Report of the CCM Working Group on Density and Viscosity

Daniela Eppers

20th CCM meeting, 26-27 June 2025

WG Meetings

CCM WG Density and Viscosity

- **Webinar on CCM WGDV on 22 May 2024 (Y Fujita/NMIJ)**

- **CCM WGDV on 23 June 2025** - Number of participants (55 for density and 44 for viscosity)

  29 member institutes (NMIs and BIPM). All RMOs represented.
  BEV, BIPM, CANNON, GUM, CEM, CENAM, LNE, NPLI, VNIIM, METAS, INMETRO, IPQ, KRISS, INRIM, NIM, NIS, NIST, NMIA, NMC A*STAR, NMIJ/AIST, NMISA, UME, NPL, NRC, PTB, RISE, SMU, SE „Ukrmetrteststandard“, VSL

  Observer
  INM (Colombia), KEBS (Kenya), NMIM (Malaysia), VNIIM(RU), SASO-NMCC (Saudi Arabia), NMIT (Thailand), EMI (United Arab Emirates), LATU (Uruguay)

Main actions and achievements

- **Objectives:**
  - To define, organize and approve the necessary key and supplementary comparisons, and to review the results
  - Harmonization and review of CMCs by establishing technical review criteria to ensure fairness and transparency
  - To support innovation and improve techniques for the dissemination of density and viscosity units
  - Regular CCM KCs of the WG DV

- **Services in density:**
  - Density and Volume of solid: Solid density artefact
  - Density of liquid: Density measuring device and Density of liquid
  - Refractive index of liquid

Main actions and achievements

- **Services in viscosity:**
  - Certified Newtonian reference liquid
  - Capillary viscometers
  - Viscosity measurement of Newtonian liquids
  - Pilot project on surface tension

Technology trends & challenges

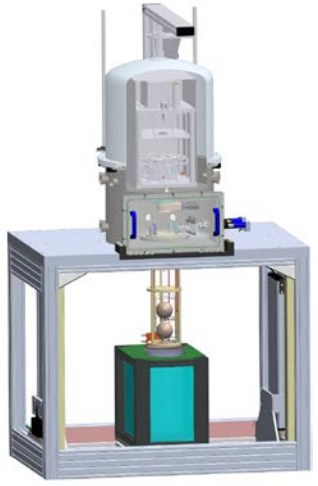
- Reduction of uncertainties in the density measurement by hydrostatic weighing of silicon spheres (CCM.D-K1.2023) due to the **redefinition of the kilogram using Si spheres**
  (by improving experience and handling of Si spheres as density or volume standards)

- Development of hydrostatic weighing for smaller density standards to extend the measuring range and reduce the uncertainties of hydrostatic weighing

  NMIJ: *"Combination method of hydrostatic weighing and pressure-of-flotation to measure small Si_3Ni_4 spheres (ϕ 30 mm) with $u_r(\rho) = 4.6 \times 10^{-6}$ ",*
  K. Nishihashi *et al.*, *Metrologia*, **62**, 015006 (2025)

- Development of hydrostatic weighing to disseminate density realization after new SI (pressure stabilized weighing)

  traditional way: $\rho = \frac{m}{V}$ new: $\rho_{Si,nat} = k \cdot \rho_{Si28}$



Technology trends & challenges

- More accurate and precise density properties measurements under wide pressure and temperature ranges
- traceable reference liquids for surface tension and refractive index or reliable measurements in science and industry, as well as for the food industry and agriculture
- Study on viscosity measurements on Non-Newtonian
- Establishment of more reliable measurement principles and standards for viscosity using new technology
- Digitalization in certificates

Liaison & stakeholders

- **Liaison:**
  - IMEKO TC3 – Measurement of force, mass, torque, and gravity
  - refractive index of liquids ⇒ Liaison with CCPR

- **Stakeholders:**
  - Industries of energy, alcohol, food, materials, etc.
  - Manufacturers for measurement of their related materials (e.g. density meters, refractometers, viscometers)
  - Producers for reference standards
  - Calibrations and testing laboratories (accredited laboratories, tax authorities)

CIPM MRA: KCs & CMCs

Completed or underway

- **CCM.D-K1.2023 (Density measurements of 1 kg Si sphere)**
  - Pilot: PTB, 11 participants, Draft A in progress → to be finished 2025
- **CCM.D-K3 (Density measurements of stainless-steel weights)**
  - Pilot: NMIJ, 15 participants, measurements in progress (2025) → to be finished 2026
- **CCM.D-K5 (Density measurements by oscillation-type density meters)**
  - Pilot: BEV, 17 participants, measurements completed, Draft A in preparation → to be finished 2025
- **Pilot study of surface tension of liquids**
  - Pilot: GUM, EURAMET/CCM → to be started 2026
  - Pilot: CENAM, SIM
- **CCM.V-K4.A/ CCM.V-K4.B (Viscosity measurements of standard liquids)**
  - Pilot: CENAM, 12 participants, Approved for equivalence in 2025

CIPM MRA: KCs & CMCs

Planed and needs

- **New key comparisons** (approved CCM/2023)
  - CCM.V-K5 (Viscosity of standard liquids across a wide range), Pilot: NIM, questionare → to be started 2026

- **Repetition of key comparisons** (approved CCM/2021) → to be started 2026
  - CCM.D-K2 (Liquid density by hydrostatic weighing), last measurements 2004 and publication 2013
  - CCM.D-K4 (Calibration on high-resolution hydrometer) last measurements 2012 and publication 2016

- **Start reviewing and updating CMCs and service category** → to be finished 2026
  Simplification and reduction of the number of CMC entries for viscosity (kinematic and dynamic viscosity) has been proposed and is under discussion.

Proposals (KCs, chairmanship, membership…)

- **New key comparison**
  - CCM.D-K6 (Refractive index of liquids), Pilot: NMIJ must be changed?, under discussion
- **Pilot study** on viscosity measurements of non-newtonian liquids in discussion
- **Since 2025**
  - Dr. Daniela Eppers (PTB) Chair, Density expert
  - Dr. Zhengdong Zhang (NIM) Vice-Chair, Viscosity expert
- **Proposal for new membership (presentations made at the WG DV meeting 23rd June 2025):**
  - KEBS, Kenya Wilson Ombati/ Beatrice Lugadiru
  - NMIT, Thailand Chompoonoot Hirunyapruk
  - NMIM, Malaysia Zulkhairi Bin Anuar/ Noor Razinah Binti Rahmat

Thank you.

daniela.eppers@ptb.de