbath using liquid media. Y.P Singh (2009) states that in metrology, liquid temperature baths are the most useful and are the best source for equilibrium temperatures for comparison of high-resolution thermometers and other precision sensors. Although liquid is the best temperature bath compared to gas or solid media, during the calibration process the liquid is still affected by the stability and uniformity of the bath temperature during measurement.

The stability of the bath varies at different temperatures throughout its measurement range. Stability and uniformity are components that depend on several parameters such as temperature range, viscosity of the liquid used, thermal conductivity, type of temperature controller, amount of liquid volume. The temperature bath should have a homogeneous temperature throughout the test zone where the comparison is performed. When two or more temperature sensors are placed in a chamber at the same immersion level, the measured temperature should be the same throughout the measurement (Y.P. Singh, et al, 1991).

Uniformity largely depends on the stirring process, how well it circulates in a uniform direction forming isothermal conditions. Baths can have good stability but poor uniformity. This parameter is critical for uncertainty as it is required for thermometers to compare at equilibrium conditions in liquid baths (Brown, 2005).

The stability and uniformity of thermal sources play an important role in the estimation of uncertainty in measurements. As J.V.Nicholas (1994) states the two most important metrological characteristics of calibration baths are time stability and homogeneity, both of which contribute to type B uncertainty. When calibration baths are used with different types of media used in the same bath, the stability and homogeneity of these media must be evaluated separately to determine the uncertainty due to inhomogeneity of the appropriate calibration bath (Drnovšek et al., 1997).

Liza Indrayani ang Margi Sasono et al (2017) have conducted research on an enclosure that evaluates homogeneity uncertainty and temperature stability using water media. The uncertainty of temperature homogeneity in the range (8.38 - 9.09) °C is 0.97°C. Meanwhile, in the temperature range of (49.02 -49.68)°C, the temperature homogeneity uncertainty was 0.33°C. Calibration at an average temperature of 8.23 ° C with an uncertainty of temperature homogeneity of 0.97 ° C obtained a digital thermometer calibration uncertainty of 2.00 ° C. Meanwhile, at an average temperature of 49.86 ° C with an uncertainty of temperature homogeneity of 0.33 ° C, a digital thermometer calibration uncertainty of 0.85 ° C is obtained.

In laboratory activities, the uniformity and stability values are updated annually to calculate the measurement uncertainty value (U95). The measurement uncertainty value for thermometers based on WMO standards should be < 0.2 ° C (WMO, 2021). Based on this, research was developed for different types of liquid, namely Water, Methanol and Glycol because they have different physical properties (Fluke Coorperations, 2019). The goal is to obtain the smallest stability and homogeneity values. The smaller the value of uniformity and temperature stability, the smaller the measurement uncertainty value. The smaller the measurement uncertainty value, the closer the true value, so the more accurate the calibration results of a thermometer. The importance of accurate results from the thermometer encourages research in determining the use of the best type of liquid.

## METHOD

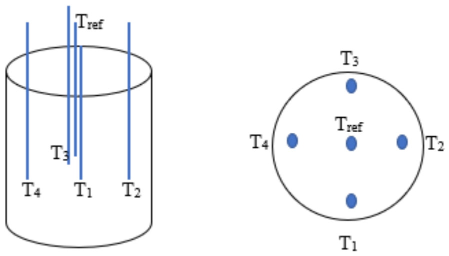
The temperature uniformity and stability test was carried out by the Calibration Laboratory of the KAN accredited Balai Besar Meteorologi Klimatologi dan Geofisika Wilayah I with accreditation number LK-095-IDN. Sensors and materials used include:

- Media : Micro-Bath Merk Fluke Tipe 7102 SN. B5B319, Resolution 0,01 °C

(Traced : LK-095-IDN Medan)
- Trefrence : Thermometer Digital Merk Fluke Hart Scientific 5626 SN. 3978, Resolution 0.0001 °C (Traced: LK-095-IDN Jakarta)
- T1 = T2 : Thermometer Digital Merk Fluke Hart Scientific 5615 SN. 935274, Resolution 0.01 (Tertelusur : LK-095-IDN Lokasi Medan)
- T3 = T4 : Thermometer Digital Merk Fluke Hart Scientific 5627A SN. 943933, Resolution 0,01°C (Tertelusur : LK-095-IDN Lokasi Medan)
- Liquid : Water, Methanol and Glycol

**Uniformity Test**

The temperature uniformity test on Microbath 7102 with dimensions of 31cm x 18 cm x 24 cm was carried out with 5 measurement points anad the centre point as a reference. This temperature uniformity test was carried out in a conditioned room with a temperature of 20 ° C - 25 ° C and 40 - 70 %RH.




a. Front view b. Top view

Figure 1 - Microbath homogeneity test

Description:
- position T1, T2, T3, T4 (comparison tool), ± 3 cm from Tref
- Tref position (reference tool) is in the middle of Microbath

*Thai Laboratory Acreditation Scheme* (2008) states that temperature homogeneity is the maximum difference between a thermometer at a reference point (centre point) and another thermometer at a stable state.

$$T_{hom} = max\,|Tref - Ti\,| \tag{1}$$

where :
- $Tref$ : the temperature shown by the reference thermometer
- $Ti$ : the temperature shown by another thermometer as a comparison to the temperature of the reference thermometer

Temperature homogeneity is a type B standard uncertainty source with a rectangular distribution so that its uncertainty is 1√3 of its temperature homogeneity value. So that the temperature homogeneity uncertainty equation can be formulated as follows:

$$u\,(T_{hom.}) = \frac{Thom.}{\sqrt{3}} \tag{2}$$

where :
- U ($T_{hom.}$) : uncertainty of homogeneity

**Stability Test**

The temperature stability test on Microbath 7102 was carried out using one sensor at the centre point by taking 10 repetition data that had been stable and recorded the starting time and stable time.

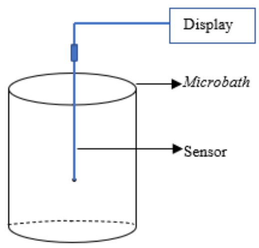



Figure 2 - Microbath stability test

*Thai Laboratory Acreditation Scheme* (2008) states that the temperature stability is half of the maximum difference at each sensor. Stability can be formulated in the following equation:

$$T_{stab.} = \left|\frac{|\mathrm{Tmax} - \mathrm{Tmin}|}{2}\right| \quad (3)$$

where :
- $Tstab$ : temperature stability in a certain period
- $Tmax$,min : are the maximum and minimum temperatures shown by the thermometer during the period.

Temperature stability is a type B standard uncertainty source with a rectangular distribution so that its uncertainty is 1√3 of its temperature stability value. So the following uncertainty equation can be formulated:

$$u\,(T_{stab.}) = \frac{Tstab}{\sqrt{3}} \quad (4)$$

where :
- $u\,(T_{stab.})$ : uncertainty of stability

**Uncertainty of Measurement**

The uncertainty of measurement method uses the GUM (*Guide to the expression of Uncertainty in Measurement*) method which is summarised in the following steps:

1) Determination of the measurand and measurement model

$$y = f(x_1, x_2, \ldots\ldots x_n) \quad (5)$$

2) Determination of sources of uncertainty such as the influence of environmental conditions, media, measuring instruments, operators and so on
3) Determination of Type A and Type B standardised uncertainty evaluation. Type A uncertainty is an evaluation that deals with sources of uncertainty from statistical analyses. The uncertainty is expressed in the equation

$$u(x) = s(\bar{x}) = \frac{s(x)}{\sqrt{n}} \quad (6)$$

Type B standard uncertainty is usually determined based on scientific research from all available external information, such as: previous measurement data, general knowledge of the measuring instrument, manufacturer specifications, calibration data, reference data taken from handbooks.

4) Determination of the combined standardised uncertainty $uc$(y) using the equation:

$$u_c(y) = \sqrt{z\left[\sum_{i=1}^{N} c_i u_i(x_i)\right]^2} \quad (7)$$

5) Determination of effective degrees of freedom $veff$ using the equation:

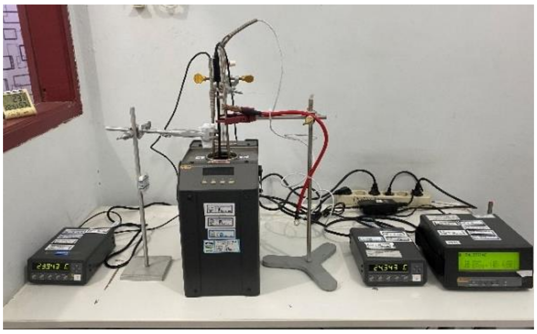
$$v_{eff} = \frac{u_y^4}{\sum_{i=1}^{N} \frac{u_{x_i}^4}{v_{x_i}}} \quad (8)$$

6) Determination of the uncertainty of the stretch $U$ using the equation:

$$U_y = k\, u_y \quad (9)$$

**RESULTS AND DISCUSSION**

Microbath homogeneity and stability tests have been carried out at a set point of 10°C ~ 50°C for each type of liquid. Data collection was carried out by recording 10 data that had been stabilised. The homogeneity and stability testing process can be seen in Figure 3. Inhomogeneity data is processed based on equations (1) and (2), stability data is processed based on equations (3) and (4), and measurement uncertainty data is processed based on the GUM method. Homogeneity, stability and measurement uncertainty data are described based on the type of liquid as followsas follows:



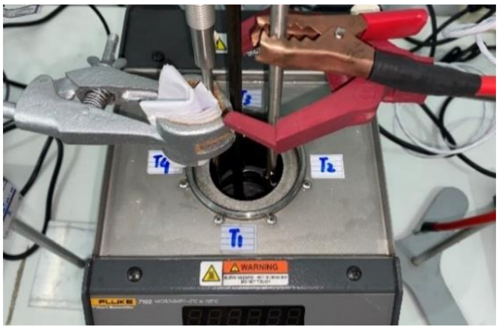



Figure 3 - Microbath homogeneity and stability test process

**Water**

The results of the temperature inhomogeneity test on water are presented in Table 1.

Table 1 Temperature inhomogeneity of water

| Set point (°C) | T1 (°C) | T2 (°C) | T3 (°C) | T4 (°C) |
|---|---|---|---|---|
| 0 | 0,037 | 0,034 | 0,004 | 0,001 |
| 10 | 0,016 | 0,015 | 0,048 | 0,049 |
| 20 | 0,036 | 0,033 | 0,018 | 0,021 |
| 30 | 0,044 | 0,047 | 0,018 | 0,024 |
| 40 | 0,031 | 0,029 | 0,011 | 0,074 |
| 50 | 0,042 | 0,051 | **0,103** | 0,099 |
| Inhomogenity (°C) | 0,103 | | | |

Based on the data in Table 1, the inhomogeneity value of water is 0.082°C. This value is taken from the absolute maximum value of each measurement point from each set point. Based on this, the measurement at point T4 at a set point of 50 ° C is a greater value of inhomogeneity. At a set point of 50°C, the inhomogeneity value is generally greater than the set point below. This happens because of the nature of water that evaporates when heated, thus increasing the value of non-uniformity in the cooker bath. The inhomogeneity data at each set point and each measurement point can be seen in graphical form in Figure 4.

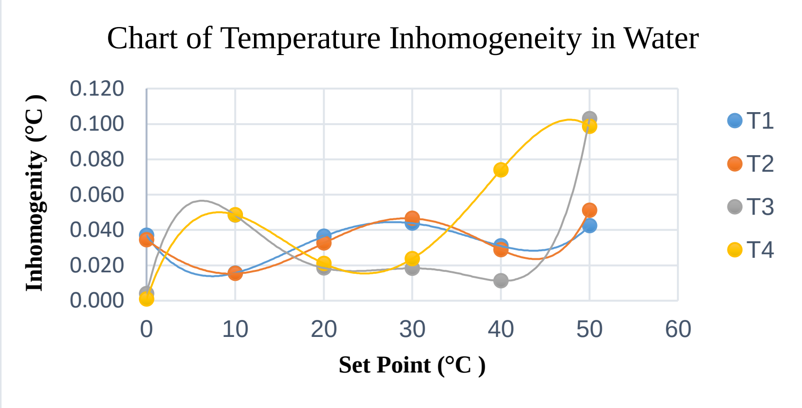



Figure 4 - Chart of temperature inhomogeneity in Water

The results of the temperature stability test on water are presented in Table 2

Table 2 Temperature stability of water

| Set Point (°C) | 0 | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|
| Temperature Stability Value (°C) | 0,0017 | 0,0009 | **0,0021** | 0,0011 | 0,0020 | 0,0014 |
| | 0,0021 | | | | | |
| Stable Time | 38 ~ 40 menit | | | | | |

Based on the data in Table 2, the stability value of water is 0.0021°C. This value indicates that Microbath with water media is quite stable because the value of half of the maximum difference to the minimum is quite small. To achieve stability requires an average time of 38 ~ 40 minutes with measurement conditioning is an increase of every 10 °C.

Water temperature inhomogeneity data of 0.103 ºC and water temperature stability of 0.0021ºC are inputted into the uncertainty measurement with the GUM method. The results of measurement uncertainty ($U_{95}$) for Water is 0.13 ºC presented in Table 3

Table 3 Uncertainty of measurement ($U_{95}$) of water

| Uncert source/ Komponen | Unit/ Satuan | Distribusi | Symbol | U atau a | Cov. Factor/ Pembagi | Deg. of freedom/ vi | Std. Uncert/ ui | Sens. Coeff/ ci | $c_i.u_i$ | $(c_i.u_i)^2$ | $(c_i.u_i)^4/v_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| repeat | ºC | normal | $u_{rep.}$ | 0,0056 | 2,000 | 3 | 0,00281525 | 1 | 0,00282 | 7,93E-06 | 2,09E-11 |
| sertifikat std | ºC | normal | $u_{sertf.}$ | 0,0580 | 2,000 | 60 | 0,02900000 | 1 | 0,02900 | 8,41E-04 | 1,18E-08 |
| drift std | ºC | rectangular | $u_{drift}$ | 0,0084 | 1,732 | 50 | 0,00484974 | 1 | 0,00485 | 2,35E-05 | 1,11E-11 |
| resolusi std | ºC | rectangular | $u_{resolusi\ std}$ | 0,0001 | 1,732 | 50 | 0,00002887 | 1 | 0,00003 | 8,33E-10 | 1,39E-20 |
| deviasi std | ºC | rectangular | $u_{deviasi\ std}$ | 0,0002 | 1,732 | 50 | 0,00011547 | 1 | 0,00012 | 1,33E-08 | 3,56E-18 |
| resolusi alat | ºC | rectangular | $u_{resolusi\ alat}$ | 0,0050 | 1,732 | 50 | 0,00288675 | 1 | 0,00289 | 8,33E-06 | 1,39E-12 |
| deviasi alat | ºC | rectangular | $u_{deviasi\ alat}$ | 0,0050 | 1,732 | 50 | 0,00288675 | 1 | 0,00289 | 8,33E-06 | 1,39E-12 |
| **Stabilitas** | **ºC** | **rectangular** | $\mathbf{u_{stabilitas}}$ | **0,0021** | 1,732 | 50 | 0,00121244 | 1 | 0,00121 | 1,47E-06 | 4,32E-14 |
| **inhomogenitas** | **ºC** | **rectangular** | $\mathbf{u_{media}}$ | **0,1030** | 1,732 | 50 | 0,05946708 | 1 | 0,05947 | 3,54E-03 | 2,50E-07 |
| | | | | | | | | Sums | 4,43E-03 | 4,43E-03 | 2,62E-07 |
| | | | | | | | | Comb. uncert, uc | | 6,65E-02 | |
| | | | | | | | | Eff. Deg of freedom, veff | | | 74,8187 |
| | | | | | | | | Cov. Factor for 95% CL | | | 1,99 |
| | | | | | | | | Expanded uncertainty, U95 | | | 0,13 |

## Glikol

The results of the temperature inhomogeneity test on glycol are presented in Table 4.

Tabel 4 Temperature inhomogeneity of glycol

| Set point (°C) | T1 (°C) | T2 (°C) | T3 (°C) | T4 (°C) |
|---|---|---|---|---|
| 0 | 0,072 | 0,038 | 0,015 | 0,065 |
| 10 | 0,019 | 0,018 | 0,049 | 0,047 |
| 20 | 0,034 | 0,043 | 0,020 | 0,036 |
| 30 | 0,038 | 0,041 | 0,015 | 0,014 |
| 40 | 0,045 | 0,032 | 0,028 | 0,017 |
| 50 | 0,047 | 0,047 | **0,094** | **0,094** |
| Inhomogenity (°C) | **0,094** | | | |

Based Based on the data in Table 4, the inhomogeneity value of glycol is 0.094°C. This value is taken from the absolute maximum value of each measurement point from each set point. Based on this, measurements at points T3 and T4 at a set point of 50 ° C are the greater value of inhomogeneity. At a set point of 50°C, the inhomogeneity value is generally greater than the set point below. This occurs due to the nature of glycol which evaporates when heated, thus increasing the value of non-uniformity in the bath of the heater. The inhomogeneity data at each set point and each measurement point can be seen in graphical form in Figure 5.

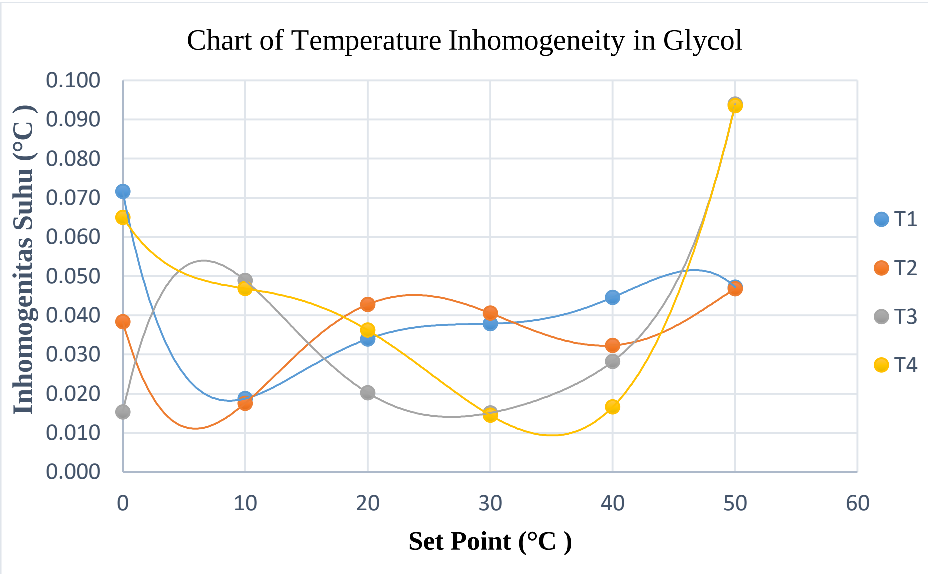



Figure 5- Chart of Temperature Inhomogeneity in Glycol

The results of the temperature stability test on glycol are presented in table 5 below

Tabel 5 Temperature stability of glycol

| Set Point (°C) | 0 | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|
| Temperature Stability Value (°C) | 0,0012 | 0,0009 | 0,0014 | 0,0014 | **0,0028** | 0,0021 |
| | 0,0028 | | | | | |
| Stable Time | 46 ~ 50 mnt | | | | | |

Based on the data in Table 5, the stability value of glycol is 0.0028°C. This value shows that Microbath with glycol media is still quite stable because the value of half of the maximum difference to the minimum is quite small. Although the stability value of glycol is greater than water by 0.0007°C. To achieve stable glycol requires an average time of 46 ~ 50 minutes with measurement conditioning is an increase of every 10 °C. Glycol takes longer to stabilise than water because the viscosity value of glycol is greater than water. *The 7102 Micro-Bath User's Guid*e (2019) states that the viscosity value of glycol is 0.7 centistokes while water is 0.4 centistokes. The smaller the viscosity the easier the liquid circulates the easier the heat is delivered throughout the bath (Y.P Sing, et al, 1991).

Glycol temperature inhomogeneity data of 0.0942ºC and glycol temperature stability of 0.0028ºC are inputted into the uncertainty measurement with the GUM method. The results of measurement uncertainty ($U_{95}$) for liquid media type glycol of 0.12 ºC are presented in Table 6.

Tabel 6 Uncertainty of measurement ($U_{95}$) of glycol

| Uncert source/ Komponen | Unit/ Satuan | Distribusi | Symbol | U atau a | Cov. Factor/ Pembagi | Deg. of freedom/ vi | Std. Uncert/ ui | Sens. Coeff/ ci | $c_i.u_i$ | $(c_i.u_i)^2$ | $(c_i.u_i)^4/v_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| repeat | ºC | normal | $u_{rep.}$ | 0,0056 | 2,000 | 3 | 0,00281525 | 1 | 0,00282 | 7,93E-06 | 2,09E-11 |
| sertifikat std | ºC | normal | $u_{sertf.}$ | 0,0580 | 2,000 | 60 | 0,02900000 | 1 | 0,02900 | 8,41E-04 | 1,18E-08 |
| drift std | ºC | rectangular | $u_{drift}$ | 0,0084 | 1,732 | 50 | 0,00484974 | 1 | 0,00485 | 2,35E-05 | 1,11E-11 |
| resolusi std | ºC | rectangular | $u_{resolusi\ std}$ | 0,0001 | 1,732 | 50 | 0,00002887 | 1 | 0,00003 | 8,33E-10 | 1,39E-20 |
| deviasi std | ºC | rectangular | $u_{deviasi\ std}$ | 0,0002 | 1,732 | 50 | 0,00011547 | 1 | 0,00012 | 1,33E-08 | 3,56E-18 |
| resolusi alat | ºC | rectangular | $u_{resolusi\ alat}$ | 0,0050 | 1,732 | 50 | 0,00288675 | 1 | 0,00289 | 8,33E-06 | 1,39E-12 |
| deviasi alat | ºC | rectangular | $u_{deviasi\ alat}$ | 0,0050 | 1,732 | 50 | 0,00288675 | 1 | 0,00289 | 8,33E-06 | 1,39E-12 |
| **Stabilitas** | **ºC** | **rectangular** | $u_{stabilitas}$ | **0,0028** | 1,732 | 50 | 0,00161658 | 1 | 0,00162 | 2,61E-06 | 1,37E-13 |
| **inhomogenitas** | **ºC** | **rectangular** | $u_{media}$ | **0,0942** | 1,732 | 50 | 0,05438640 | 1 | 0,05439 | 2,96E-03 | 1,75E-07 |
| | | | | | | | | Sums | | 3,85E-03 | 1,87E-07 |
| | | | | | | | | Comb. uncert, uc | | 6,20E-02 | |
| | | | | | | | | Eff. Deg of freedom, veff | | | 79,3322 |
| | | | | | | | | Cov. Factor for 95% CL | | | 1,99 |
| | | | | | | | | Expanded uncertainty, U95 | | | **0,12** |

## Methanol

The results of the temperature inhomogeneity test on methanol are presented in Table 7

Tabel 7 Temperature inhomogeneity of methanol

| Set point (°C) | T1 (°C) | T2 (°C) | T3 (°C) | T4 (°C) |
|---|---|---|---|---|
| 0 | 0,052 | 0,044 | 0,048 | 0,020 |
| 10 | 0,002 | 0,005 | 0,059 | 0,062 |
| 20 | 0,042 | 0,041 | 0,020 | 0,028 |
| 30 | 0,068 | 0,005 | 0,026 | 0,051 |
| 40 | 0,054 | 0,036 | 0,048 | 0,021 |
| 50 | 0,072 | 0,040 | 0,066 | **0,086** |
| Inhomogenity (°C) | 0,086 | | | |

Based on the data in Table 7, the inhomogeneity value of methanol is 0.086 °C. This value is taken from the absolute maximum value of each measurement point from each set point. Based on this, the measurement at point T4 at a set point of 50 °C is a greater value of inhomogeneity. At a set point of 50°C, the inhomogeneity value is generally greater than the set point below. This is due to the nature of methanol which evaporates when heated, thus increasing the value of non-uniformity in the analyser bath. The inhomogeneity data at each set point and each measurement point can be seen in graphical form in Figure 6.

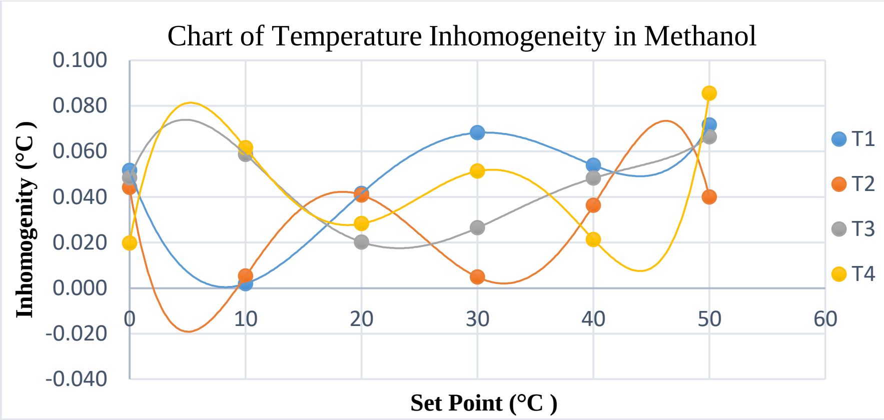


Figure 6 - Chart of temperature inhomogeneity in methanol

The results of the temperature stability test on Methanol are presented in Table 8

Tabel 8 Temperature stability of methanol

| Set Point | 0 | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|
| Temperature Stability Value (°C) | 0,0014 | **0,0027** | 0,0017 | 0,0021 | 0,0021 | 0,0023 |
| | 0,0027 | | | | | |
| Stable Time | 35 ~ 40 mnt | | | | | |

Based on the data in Table 8, the stability value of methanol is 0.0027°C. This value shows that Microbath with methanol media is still quite stable because the value of half of the maximum difference to the minimum is quite small. Although the stability value of methanol is greater than water by 0.0006°C. To achieve stable methanol requires an average time of 35 ~ 40 minutes with measurement conditioning is an increase of every - every 10 °C.

Methanol temperature inhomogeneity data of 0.086ºC and Methanol temperature stability of 0.0027ºC were inputted into the uncertainty measurement with the GUM method. The results of measurement uncertainty ($U_{95}$) for liquid media type Methanol of 0.11 ºC are presented in Table 9.

Tabel 9 Uncertainty of Measurement ($U_{95}$) of Methanol

| Uncert source/ Komponen | Unit/ Satuan | Distribusi | Symbol | U atau a | Cov. Factor/ Pembagi | Deg. of freedom/ vi | Std. Uncert/ ui | Sens. Coeff/ ci | $c_i.u_i$ | $(c_i.u_i)^2$ | $(c_i.u_i)^4/v_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| repeat | ºC | normal | $u_{rep.}$ | 0,0056 | 2,000 | 3 | 0,00281525 | 1 | 0,00282 | 7,93E-06 | 2,09E-11 |
| sertifikat std | ºC | normal | $u_{sertf.}$ | 0,0580 | 2,000 | 60 | 0,02900000 | 1 | 0,02900 | 8,41E-04 | 1,18E-08 |
| drift std | ºC | rectangular | $u_{drift}$ | 0,0084 | 1,732 | 50 | 0,00484974 | 1 | 0,00485 | 2,35E-05 | 1,11E-11 |
| resolusi std | ºC | rectangular | $u_{resolusi\ std}$ | 0,0001 | 1,732 | 50 | 0,00002887 | 1 | 0,00003 | 8,33E-10 | 1,39E-20 |
| deviasi std | ºC | rectangular | $u_{deviasi\ std}$ | 0,0002 | 1,732 | 50 | 0,00011547 | 1 | 0,00012 | 1,33E-08 | 3,56E-18 |
| resolusi alat | ºC | rectangular | $u_{resolusi\ alat}$ | 0,0050 | 1,732 | 50 | 0,00288675 | 1 | 0,00289 | 8,33E-06 | 1,39E-12 |
| deviasi alat | ºC | rectangular | $u_{deviasi\ alat}$ | 0,0050 | 1,732 | 50 | 0,00288675 | 1 | 0,00289 | 8,33E-06 | 1,39E-12 |
| **Stabilitas** | **ºC** | **rectangular** | $\mathbf{u_{stabilitas}}$ | **0,0027** | 1,732 | 50 | 0,00155885 | 1 | 0,00156 | 2,43E-06 | 1,18E-13 |
| **inhomogenitas** | **ºC** | **rectangular** | $\mathbf{u_{media}}$ | **0,0855** | 1,732 | 50 | 0,04936345 | 1 | 0,04936 | 2,44E-03 | 1,19E-07 |
| | | | | | | | | Sums | | 3,33E-03 | 1,31E-07 |
| | | | | | | | | Comb. uncert, uc | | 5,77E-02 | |
| | | | | | | | | Eff. Deg of freedom, veff | | | 84,8353 |
| | | | | | | | | Cov. Factor for 95% CL | | | 1,99 |
| | | | | | | | | Expanded uncertainty, U95 | | | **0,11** |

Based on the data, the values of inhomogeneity, stability, uncertainty of measurement and stable time of each liquid are summarized in Tabel 10

Table 10 Values of Inhomogeneity, Stability, Uncertainty of Measurement and Stable Time

| Liquid | Inhomogeneity (ºC) | Stability (ºC) | $U_{95}$ (ºC) | Stable Time |
|---|---|---|---|---|
| Water | 0,1030 | 0,0021 | 0,13 | 38 ~ 40 mnt |
| Glycol | 0,0942 | 0,0028 | 0,12 | 46 ~ 50 mnt |
| Methanol | 0,0855 | 0,0027 | 0,11 | 35 ~ 40 mnt |

Based on the data generated, the values of inhomogeneity and temperature stability of each measurement point and each set point are different. The value of temperature inhomogeneity, temperature stability, stable time and measurement uncertainty value are also different from each type of liquid. The uncertainty value of methanol is smaller than water and glycol. So the use of methanol can be a reference for the type of media used for the Bath type calibration process. The determination of the smallest uncertainty value is better based on the smaller the uncertainty, the higher the accuracy of a measurement (Brown, 2005).

## CONCLUSION

The difference in liquid type affects the uniformity and temperature stability in Microbath 7102. Methanol is more homogeneous than Glycol and water, with values of 0.0855ºC < 0.0942ºC < 0,1030ºC. The difference in homogeneity is influenced by environmental conditions and physical properties of each liquid such as specific heat, thermal conductivity, thermal expansion, viscosity and density.

Water is more stable than Methanol and Glycol, with values of 0.0021 ºC < 0.0027 ºC < 0.0028 ºC. The time to stabilise Methanol is better than Water and Glycol. Methanol can be stabilised with ± 35 - 40 minutes, water needs ± 38 - 40 minutes and glycol needds ± 48 - 50 minutes.

The relationship between uniformity and temperature stability is that the smaller the uniformity and stability values, the smaller the $U_{95}$ of a calibration result. The smaller the $U_{95}$ the more accurate the calibration results. The $U_{95}$ value of methanol 0.11 ºC, glycol 0.12 ºC and water is 0.13ºC,

## RECOMMENDATION

For the improvement and development of this research, it is necessary to test the uniformity and stability of temperature based on the depth of the Microbath and it is necessary to analyse the effect of an increase or decrease of 1ºC in the calibration room on the value of uniformity and stability.

## REFERENCES

Brown. (2005). Understanding and Expressing Measurement Uncertainties Associated with Thermodynamic Metrology. In Quality System Lab (pp. 1–4).

Deutscher Kalibrierdienst.(2004). Guideline DKD-R 5-7 Calibration of Climatic Chambers. www.dkd.eu

Fatwasauri, I., Erawati, S. T., Sasono, M., & Surakusumah, R. F. (2021). Evaluasi ketidakpastian pengukuran dalam kalibrasi termometer digital menggunakan persamaan regresi kalibrasi. Komunikasi Fisika Indonesia, 18(2), 131. https://doi.org/10.31258/jkfi.18.2.131-136

Fluke Coorporation. (2019). 7102 Micro-Bath User's Guide.

Indrayani, L., & Sasono, M. (2017). Uji Homogenitas dan Stabilitas Suhu Mini Liquid Bath untuk Kalibrasi Termometer Digital Makanan. Prosiding SNFA (Seminar Nasional Fisika Dan Aplikasinya), 1–13.

ISO/IEC 17025. (2017). General requirements for the competence of testing and calibration laboratories (Third).

JCGM 100. (2008). Evaluation of measurement data-Guide to the expression of uncertainty in measurement. www.bipm.org

J. Drnovs'ek. (1997). A General Procedure for Evaluation of Calibration Baths in Precision Temperature Measurements. IEEE Instrumentation and Measurement Technology Conference, 19–21. https://doi.org/0-7803-3312 -8/9

J. V. Nicholas & D. R. White. (1994). Traceable Temperatures: An Introduction to Temperature Measurement and Calibration. John Willey & Sons.

Kaatze, U. (2007). Reference liquids for the calibration of dielectric sensors and measurement instruments. Measurement Science and Technology, 18(4), 967–976. https://doi.org/10.1088/0957-0233/18/4/002

Komite Akreditasi Nasional. (2019). Pedoman Kalibrasi Enklosur Suhu. http://www.bsn.or.id

Mikko Tervala. (2020). Portable Field Temperature Calibration System. Metropolia University of Applied Sciences.

Nely Ana Mufarida. (2019). Perpindahan Panas1 : Konsep dan Penerapannya. CV Pustaka Badi.

Thai Laboratory Accreditation Scheme. (2008). Publication Reference G-20 Guidelines for Calibration and Checks of Temperature Controlled Enclosures.

WMO. (2021). Guide to Instruments and Methods of Observationorological Instruments and Methods of Observation. World Meteorological Organization (2021st ed.).

Y.P Singh. (2009). Basic Concepts in Temperature Metrology: Formulation and Importance of the International Temperature Scales. Global Sci-Tech., Al-Falah's J. Sci. Technol, 4, 191–214.

Y.P. Singh, V. P. W. P. R. S. and Z. H. Z. (1991). Heat Pipe Extension Bath for Calibration of Long Stem Reference Thermometers Against the Standard Platinum Resistance Thermometer. Indian Journal of Pure & Applied Physics (IJPAP), 459–462.

Žužek, V., & Pušnik, I. (2017). Calibration of Air Thermometers in a Climatic Chamber and Liquid Baths. International Journal of Thermophysics, 38(7). https://doi.org/10.1007/s10765-017-2234-6