



## Summary Report of INMETRO Activities on Thermometry and Hygrometry from 2017 to 2020

### *Contact Thermometry*

- Participation in CCT-K9.
- Collaboration with NIST on the evaluation of SF6 triple point cells.
- Peer reviewed in May 2019.
- ITS-90 training to technicians from Trinidad and Tobago Bureau of Standards – TTBS.
- Development of a new open zinc fixed point cell.
- Local pilot in a bilateral comparison with Trinidad and Tobago Bureau of Standards – TTBS (SIM.T-K9.3). Measurements completed.
- Acquisition of a quartz water triple point cell with isotopic analysis certificate.

### *Radiation Thermometry*

- Recent membership in CCT-WG-NCTh and CCT-WG-BTM.
- Manufacture of a low temperature blackbody cavity and testing of forehead infrared thermometers.
- Study on the calibration of radiation thermometers by fixed points below the Ag point.

### *Hygrometry*

- Study and characterization of a two-pressure humidity generator in the dew/frost-point temperature range from -35 °C to 68 °C (in progress).
- Development of a dew/frost-point generator (in progress).
- Study of the metrological characteristics of capacitive relative humidity sensors along the years (in progress).
- Local pilot in a key comparison with INTI (Argentina) in the dew/frost-point temperature range from -30 °C to 60 °C (SIM.T-K6.7). Final report available at the KCDB website.
- Local pilot in a supplementary comparison of relative humidity standards in the range from 30 %rh to 90 %rh (at 20 °C and 40 °C) among nine Latin-American National Metrology Institutes (SIM.T-S10). Final report submitted in November 2020.
- Technical activities related to the environment in the scope of the sub-project “Metrology for Meteorology and Climatology” of the project “Regional Fund Quality Infrastructure for Biodiversity & Climate Protection in Latin America and The Caribbean” implemented by PTB, COPANT, SIM, OAS and IAAC.
- Two papers presentation about the comparisons described above at TEMPMEKO 2019.
- Recent membership in CCT-WG-Hu and CCT-WG-Env.
- Humidity trainings to technicians of Latin-American National Metrology Institutes (CENAMEP, INEN, IBMETRO, INACAL and INTN).
- Peer reviewed in March 2019.
- Peer review in two South-American National Metrology Institutes (INTI and INACAL).

### *Paper Publications (2015-2020)*

- Brionizio, J.D.; Skabar, J.G. *Bilateral Key Comparison of INMETRO and INTI Humidity Standards in the Dew/Frost-Point Temperature Range from -30 °C to +60 °C (SIM.T-K6.7)*. Metrologia, vol. 57, n° 1A, 03002, 2020.
- Diniz, P.H.F. *Calibração de Termômetros de Radiação por Pontos Fixos: Operacionalização e Primeiras Medições*. Proceedings of the Brazilian Congress of Quality in Metrology – Enqualab 2020, São Paulo, 2020.

- Chagas, R.; Brionizio, J.D.; Ribeiro, L.C.; Garcia, G.A.; Tarelho, L.V.G. *Comparação entre o Atraso Troposférico Zenital Determinado pelo Método PPP para Medições Realizadas por Satélites e o Valor Determinado pelo Modelo de Hopfield para Medições Meteorológicas de Superfície*. Proceedings of the 10<sup>th</sup> Brazilian Congress of Metrology, Florianópolis, 2019.
- Quelhas, K.N. *O novo kelvin no SI*. Cadernos de Metrologia, Inmetro, 2019.
- Tew, W.L.; Quelhas, K.N. *Realizations of the Triple Point of Sulfur Hexafluoride in Transportable and Refillable Cells*. Journal of Research of the National Institute of Standards and Technology, v. 123, p. 123013, 2018.
- Brionizio, J.D.; Orlando, A.F.; Bonnier, G. *Characterization of a Spherical Heat Source for Measuring Thermal Conductivity and Water Content of Ethanol and Water Mixtures*. Int. J. Metrol. Qual. Eng., v. 8, p. 18, 2017.
- Freitas, B.B.; Sohn, R.S.T.M.; Pereira Neto, M.A. *Aspectos Metrológicos da Termografia na Indústria de Petróleo*. HOLOS (Online), v. 1, p. 279-291, 2017.
- Flavio, M.L.; Quelhas, K.N. *Avaliação de Métodos para Calibração de Indicadores de Temperatura com Compensação Eletrônica da Junção de Referência (CEJR) para Sensor Termopar*. Novas Edições Acadêmicas, 1<sup>st</sup> Ed., 68 p., 2017.
- Diniz, P.H.F.; Teixeira, R.N.; Tarelho, L.V.G. *Construção e Avaliação de Termopar Pt/Pd para Utilização em Fornos de Alta Temperatura*. Proceedings of the 9<sup>th</sup> Brazilian Congress of Metrology, Fortaleza, 2017.
- Silva, J.; Rotger, A. *Characterization of a Gallium Fusion Point Cell for Traceability in Temperature Measurement in the Oil Industry*. Proceedings of the 2<sup>nd</sup> National Congress on Petroleum, Natural Gas and Biofuels Engineering, Natal, 2016.
- Machin, G.; Teixeira, R.N.; Lu, X.; Lowe, D. *Bilateral Comparison between NPL and INMETRO Using a High-Temperature Fixed Point of Unknown Temperature*. Int. J. Thermophys., v. 36, p. 327-335, 2015.
- Huang, P.; Meyer, C.; Brionizio, J.D. *Final Report: Bilateral Key Comparison Sim.T-K6.3 on Humidity Standards in The Dew/Frost-Point Temperature Range from -30 °C to 20 °C*. Metrologia, v. 52, p. 03001-03001, 2015.
- Brionizio, J.D. *Coefficientes de Sensibilidade para Umidade Relativa a partir da Temperatura de Ponto de Orvalho ou da Temperatura de Bulbo Úmido*. Proceedings of the 8<sup>th</sup> Brazilian Congress of Metrology, Bento Gonçalves, 2015.
- Brionizio, J.D. *Avaliação da Incerteza de Medição na Calibração de Sensores de Umidade Relativa por meio de Higrômetro de Ponto de Orvalho*. Proceedings of the 8<sup>th</sup> Brazilian Congress of Metrology, Bento Gonçalves, 2015.
- Sohn, R.S.T.M.; Pereira Neto, M.A. *Using Scilab in the Radiation Thermometry Laboratory of Inmetro*. 7<sup>th</sup> International Scilab Users Conference, Paris, 2015.