

ABSTRAK

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PENERAPAN PERSAMAAN MAGNUS PADA PENGUKURAN *SPATIAL INHOMOGENEITY* DAN *TEMPORAL INSTABILITY* SUHU DAN KELEMBABAN *CLIMATIC CHAMBER* DENGAN KONDISI *LOAD - UNLOAD*
xxi + 124 halaman + 25 tabel + 3 Lampiran

Climatic chamber merupakan perangkat yang dirancang untuk mengendalikan suhu dan kelembapan secara presisi, sehingga banyak digunakan dalam kalibrasi thermohygrometer. Ketidakpastian hasil pengukuran dipengaruhi oleh kestabilan temporal dan keseragaman spasial, sehingga kedua parameter ini penting untuk dievaluasi. Penelitian ini menganalisis pengaruh kondisi tanpa beban (*unload*) dan dengan beban (*load*) terhadap performa chamber. Pengujian dilakukan pada kondisi 25 °C dan 50 %RH dengan sistem akuisisi data berbasis ESP32 yang dilengkapi sembilan sensor termokopel tipe T dan satu sensor SHT45 sebagai acuan. Data kelembapan dihitung menggunakan persamaan Magnus, ditampilkan secara real-time pada LCD-TFT, disimpan di Google Spreadsheet, dan divisualisasikan melalui Node-RED. Hasil menunjukkan bahwa sensor termokopel memerlukan koreksi maksimum -0,31 °C, sedangkan SHT45 menunjukkan koreksi 0,10 °C dengan ketidakpastian ±0,25 °C. Pada pengukuran kelembapan, deviasi awal -6,7 %RH berhasil dikurangi menjadi -1,7 %RH setelah dilakukan regresi linear sederhana dengan persamaan $Y = 1,1188X - 11,8372$ dan koefisien determinasi $R^2 = 0,99997$. Kondisi *load* menghasilkan stabilitas suhu 0,08 °C dan kelembapan 0,31 %RH yang lebih baik dibanding *unload* (0,11 °C dan 0,35 %RH), namun diikuti peningkatan ketidakseragaman spasial baik pada suhu maupun kelembapan. Pengujian ini membuktikan bahwa keberadaan beban dapat memperbesar Spatial Inhomogeneity, tetapi memperkecil Temporal Instability. Dengan hasil stabilitas yang masih berada dalam batas toleransi spesifikasi, kinerja chamber dinyatakan memenuhi standar. Hal ini mengindikasikan bahwa faktor beban perlu diperhatikan dalam kalibrasi thermohygrometer karena berpotensi memengaruhi ketidakpastian pengukuran.

Kata Kunci : Climatic Chamber, *Temporal Instability & Spatial Inhomogeneity*, Relative Humidity, ESP32, Persamaan Magnus

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ABSTRACT

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**APPLICATION OF THE MAGNUS EQUATION IN THE MEASUREMENT OF
SPATIAL INHOMOGENEITY AND TEMPORAL INSTABILITY OF
TEMPERATURE AND HUMIDITY IN A CLIMATIC CHAMBER UNDER LOAD –
UNLOAD CONDITIONS**

xix + 124 pages + 25 tables + 3 appendices

A climatic chamber is a device designed to control temperature and humidity with high precision, and therefore is widely used in thermohygrometer calibration. The uncertainty of measurement results is influenced by temporal stability and spatial uniformity, making both parameters essential to evaluate. This study analyzes the effect of unload and load conditions on chamber performance. The testing was conducted at 25 °C and 50 %RH, with a data acquisition system based on ESP32 equipped with nine type-T thermocouples and one SHT45 sensor as reference. Relative humidity was calculated using the Magnus equation, displayed in real time on an LCD-TFT, stored in Google Spreadsheet, and visualized via Node-RED. The results showed that the thermocouple sensors required a maximum correction of – 0.31 °C, while the SHT45 required 0.10 °C with an uncertainty of ±0.25 °C. For humidity measurement, the initial deviation of –6.7 %RH was successfully reduced to –1.7 %RH after applying a simple linear regression with the equation $Y = 1.1188X - 11.8372$ and a determination coefficient of $R^2 = 0.99997$. Under load condition, temperature stability of 0.08 °C and humidity stability of 0.31 %RH were achieved, which were better than in unload condition (0.11 °C and 0.35 %RH), although accompanied by increased spatial inhomogeneity for both temperature and humidity. This study demonstrates that the presence of load decreases temporal instability but increases spatial inhomogeneity. Since the stability results remain within the specified tolerance limits, the chamber performance is confirmed to meet the standard. These findings indicate that load factors should be carefully considered in thermohygrometer calibration, as they may affect measurement uncertainty.

*Keywords: Climatic Chamber, Temporal Instability & Spatial Inhomogeneity,
Relative Humidity, ESP32, Magnus Equation*

References: 21 Journals (2018–2024)