Flow measurements in a lab-on-a-chip device: metrological traceability and accuracy

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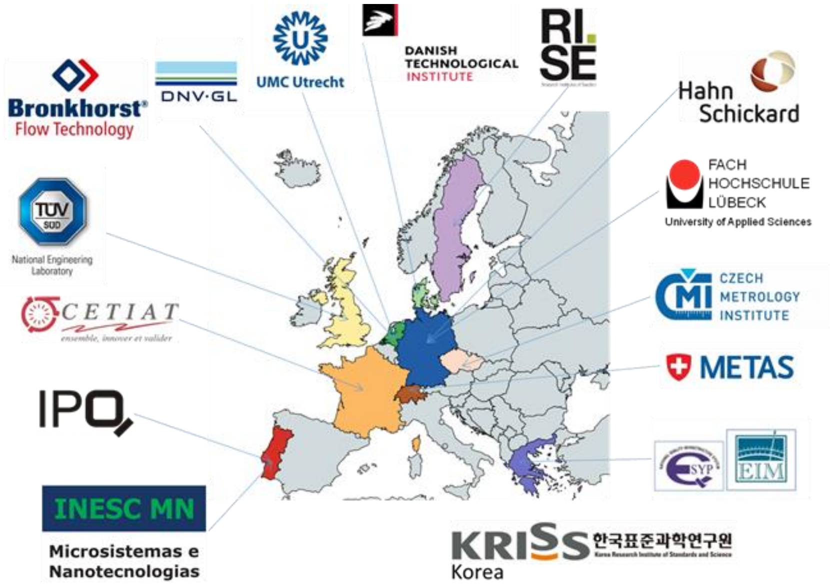
MEDD II

https://drugmetrology.com

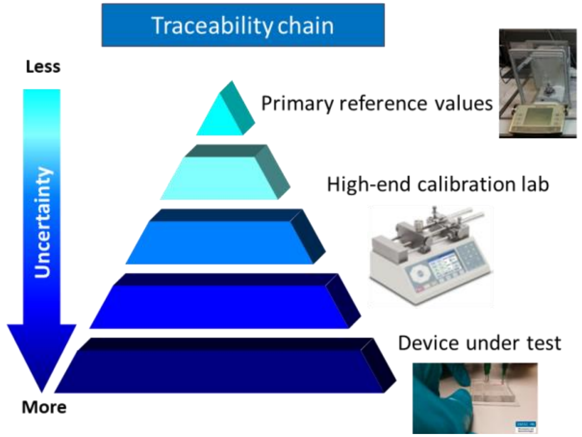
EURAMET – 18HLT08 MeDD II – EMPIR

For the characterization and improvement of **dosing accuracy** of existing **drug delivery devices and multi infusion systems** and enablement of traceable measurements of their volume, flow rate, pressure and inline sensing operation at very low infusion rates

DEVELOPMENT OF **NEW CALIBRATION METHODS** • **EXPANSION OF EXISTING METROLOGICAL INFRASTRUCTURE**



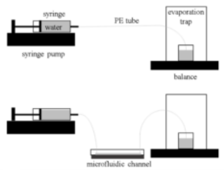
To ensure accuracy of flow through a lab-on-a-chip it is fundamental that the flow generator used is calibrated using appropriate and traceable methods



CALIBRATION METHODS

Gravimetric method

The gravimetric method relies on weighing the mass of the working fluid delivered by the instrument under test for a set time



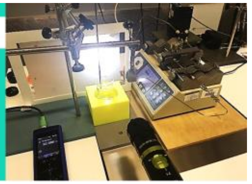
$$Q = \frac{1}{t_f - t_i}\left[\left((I_f - I_i) - (\delta m_{buoy})\right) \times \frac{1}{\rho_W - \rho_A} \times \left(1 - \frac{\rho_A}{\rho_B}\right) \times [1 - \gamma(T - 20)]\right] + \delta_{evap}$$

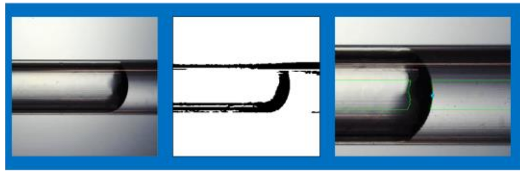
Range down to 120 mL/h with an expanded uncertainty of 3 %

CMC published at BIPM-KCDB (Bureau International des Poids et Mesures – Key Comparison Data Base)

Front track method

The experimental setup consists of using a high-resolution camera and an image processing software (Python) to track the distance traveled by the meniscus of a liquid in a capillary tube and calculate the flow rate.

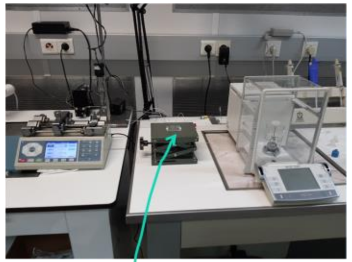




The displacement of the meniscus is calculated between frames, through the positions

$$Q = \frac{x_2 - x_1}{\Delta t} \times \pi \times r^2 \times [1 - \gamma\,(T - 20)]$$

GRAVIMETRIC SETUP



Test conditions

a) Controlled temperature T = 20 ± 3 °C

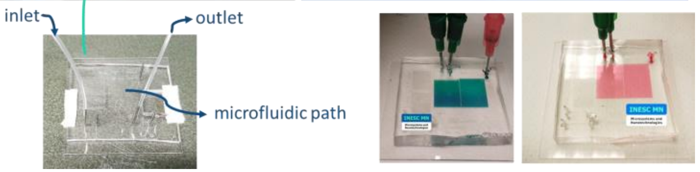
b) Humidity > 50 %

c) 1 mL glass syringe

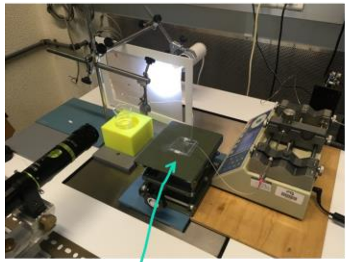
d) Nominal flow rate = 600 µL/h

e) Calibration liquid: DI water

f) Acquisition rate: every 30 s for 15 min



FRONT TRACK SETUP



Test conditions

a) Controlled temperature T = 20 ± 3 °C

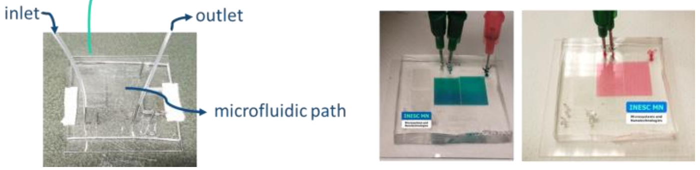
b) Humidity > 50 %

c) 1 mL glass syringe

d) Nominal flow rate = 600 µL/h

e) Calibration liquid: DI water

f) Acquisition rate: every 1 s for 70 s



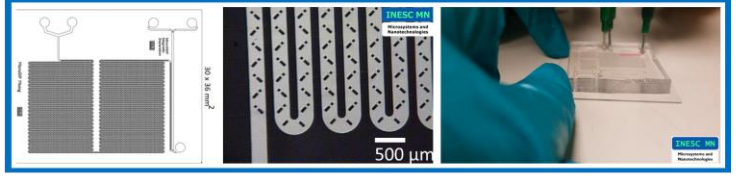
INSTRUMENTS

The flow is generated by a
PROGRAMMABLE SYRINGE PUMP

flow measurement range: 2 pl/min to 500 ml/min
± <0.35%, 0.1% reproducibility

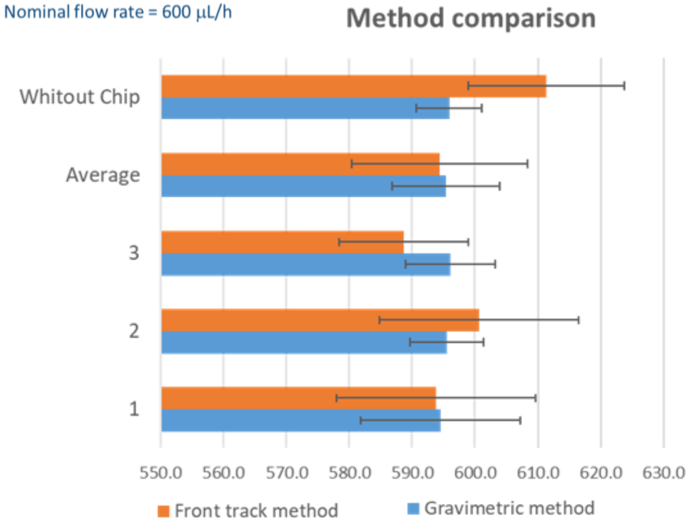
Nexus 3000 infuse/withdraw system
Chemix Precision Syringe Pumps

Microfluidic Lab-On-a-Chip device for passive mixing and magnetic separation of bioanalytes with square channel cross section with obstacles that allows mixtures of components



TEST RESULTS

Nominal flow rate = 600 µL/h



SUMMARY

- The aim of this work was to provide and compare the flow rate obtained in a microfluidic chip using two different calibration methods, in order to define the most suitable one that can give better uncertainty and accuracy
- The results obtained were consistent for the two methods used. The uncertainties values were very similar for the two methods, being higher for the front track method due to the new implementation in the laboratory
- The flow error results obtained without the microfluidic chip are higher than the test with the microfluidic chip due pressure losses and internal constraints inside the chip
- The uncertainty obtained without the chip was smaller in both cases due to better flow stability. The channels inside the chip causes some flow disturbances

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