



Dutch
Metrology
Institute

“How do we provide and maintain flow measurement traceability for the fluids of the future?”

26 June 2019, Flomeko Lisbon, Portugal

Erik Smits

Manager Flow Metrology

This PowerPoint presentation is for educational purposes only!





**“Measure what can be
measured and make
measurable what
cannot be measured.”**

Galileo



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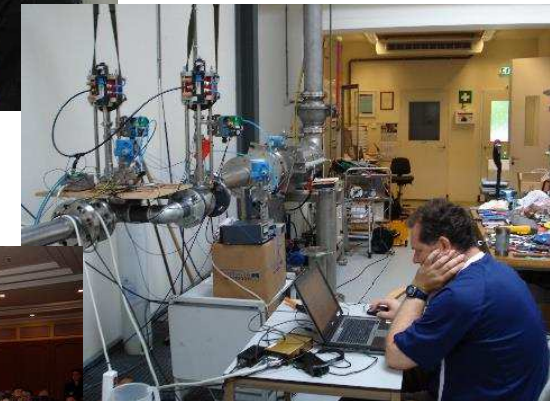
Introduction

Manager Flow Metrology at VSL



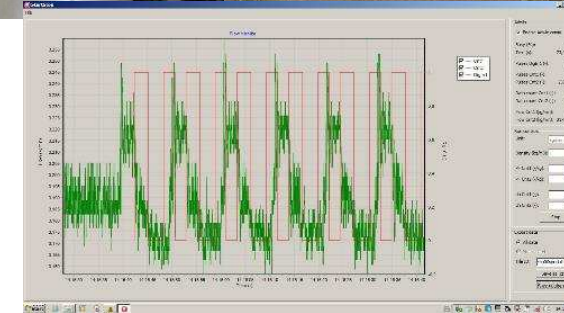
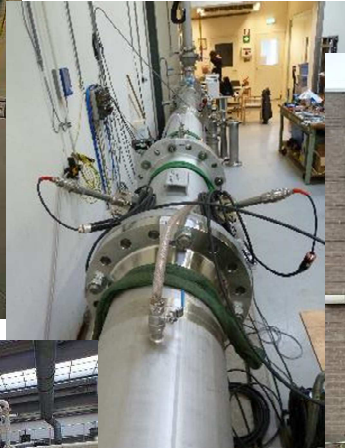
Career at VSL and NMI-VSL and TAC

- April 1st 1993 started at NMI-TAC (Test en Advies Centrum) as calibration and verification engineer
- 1998 to NMI-VSL (Van Swinden Laboratorium) as a Metrologist Liquid Flow & Volume.
- 2009 NMI-VSL name change to VSL
- 2012 Senior Metrologist Liquid Flow & Volume
- 2017 Manager Metrology Services
- June 1st 2019 Manager Flow Metrology



Activities over the years (1)

- Calibration and verification of flow and volume instruments at VSL
- Modernization of the flow and volume standards of VSL
- Design and construction of the water flow facility of VSL
- R&D for VSL and customers



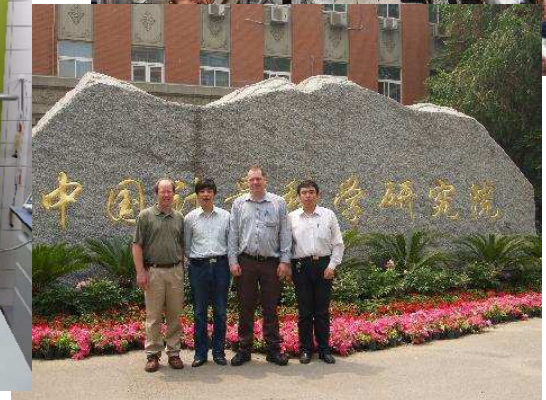
Activities over the years (2)

- VSL CMC Certified and calibration at customers
- Consultancy for calibration facilities, metering etc...
- Training for calibration of flow meters, pipe provers, uncertainty etc...
- Visiting colleagues around the world



Activities over the years (3)

- Metering review, auditing of metering systems (from preliminary design till 30 years in use)
- International comparisons
- Metrology workgroups
 - Euramet TC-Flow
 - BIPM working group for fluid flow
 - ISO/TC 28/WG 20 LNG flow measurement
- Workshop, conferences etc..





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Why measure flow?

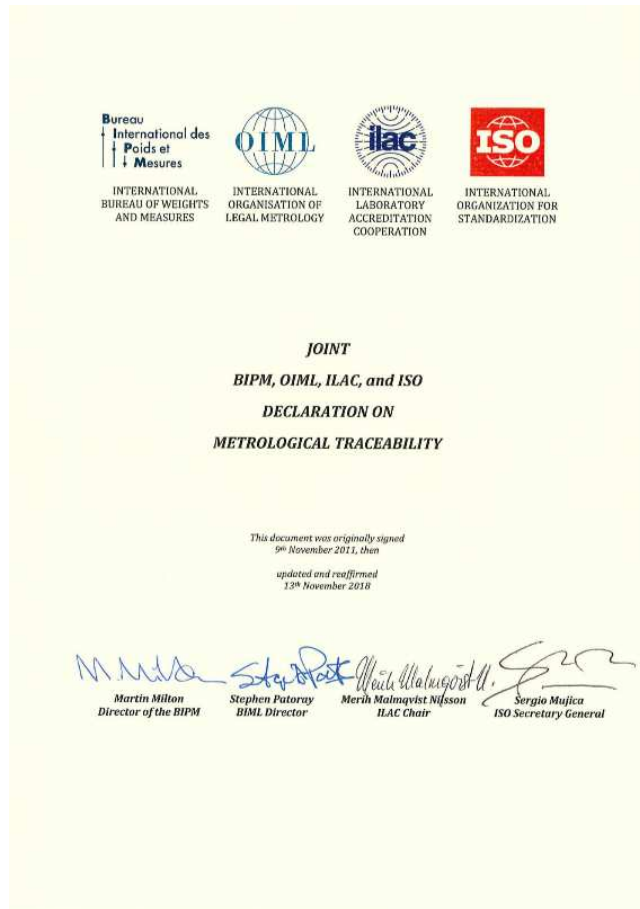


■ Why do we want to make measurements? What value does it have?

- Trade of oil, gas and other fluids flowing through a pipeline (business, taxing etc.)
- Amount of fuel required to propel a rocket into space (navigation, science etc.)
- Amount of medicine required to cure a patient without making them worse (healthcare)
- CO₂ emissions going into the atmosphere (environment, taxing pollution)
- New fuels in trade like LNG and hydrogen (innovation for the future, energy transition)
- Much more....



Metrological traceability



3 Recommendations

BIPM, OIML, ILAC, and ISO endorse the following recommendations:

- In order to be able to rely on their **international acceptability**, calibrations should be performed
 - in **National Metrology Institutes** which should normally be signatories to the CIPM MRA and have CMCs published in the relevant areas of the KCDB or
 - in laboratories **accredited to ISO/IEC 17025** by accreditation bodies that are signatories to the ILAC Arrangement;
- **measurement uncertainty** should follow the principles established in the GUM;
- the results of the measurements made in accredited laboratories should be **traceable to the SI**;
- NMIs providing metrological traceability for accredited laboratories should normally be signatories to the CIPM MRA and have CMCs published in the relevant areas of the KCDB;
- within the OIML-CS, accreditation should be provided by bodies which are signatories to the ILAC Arrangement and the above policies on metrological traceability to the SI should be followed.

The above principles should be used whenever there is a need to demonstrate metrological traceability for international acceptability.

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

William Thompson, aka Lord Kelvin

Make Measurable

- **NMI's make primary measurements with extremely low uncertainties**
 - kg, VSL able to measure 1kg for customers with an uncertainty of 0.1mg (0.00001%)
 - s, VSL able to measure 1ms for customers with an uncertainty 1ns (0.0001%)

- **What about fluid flow measurement?**
 - kg/s or m³/s VSL and other NMI's have the lowest CMC for water flow of 0.02% @ $k=2$

Additional sources of uncertainty not being measured?

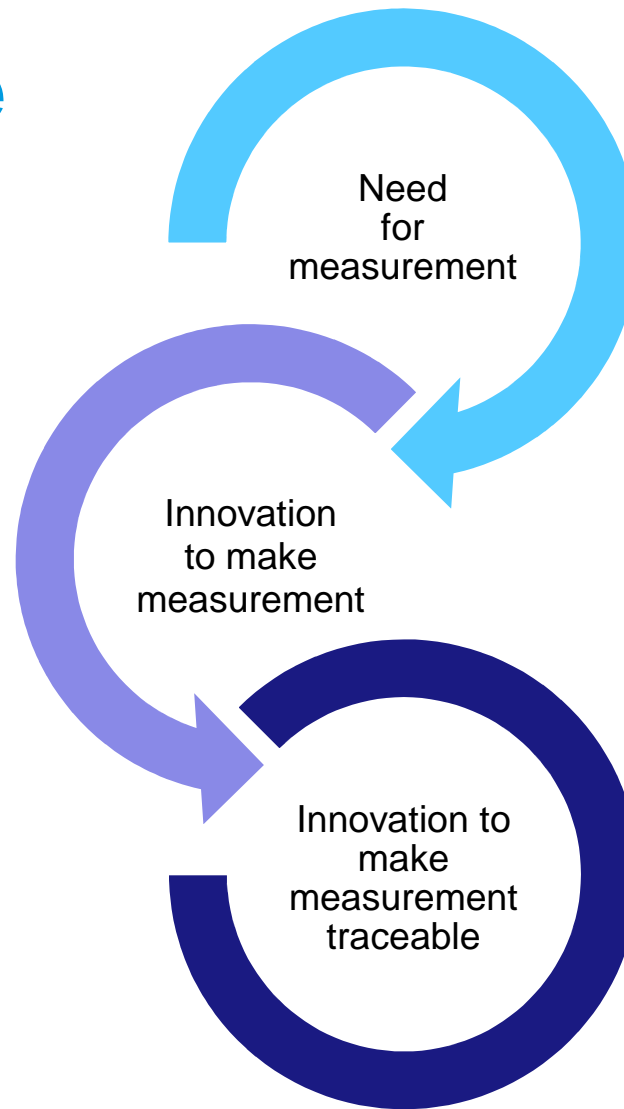
- Can we make the additional sources measurable to reduce the uncertainty?
- Do these uncertainties need to be reduced?





Make Measurable

Inventor / Manufacturer / NMI

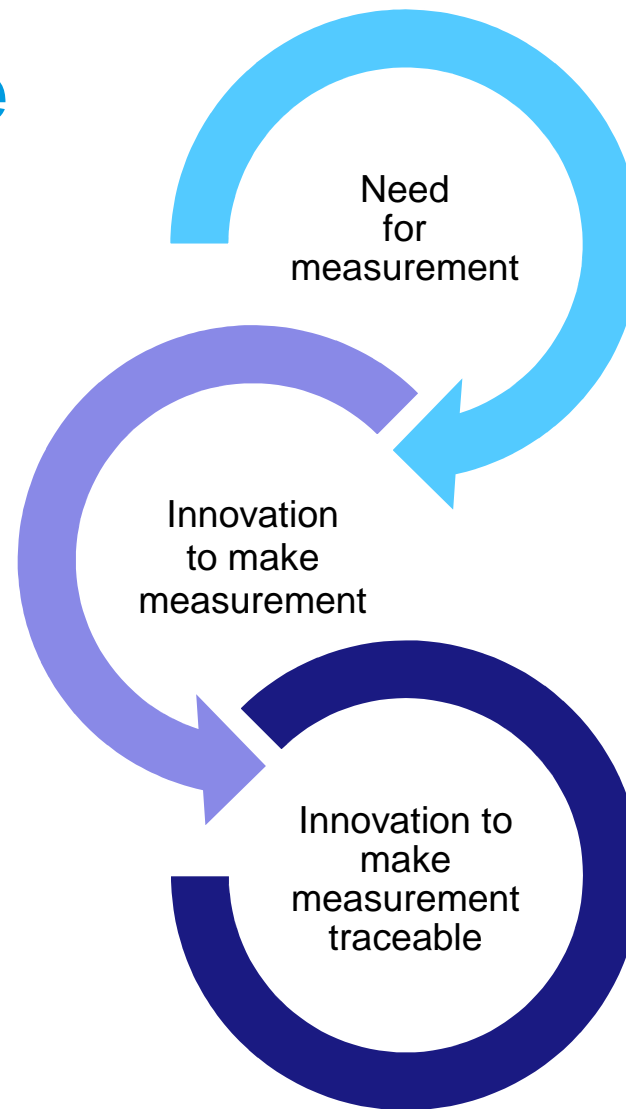


Society
(trade, environment,
health care, energy transition)

National Metrology Institute



Make Measurable





"Any measurement that you make without the knowledge of its uncertainty is completely meaningless."

Professor Walter Lewin, MIT

Measurement Challenges – *Beyond All Doubt*



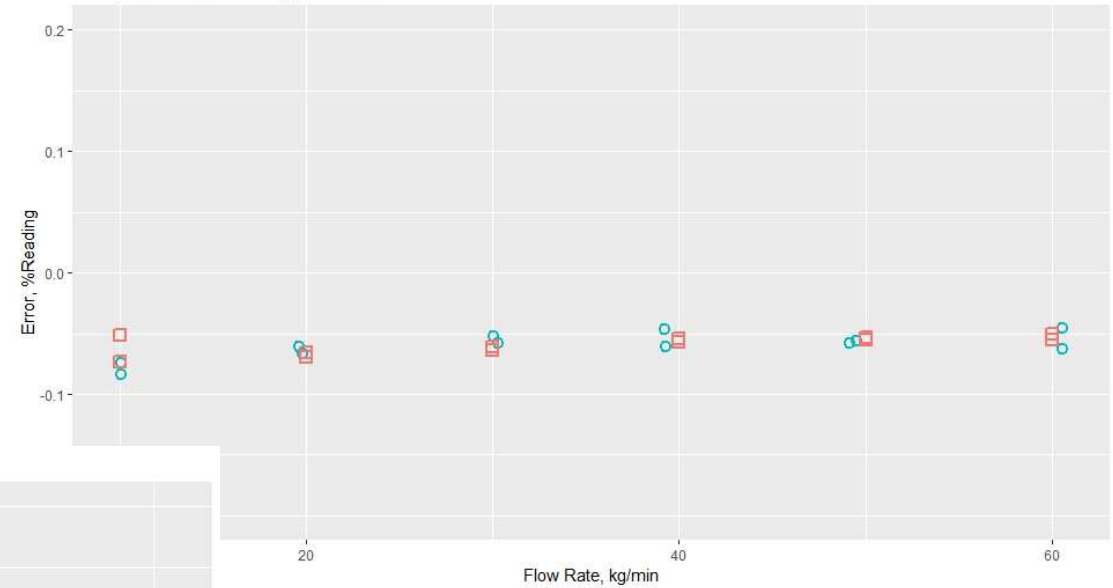
- Is there a threshold, or a maximum uncertainty that applies when talking about measurements?
 - How meaningful is a value if the uncertainty of the value is very large?
- How many NMI's are required to make a measurement to ensure the correct uncertainty in the traceability chain?
 - Can the base measurements be split up among global NMI's to reduce infrastructure cost?
 - Future model of the NMI's? (EMN European Metrology Networks?)

Measurement Challenges

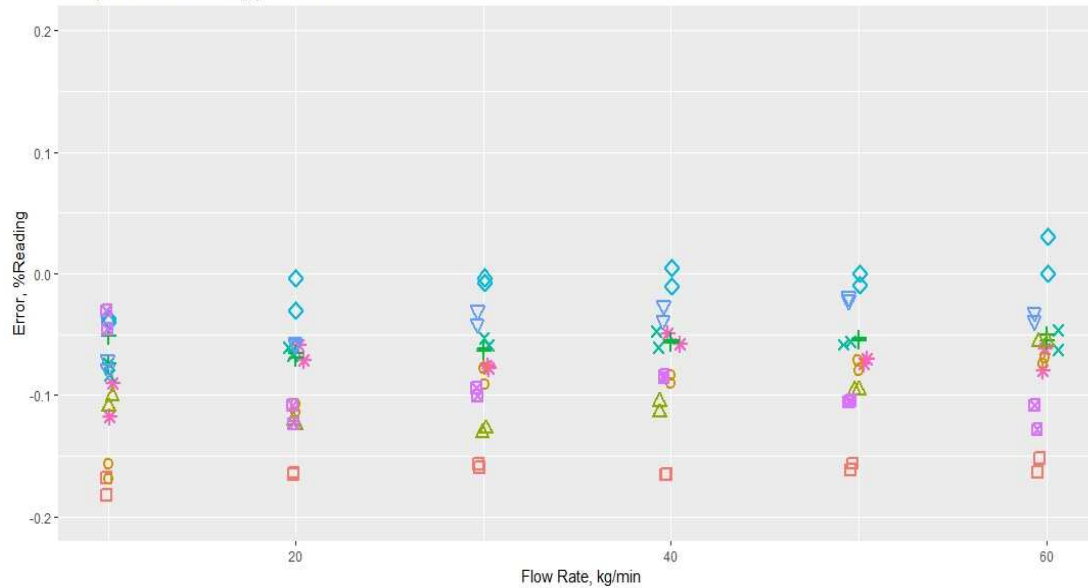
What if:?

Only two labs were compared?

Comparison Results - (2) Flow Labs



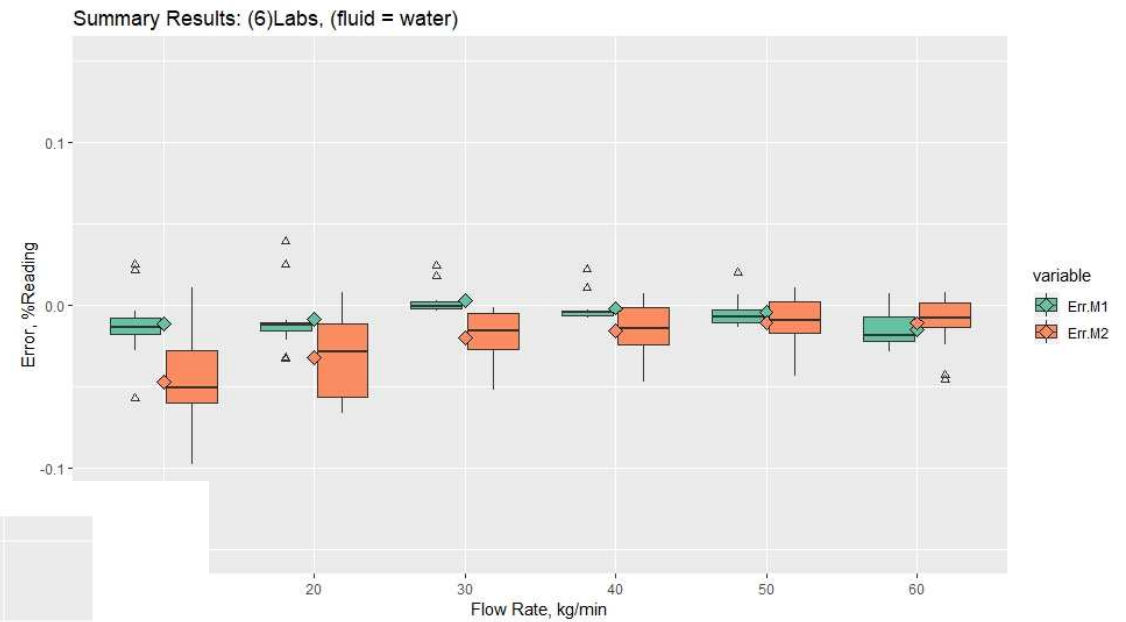
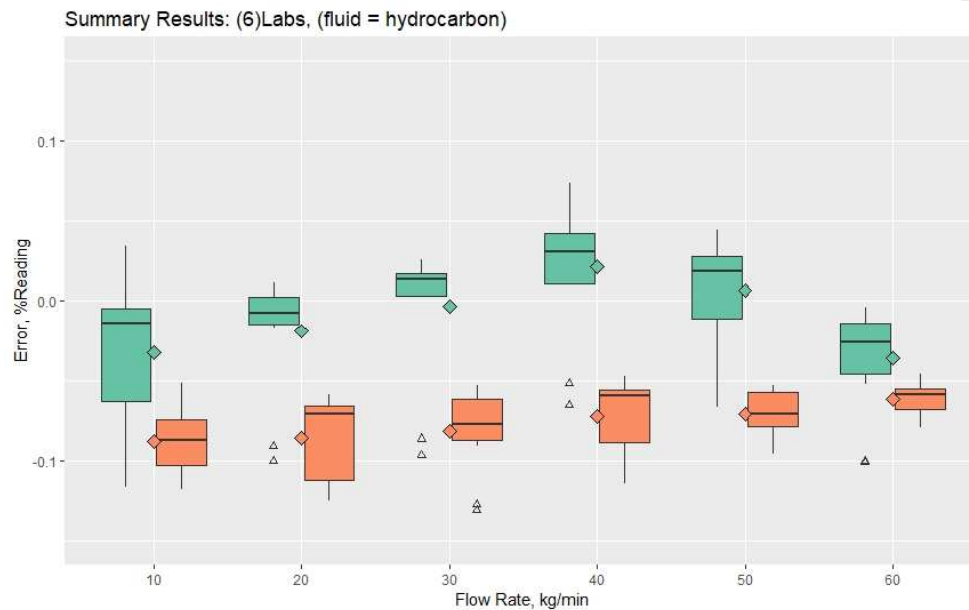
Comparison Results - (9) Flow Labs



Measurement Challenges

What if:?

Only one fluid was used?

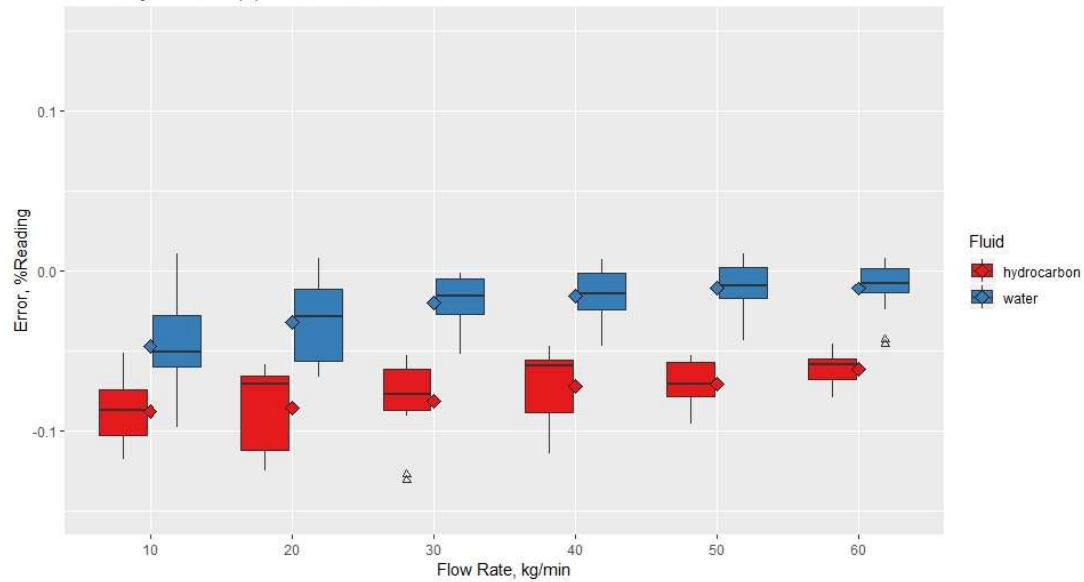


Measurement Challenges

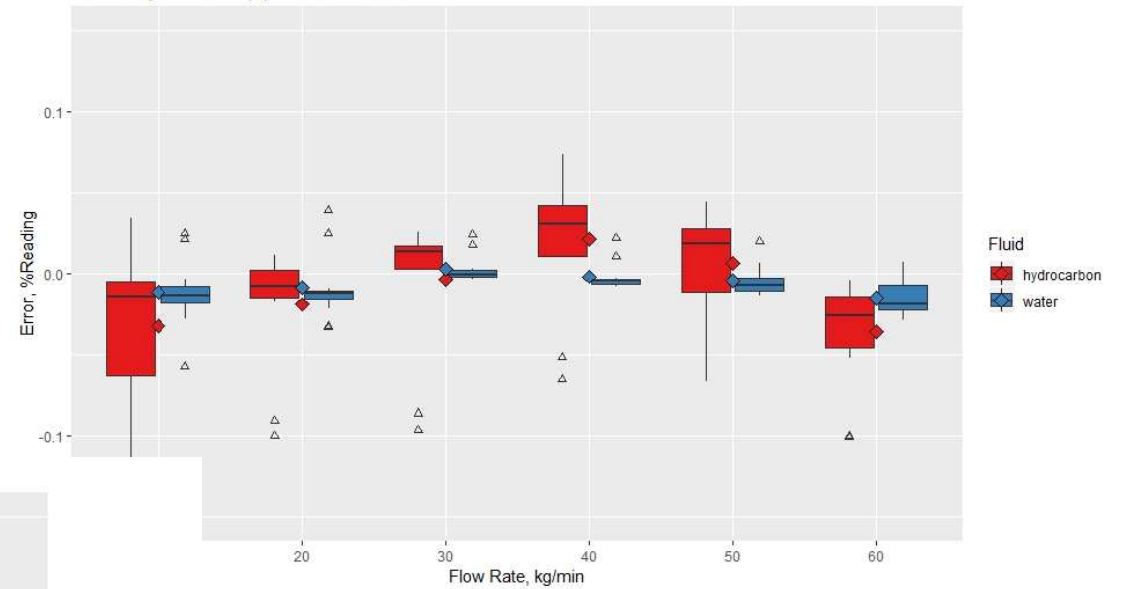
What if:?

Only one flow meter was used?

Summary Results: (6)Labs, Meter #2



Summary Results: (6)Labs, Meter #1



“Can it be, Ischomachus, that asking questions is teaching? I am just beginning to see what is behind all your questions. You lead me on by means of things I know, point to things that resemble them, and persuade me that I know things that I thought I had no knowledge of.”

Socrates (Quoted in Xenophon's "Economics")

What do we need for the future?

- What does it mean to make measurable? “Beyond All Doubt”
 - How far do we push innovation in metrology?
 - How far are we willing to invest in (ultra) low uncertainties in flow
- How many NMI's are required to make a measurement to ensure the correct uncertainty in the traceability chain?
- What does the future model (role) of the NMI look like to support future measurements?
 - Are all NMI's providing traceability to all SI units? Do they need to choose?
 - Who is funding the model? As a flow industry can we wait for innovation on our governments?



“How do we provide and maintain flow measurement traceability for the fluids of the future?”

- If I had the answer, I would tell you!
- The minimum we need to do is work together:
 - NMI, manufacturers, industry and regulators
 - Joint investment, innovation and R&D
 - Make sure when we invest, we all share the same goal
- My dream would be to have a platform where we are no longer just interested in the individual goals of our companies and institutes but one where we make a difference for the world. This can be in many area's like health care, environment, energy transition or any other challenge in the future. In the end that would support the goals of those we work for.
- How can we achieve this? You tell me!

VSL

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