

Challenges and solutions for air speed and air flow rate calibration

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JCGM 200:2008

International vocabulary of metrology — Basic and general concepts and associated terms (VIM)

Vocabulaire international de métrologie — Concepts fondamentaux et généraux et termes associés (VIM)

VIM:

http://www.bipm.org/utis/common/documents/jcgm/JCGM_200_2008.pdf

What is calibration?

■ Calibration

- Comparison between a device (under calibration) and a standard
- Many parameters may influence the result:
 - ☞ Pressure, Temperature
 - ☞ Flow nature
 - ☞ Device type itself
 - ☞ ...

Formal definition (VIM)

■ Calibration (2.39)

- *operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication*

What is a standard?

■ Standard

- *measuring instrument or system intended to reproduce values of a quantity as a reference*
 - ☞ Fans, pipes, fluids, instrumentation, calculations, ...

Formal definition (VIM)

■ measurement standard (6.1)

- *realization of the definition of a given quantity, with stated quantity value and associated measurement uncertainty, used as a reference*

What is an air speed standard?

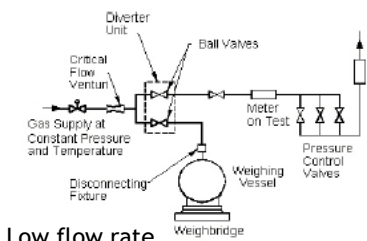


Tow carriage (Japan)

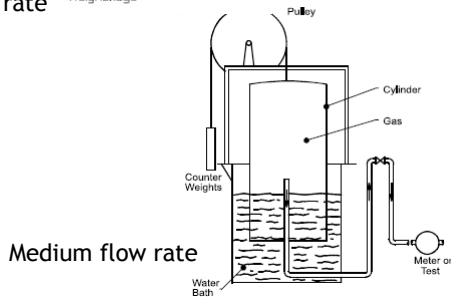


Wind tunnel & Laser Doppler Anemometer (France)

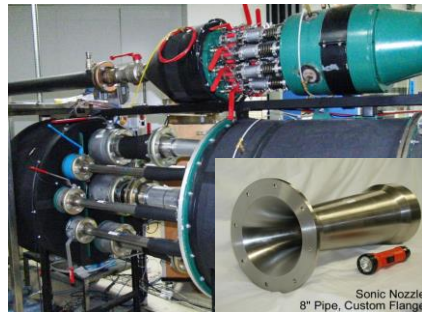
What is a (gas) flow standard?



Low flow rate



Medium flow rate

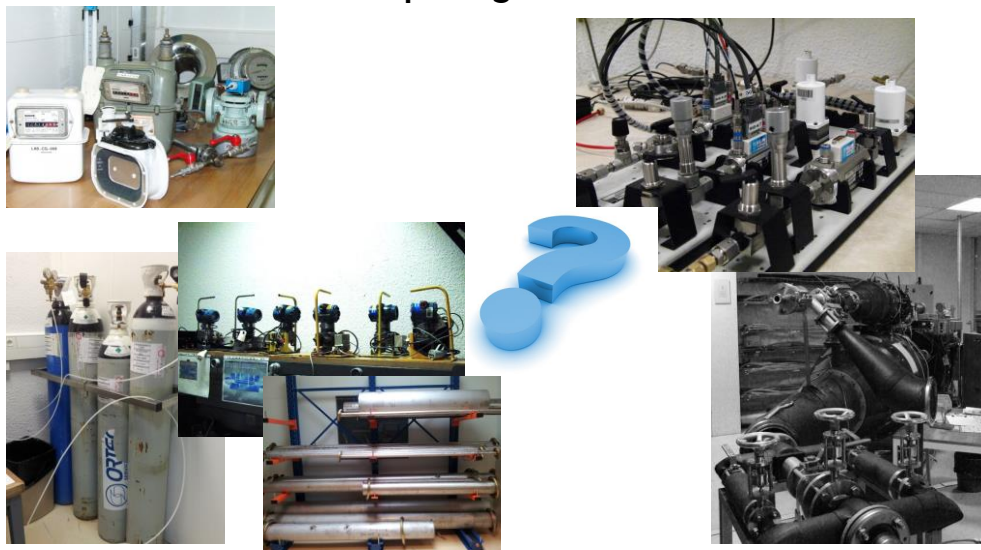


High flow rate

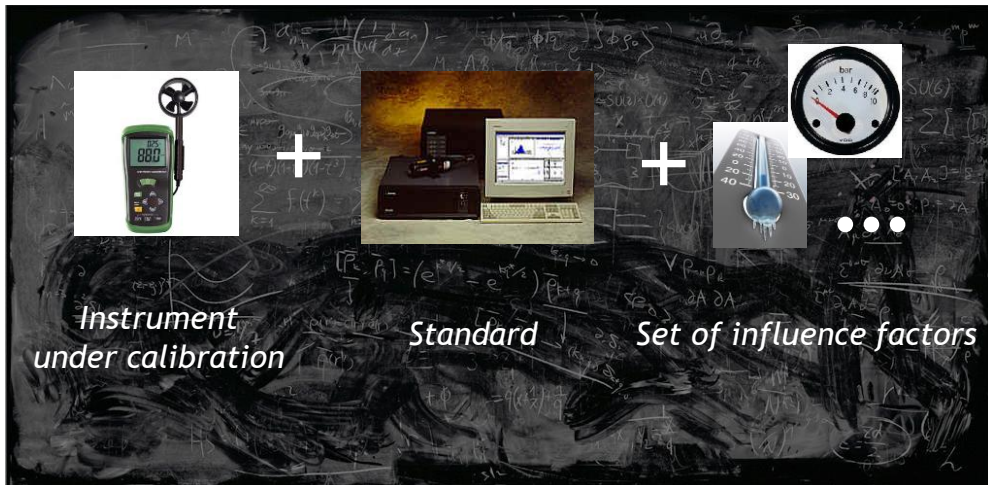
Some examples: air speed calibration



Some examples: gas flow calibration



What is a air speed/flow calibration?



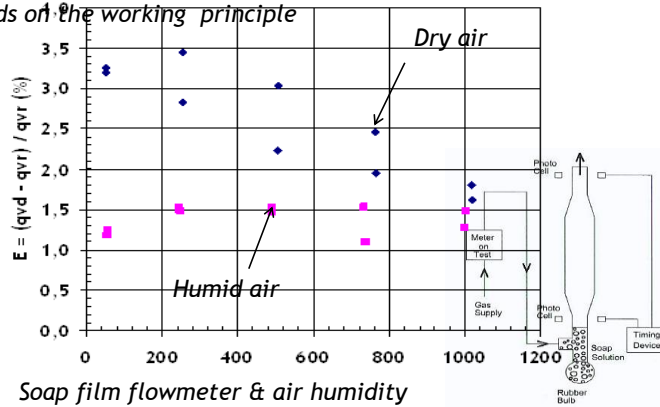
Importance of calibration conditions

- **Calibration: operation that, under specified conditions, ..., establishes a relation between the quantity values ... provided by measurement standards and corresponding indications ...**
 - relevant calibration = calibration under conditions as closed as possible as use conditions
 - Fluid (composition, pressure, temperature, humidity, ..)
 - Flow profile
 - Flow range & standard type

Importance of calibration conditions: fluid properties

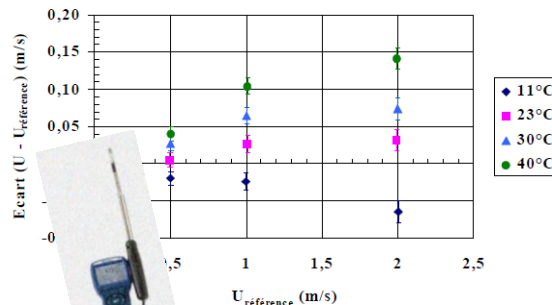
- **ALL** flowmeters interact with the flowing fluid **BUT** not in the same way!

- depends on the working principle



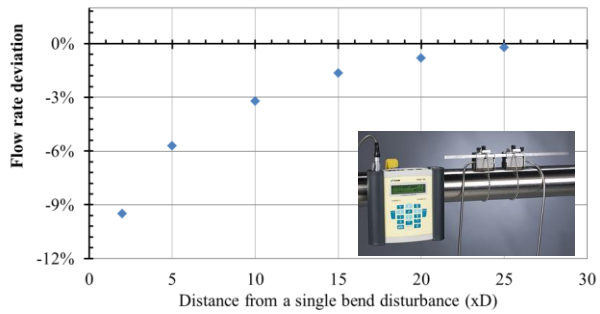
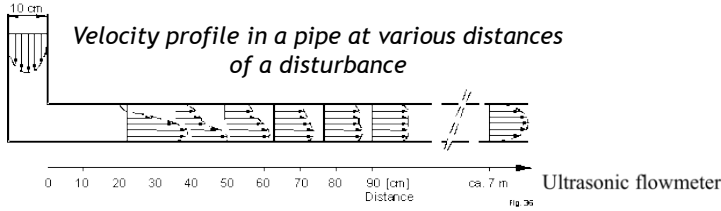
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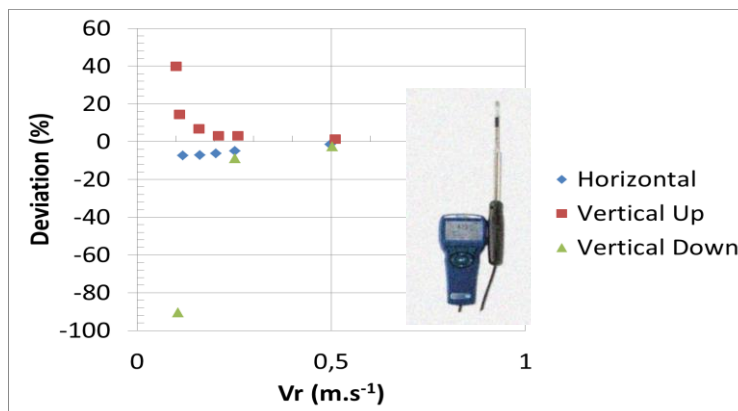


Thermal anemometer & air temperature

Importance of calibration conditions: flow profile



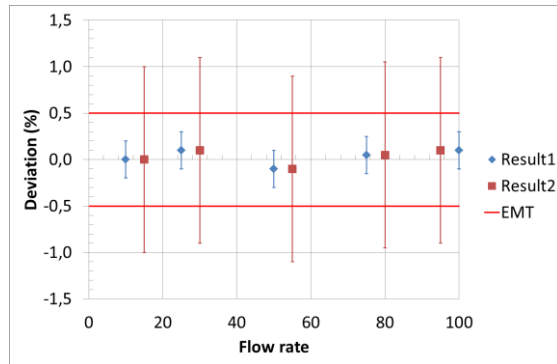
Importance of calibration conditions: flow profile



Thermal anemometer & flow direction

Importance of calibration conditions: standard type

- **Measurement of the same quantity as the device under test (mass/volume)**
- **Confidence in the standard measurement**
 - Low enough uncertainty measurement for the purpose



How to reach relevant flow calibration conditions?

Device under test

- **Understanding of the working principle**
 - Kind of measurement (mass/volume)
 - Straight lengths
- **Use conditions**
 - Nature of fluid
 - Pressure, temperature & humidity conditions

Calibration method choice

- **Flow range & conditions**
- **Device under test type**
- **Accuracy required**

Thank you for your attention

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