Traceable pipe viscometers for in-line measurement of dynamic viscosities

18HLT08 MeDD II – WP2 Partners

14th Workshop Low Liquid Flows in Medical Technology
Lübeck, Germany, September 15th, 2021

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Agenda

- ✓ 18HLT08 MeDD II WP2 Motivation
- ✓ 18HLT08 MeDD II WP2 Deliverables
- ✓ Traceable pipe viscometer
  - Facility NEL
  - Facility RISE
  - Facility METAS
- ✓ Devices for in-line measurement of viscosity
- ✓ Validation pipe viscometer & devices
- ✓ Application: determination of mixtures of drugs
- ✓ Summary

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18HLT08 MeDD II WP2 Motivation

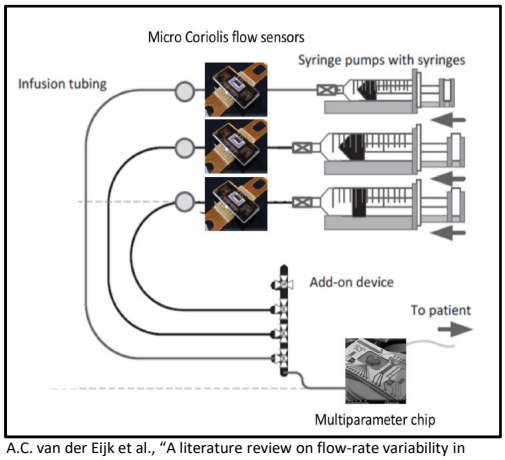
MeDD II WP1
Development and validation of calibration techniques for ultra-low flow rates below 100 nL/min

Tool

More than just flow

MeDD II WP2
Traceable pipe viscometers for in-line measurement of dynamic viscosities

MeDD II WP4
Designing a multi-infusion system representative for clinical practice



A.C. van der Eijk et al., "A literature review on flow-rate variability in neonatal IV therapy", *Pediatric Anesthesia*, 23(1), 2013, pp. 9-21.

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18HLT08 MeDD II WP2 Deliverables

Task: Upgrading flow facilities for the in-line measurement of viscosity

Validation report on the primary standards developed for the in-line measurement of the dynamic viscosity of Newtonian liquids with a target uncertainty of 2 %.

Task: Characterisation of devices for in-line measurements

Report on the use of a calibrated microfluidic multi-parameter chip for the in-line measurement of pressure, viscosity and temperature

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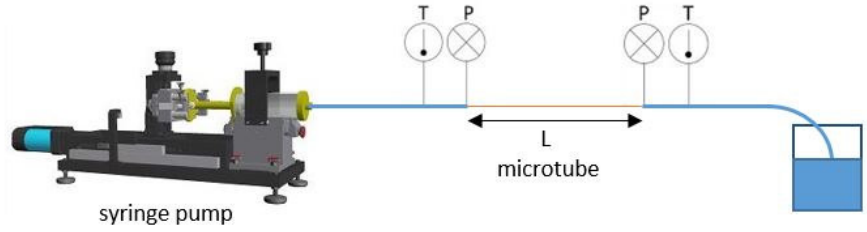
Traceable pipe viscometer

Scheme of the facilities (NEL, RISE, METAS)



Laminar flow regime

Determination of the inner radius of the micro-tube: $r_{exp} = \sqrt[4]{8\,\eta\,L\,Q/(\pi\,\Delta P)}$, using water with known viscosity

Determination of the dynamic viscosity of the liquid: $\eta = \pi\, r_{exp}^4\, \Delta P/(8\,L\,Q)$

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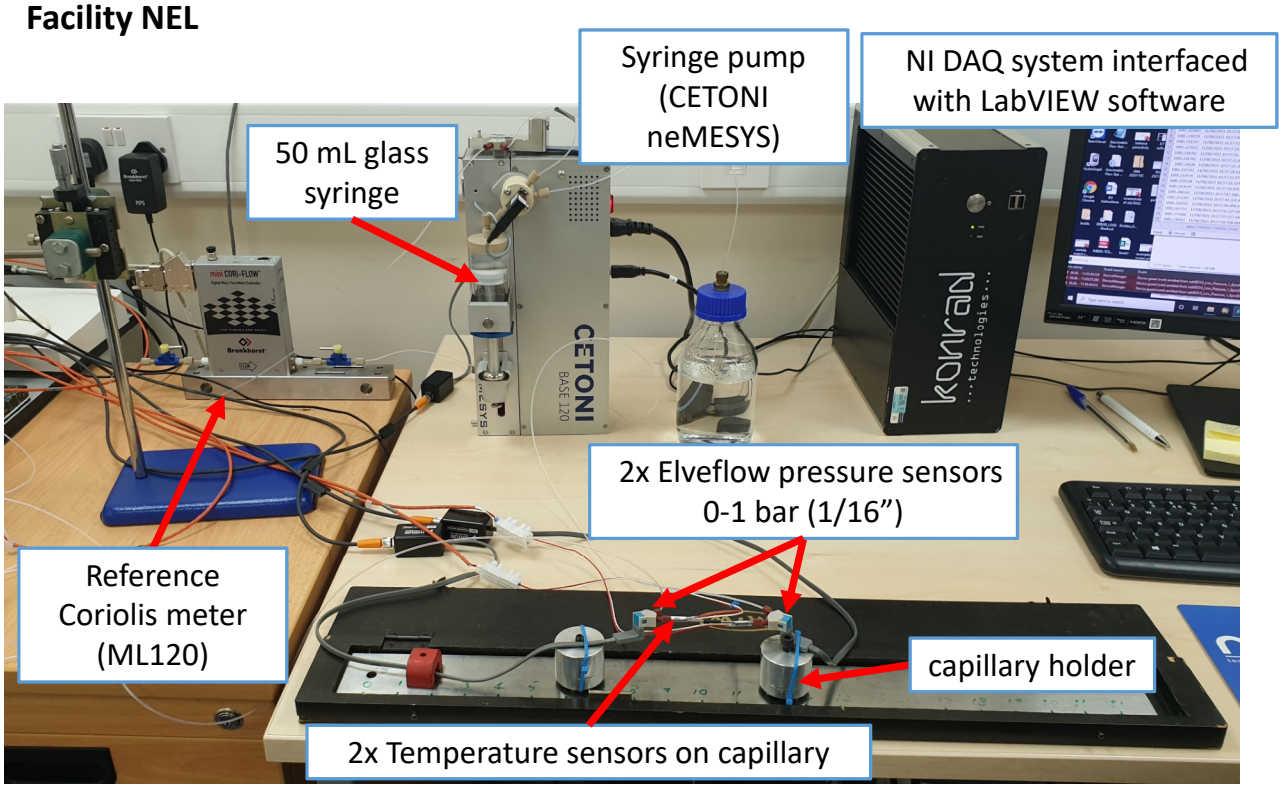
Traceable pipe viscometer

Facility NEL



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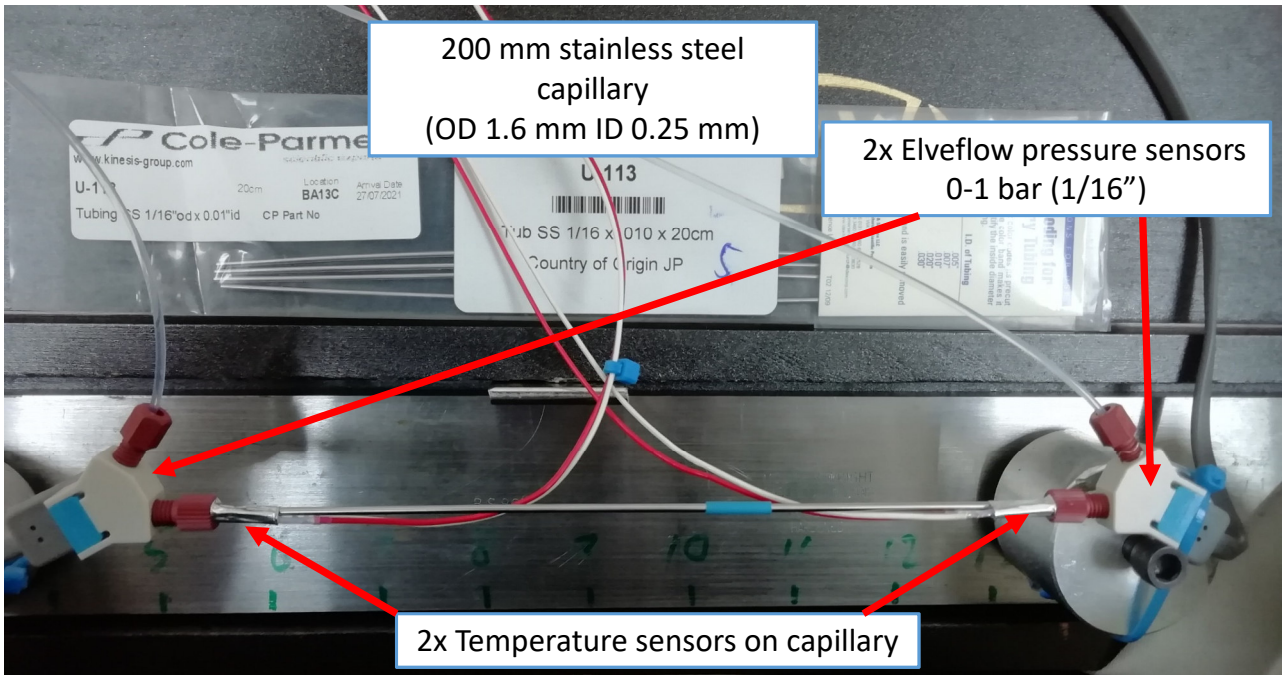
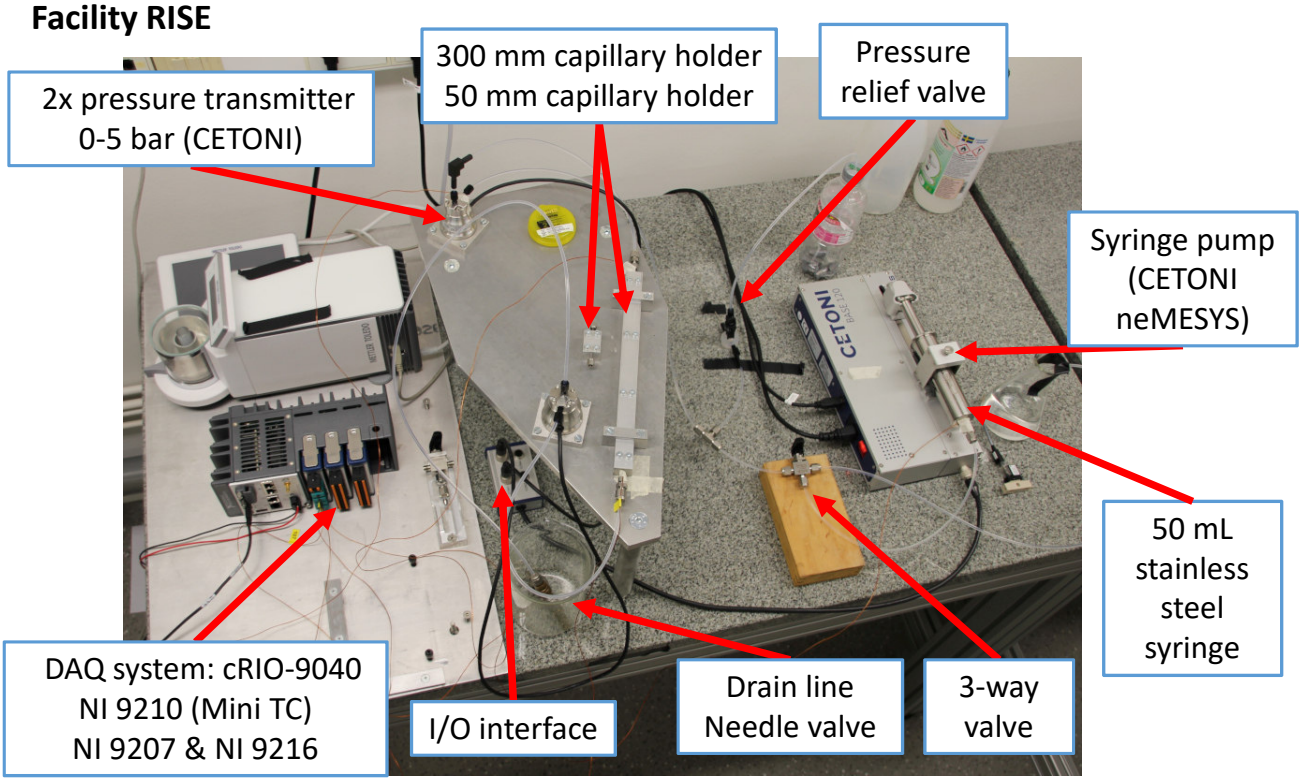
Traceable pipe viscometer

Facility NEL



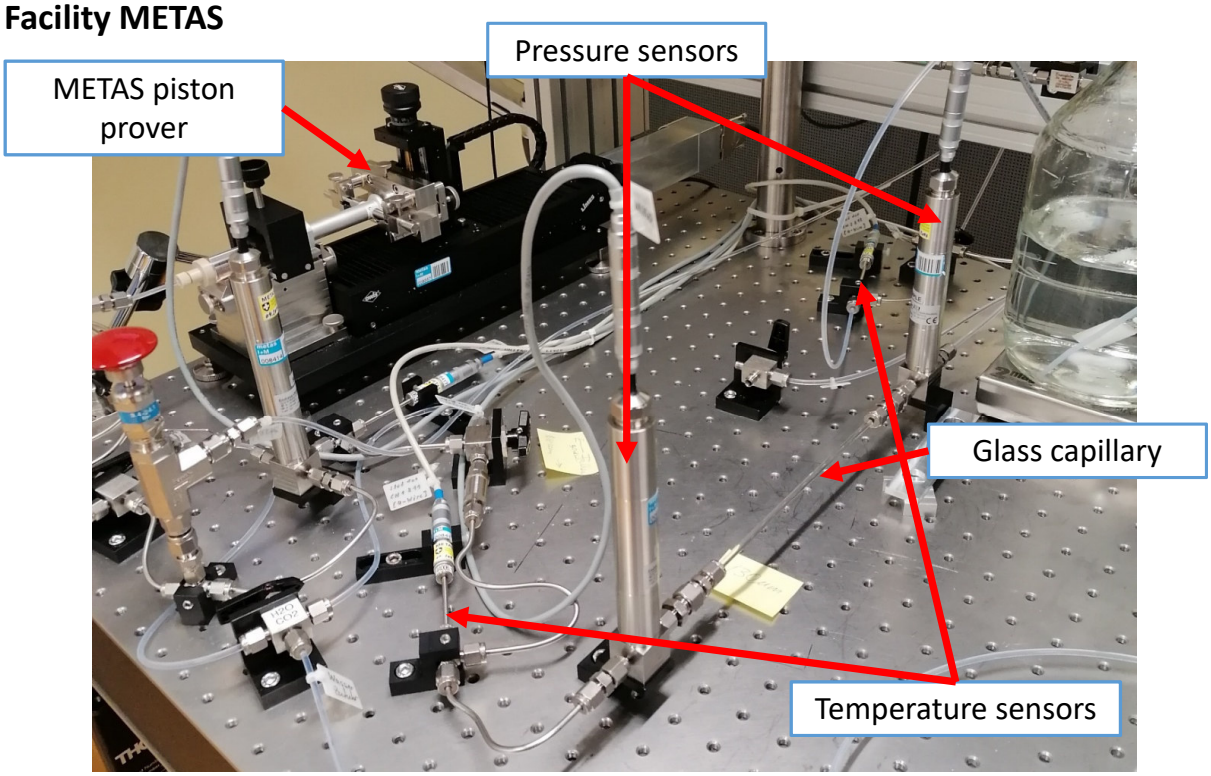
Traceable pipe viscometer

Facility RISE



Traceable pipe viscometer

Facility METAS



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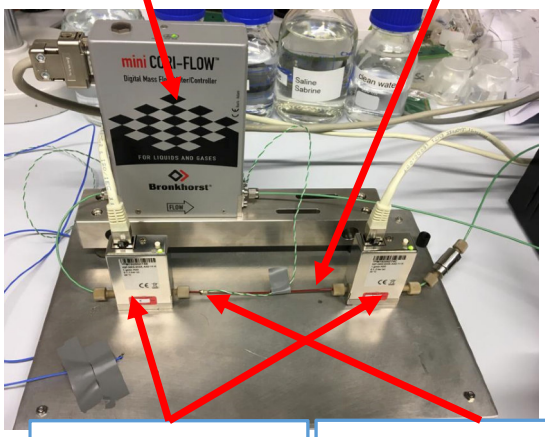
Devices for in-line measurement of viscosity

Bronkhorst High-Tech B.V.
Conventional Multiparameter Measurement System
Technology Demonstrator (not commercially available)



- Flow rate
- Density
- Temperature
- Pressure

➢ Dynamic viscosity

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Devices for in-line measurement of viscosity

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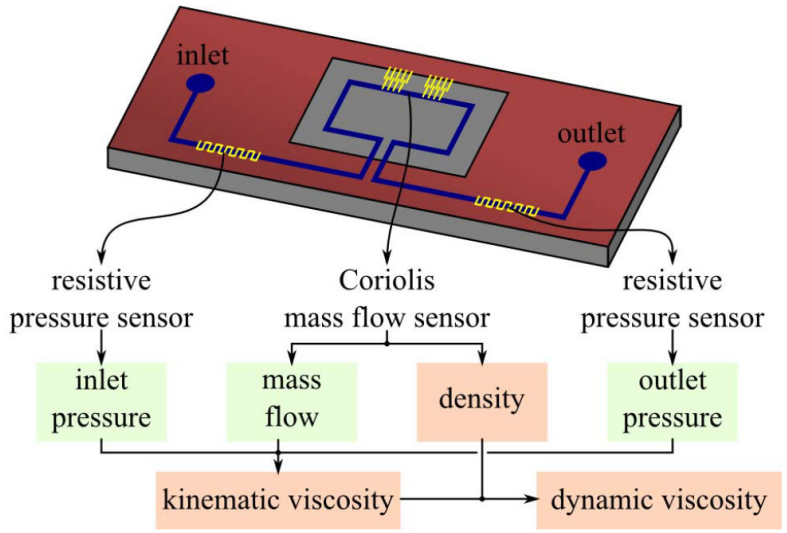
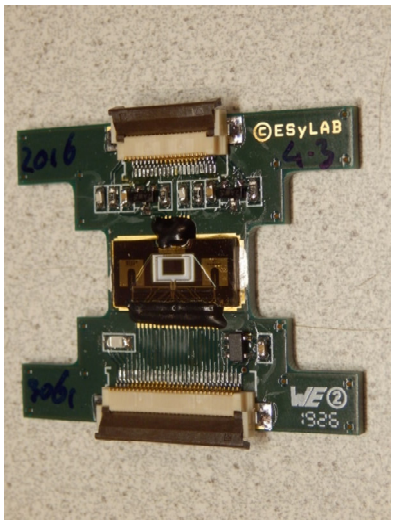
MEMS Multiparameter Measurement System
Technology Demonstrator (not commercially available)





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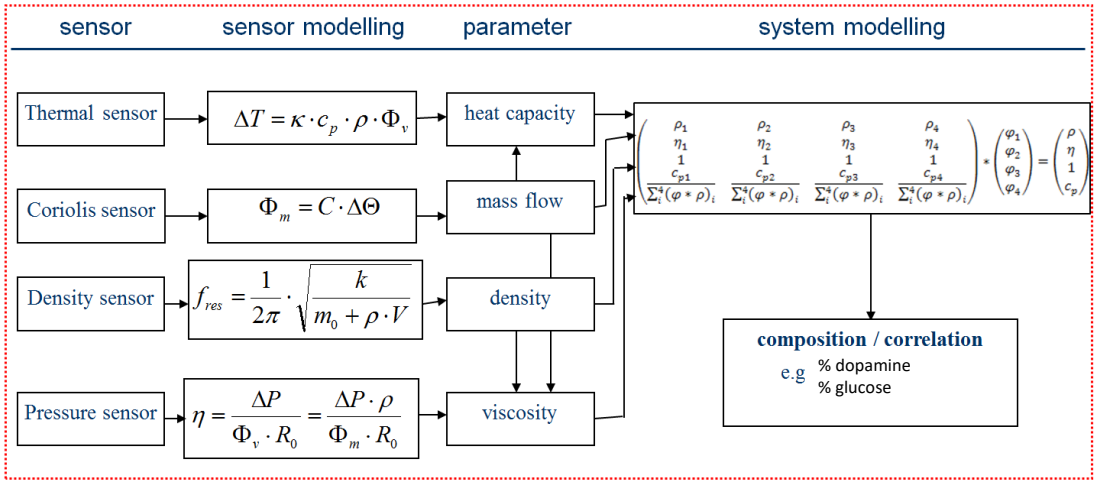

Mixtures of known drugs can be determined (WP4 Multi-Infusion Systems)

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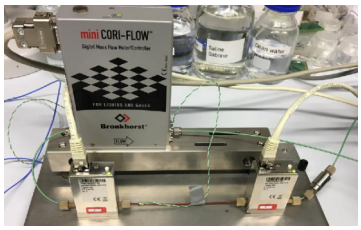
Devices for in-line measurement of viscosity

TrueDyne Sensors AG
VLO-M1

- Dynamic viscosity
- Density
- Temperature

Bronkhorst High-Tech B.V.
Conventional Multiparameter Measurement System
Technology Demonstrator
(not commercially available)



- Dynamic viscosity
- Density
- Temperature
- Flow rate
- Pressure

Bronkhorst High-Tech B.V.
MEMS Multiparameter Measurement System
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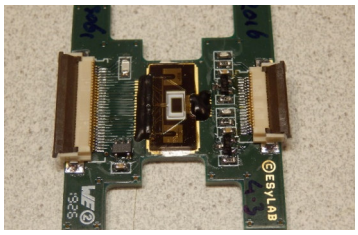

- Dynamic viscosity
- Density
- Temperature
- Flow rate
- Pressure
- Heat capacity

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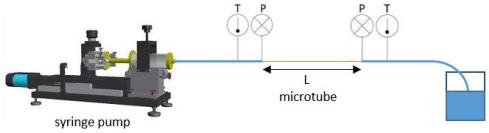
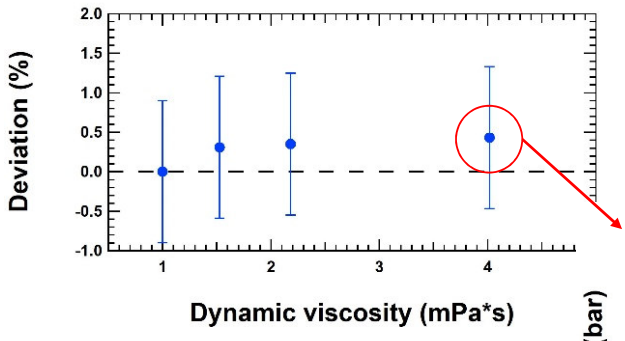
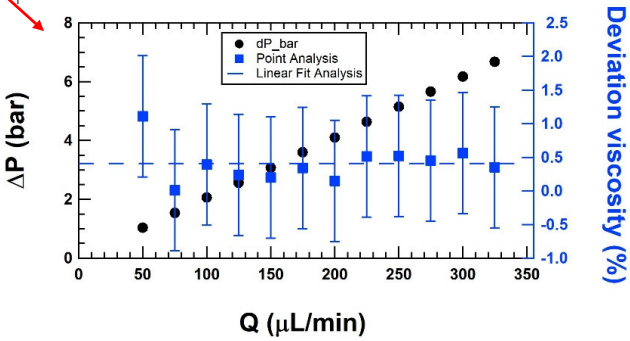
Validation pipe viscometer



Laminar flow regime



Reference liquids with traceable density and dynamic viscosity values



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Validation pipe viscometer & Devices

- Newtonian Liquids (T = 20 °C – 27 °C)
  - A - Saline solution (0.9%) (~ 0.87 mPa*s @ 23°C)
  - B - Glucose solution (10%) (~ 1.14 mPa*s @ 23°C)
  - C - Glucose solution (20%) (~ 1.54 mPa*s @ 23°C)
  - D - Sodium chloride solution (0.22%) and glucose (2.75%) (~ 0.87 mPa*s @ 23°C)
  - E - Sodium chloride solution (0.22%) and glucose (5.55%) (~ 0.94 mPa*s @ 23°C)
  - F - Sodium chloride solution (0.45%) and glucose (5.54%) (~ 1.02 mPa*s @ 23°C)
  - G - Glycerol solution (52.04%) (~ 4.80 mPa*s @ 23°C)
  - H - Glycerol solution (58.8%) (~ 7.40 mPa*s @ 23°C)

- Characterisation of the dynamic viscosity
  - by means of well established measurement techniques (including CMCs)
  - by means of the newly developed pipe viscometers
  - by means of Rheometer

- Characterisation of the density and thermal properties

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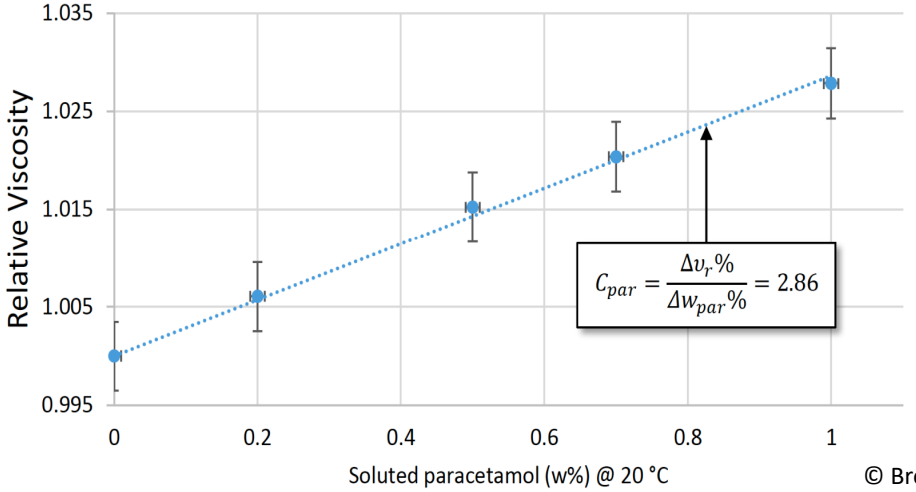
Application: determination of mixtures of drugs

Dynamic viscosity measured with conventional measurement system;
Paracetamol in DI water, from 0 to 1%.
(Preliminary results by technology demonstrator)



Paracetamol can be well distinghuished from water via viscosity
the viscosity changes ca. 3% over the measurement range of 0 – 1% paracetamol

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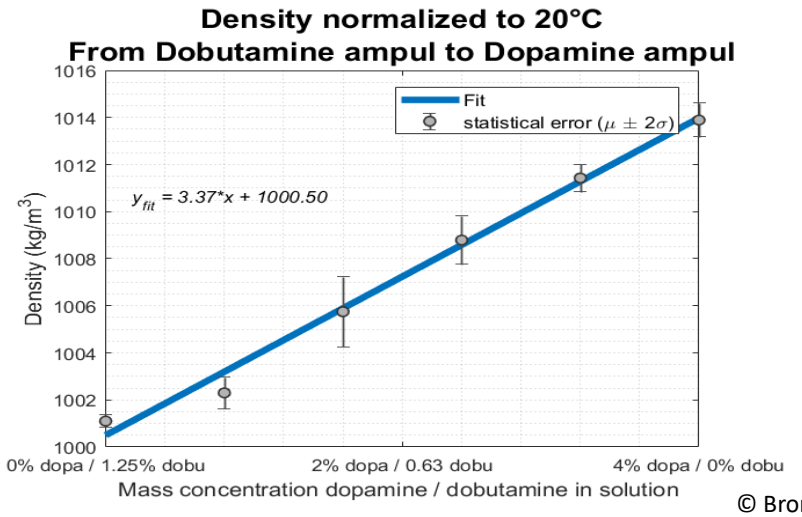
Application: determination of mixtures of drugs

Density measured with conventional measurement system;
From Dobutamine ampul to Dopamine ampul
(Preliminary results by technology demonstrator)



Dobutamine can be well distinghuished from dopamine via density
the density changes ca. 1.5% over the measurement range from dobutamine to dopamine

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Summary

- Traceable pipe viscometer (NEL, RISE, METAS) are built for low flow rates
- Devices for in-line measurement of viscosity are commercially available or are currently developed for low flow rates
- Validation of pipe viscometer & devices is ongoing
- Important application is the determination of mixtures of drugs occurring in Multi-Infusion Systems
- Not limited to any fields of applications

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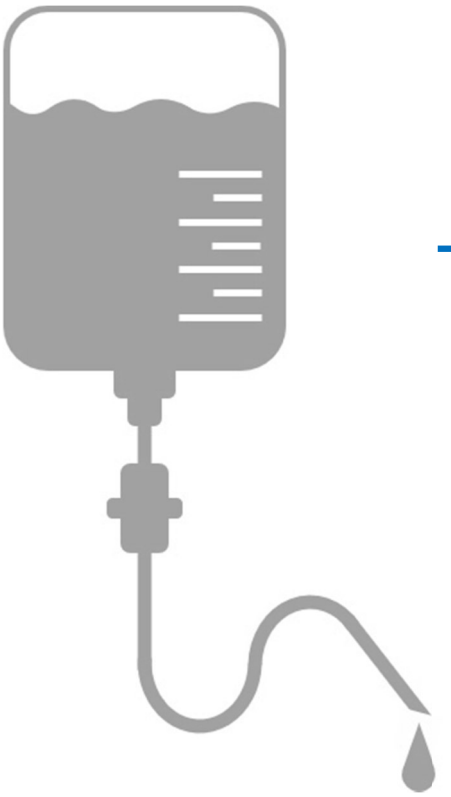

MEDD II
Drugmetrology.com

THANK YOU

www.drugmetrology.com

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