Installation Effects with Asymmetric Interference Generator with Glycol

EMATEM, Kloster Seeon, 29.09.2021

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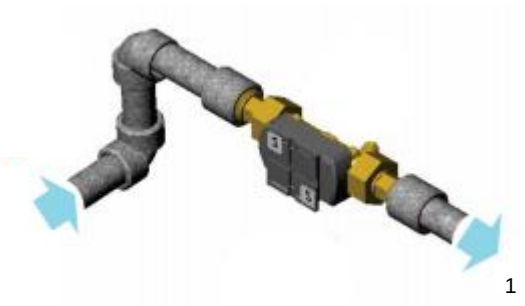
Agenda

- Motivation
- Test setup
- Results and comparison to water
- Conclusion

Motivation

- The accuracy of the flow measurement of an approved thermal energy meter needs to be guaranteed
  - over a wide flow range — typical dynamic range (q_i:q_p): 1:100
  - over a wide temperature range — typical temperature range: 5°C…120°C water, -20°C with glycol
  - for flow conditions occurring in the application



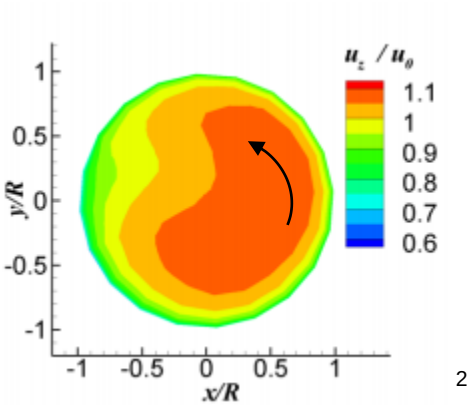
1

1] D.F. Hinz, C. Bombis, M. Turiso (Kamstrup): Neuer asymmetrischer Drallgenerator, EMATEM 2016

Motivation

- Extract EN1434:4-2020 (pattern approval tests)
  - 7.22 flow disturbances:
    *"The flow sensor shall be exposed to **flow conditions** … usually found **downstream of 90°- bends connected at right angles**"*

real installation



asymmetric velocity distribution and swirl

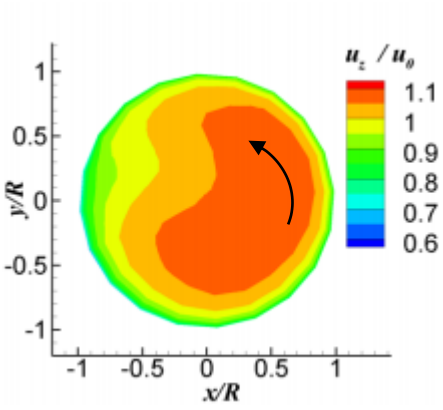
2

2] Karsten Tawackolian (PTB): Verbesserter Störkörper, EMATEM 2012

Motivation

- Extract EN1434:4-2020 (pattern approval tests)
  - 7.22 flow disturbances:
    *"**At the test rig**, these flow conditions shall be created by the **asymmetric swirl generator (ASG)**"*

ASG

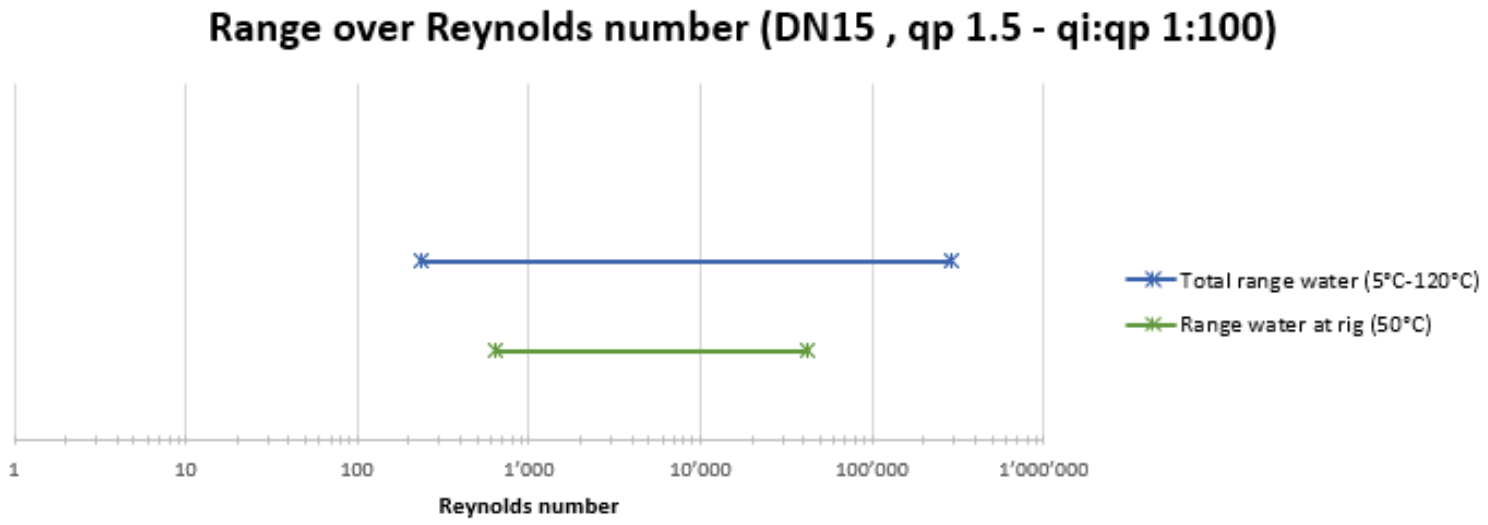


asymmetric velocity distribution and swirl

Motivation

- Extract EN1434:4-2020 (pattern approval tests)
  - 7.22 flow disturbances:

*"Error determinations at **flow levels $q_1 \ldots q_4$** at the **temperature level of (50 ± 5) °C** shall be made without and with the ASG and no significant faults shall occur"*

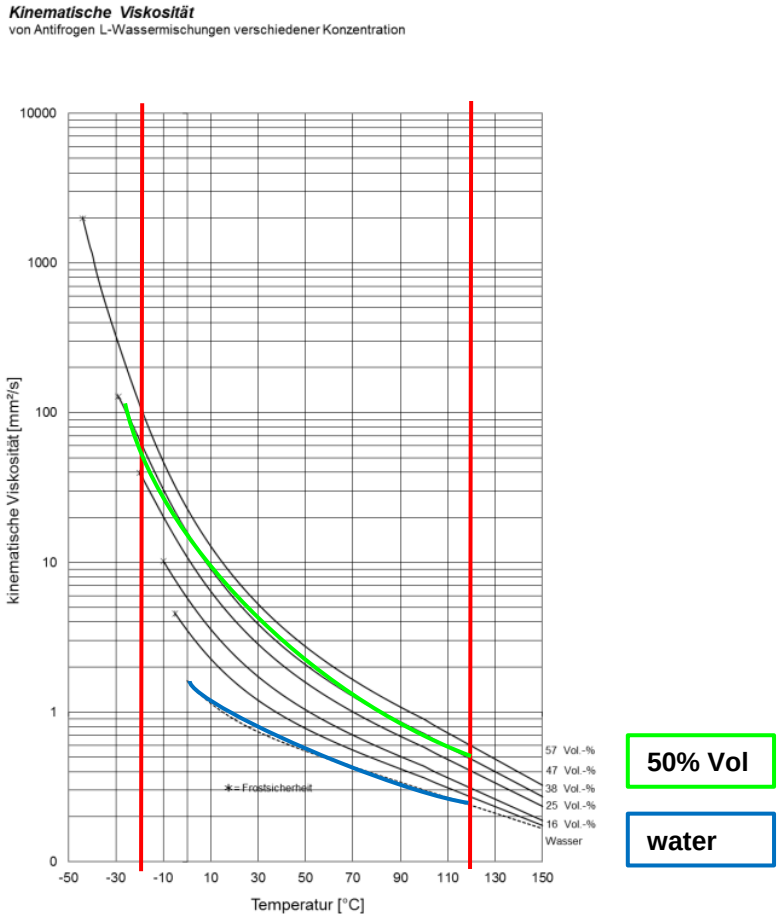


Motivation

- A change of the fluid from water to glycol shifts the operating range to lower Reynolds numbers due to the higher kinematic viscosity

$$Re = \frac{v \cdot D}{\upsilon}$$

Re = Reynolds number
v = flow velocity
D = hydraulic diameter
υ = kinematic viscosity



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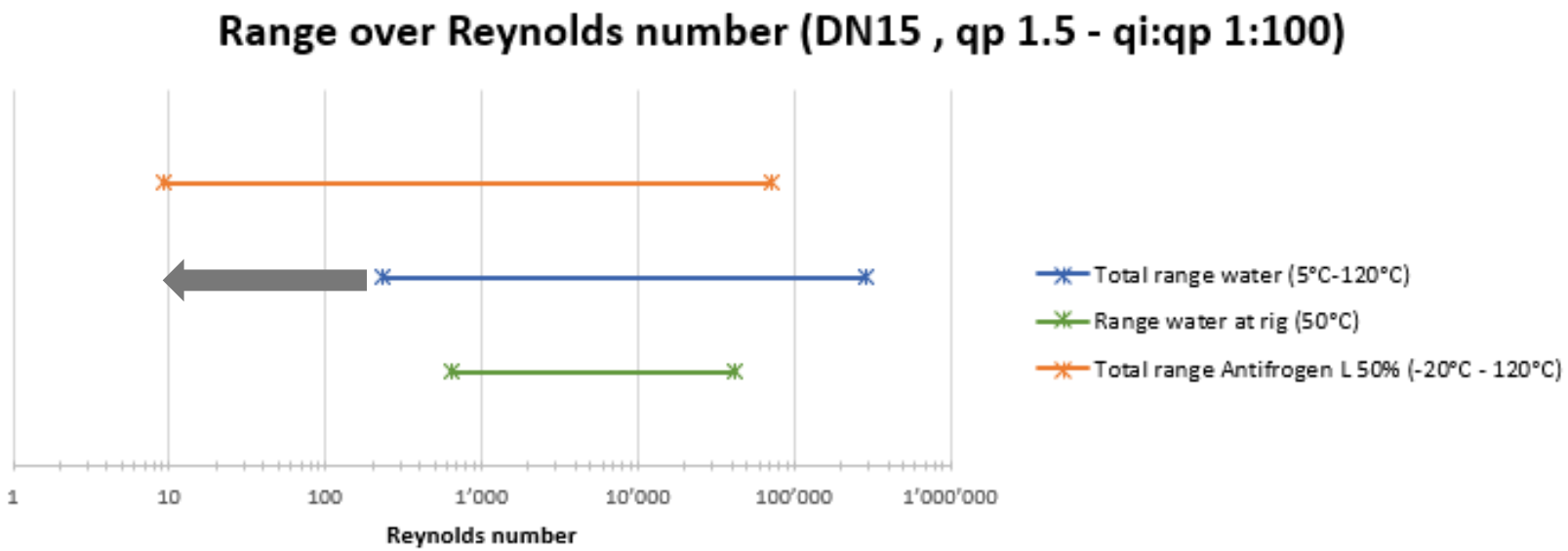

Motivation

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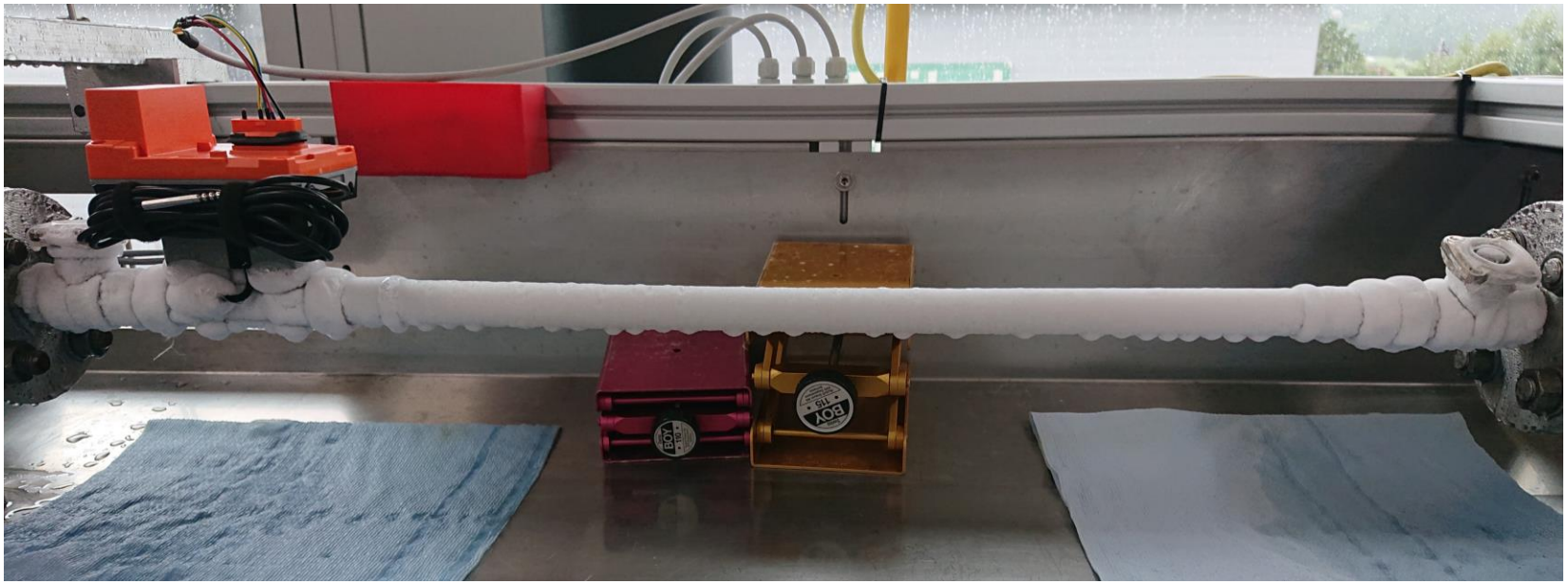
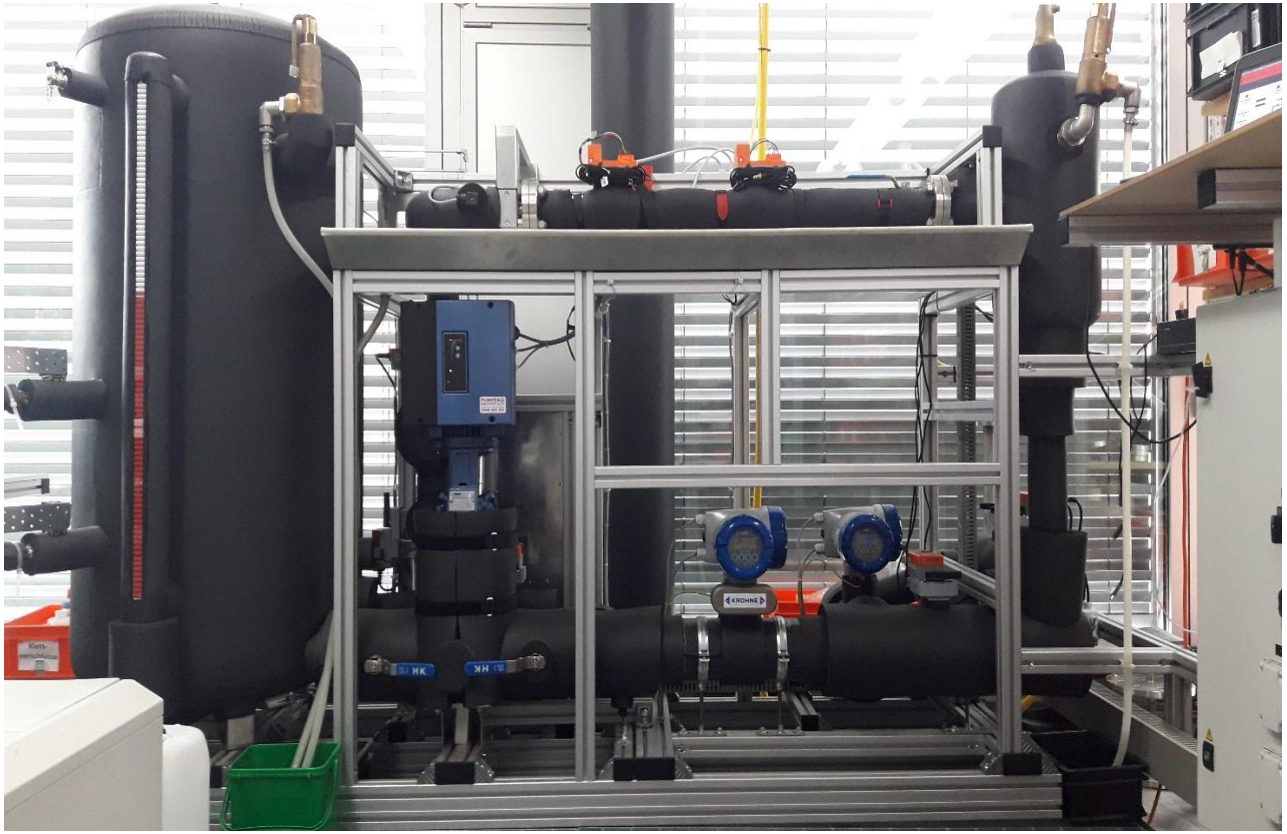


- What is the influence of the ASG on the flow sensor at a high kinematic viscosity (≥ 5 mm^2/s) and small Reynolds numbers (<100)?

Test Setup

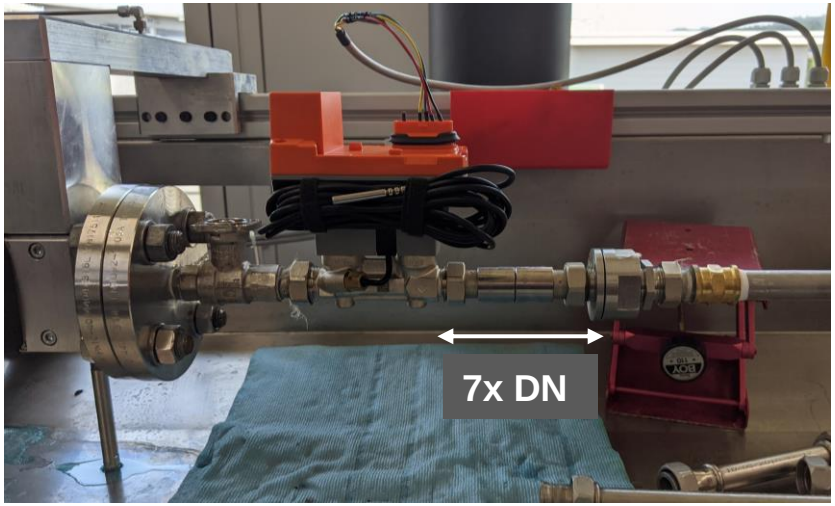
- Closed loop
- Reference:
  Coriolis meters*
- Flow range:
  5…7000 l/h
- Temperature range:
  -10°C…120°C
- Fluid: Antifrogen L 50%



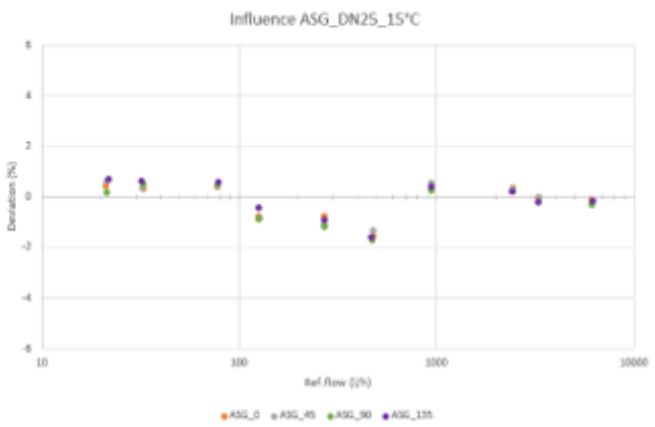
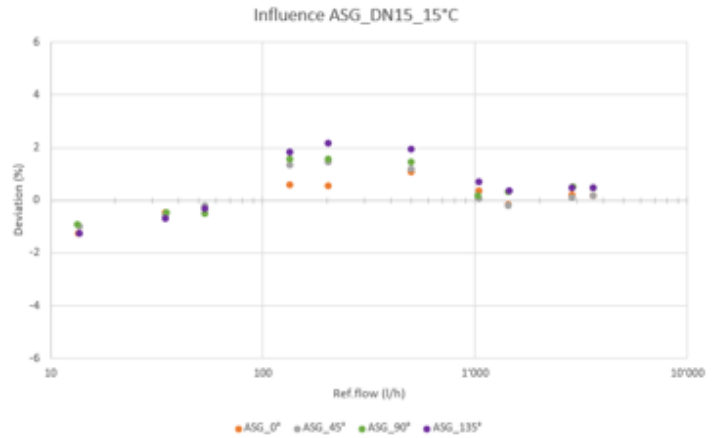
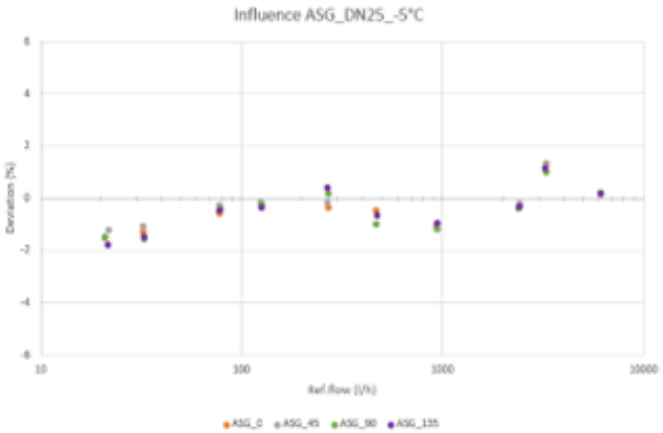
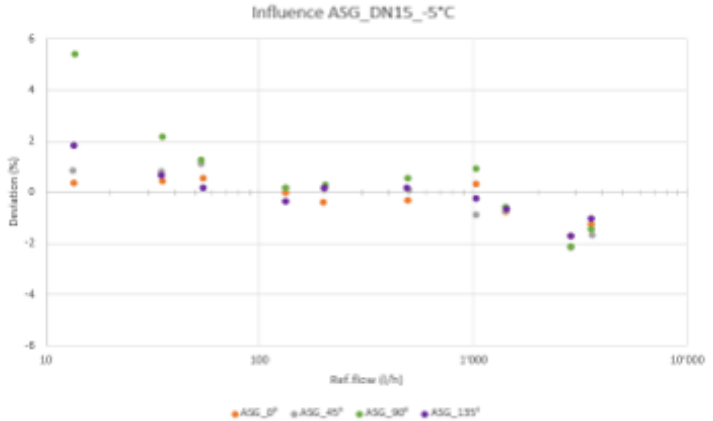
* Conversion from mass flow to volume flow using the density of Antifrogen L in respect to the fluid temperature

Test setup

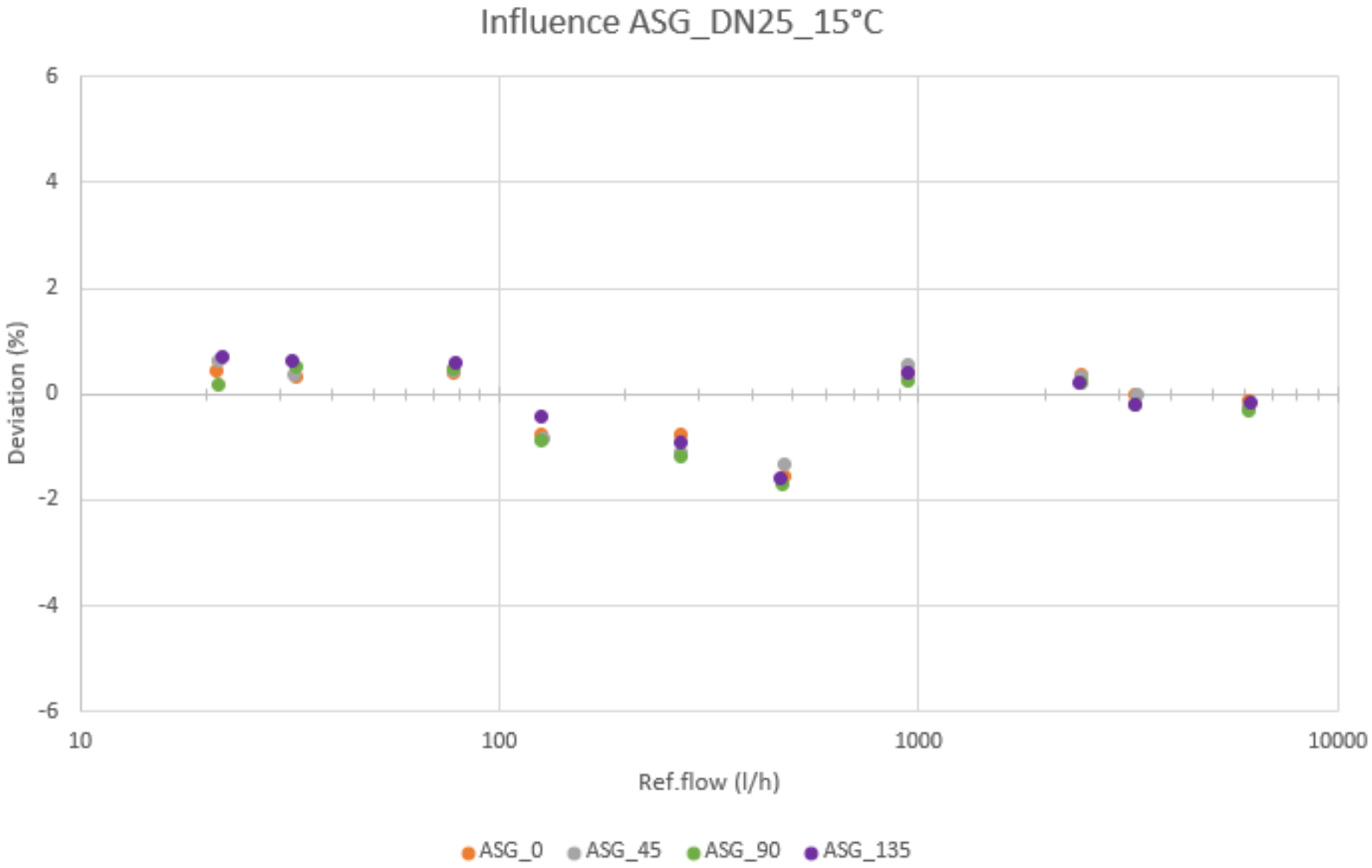
- Devices under Test: Belimo ultrasonic flow sensor DN15 (qp 1.5) and DN25 (qp (2.5)
- Installation of ASG according to EN1434:4 (distance of 7xDN, 4 orientations of ASG)
- Fluid temperature: 15°C and -5°C



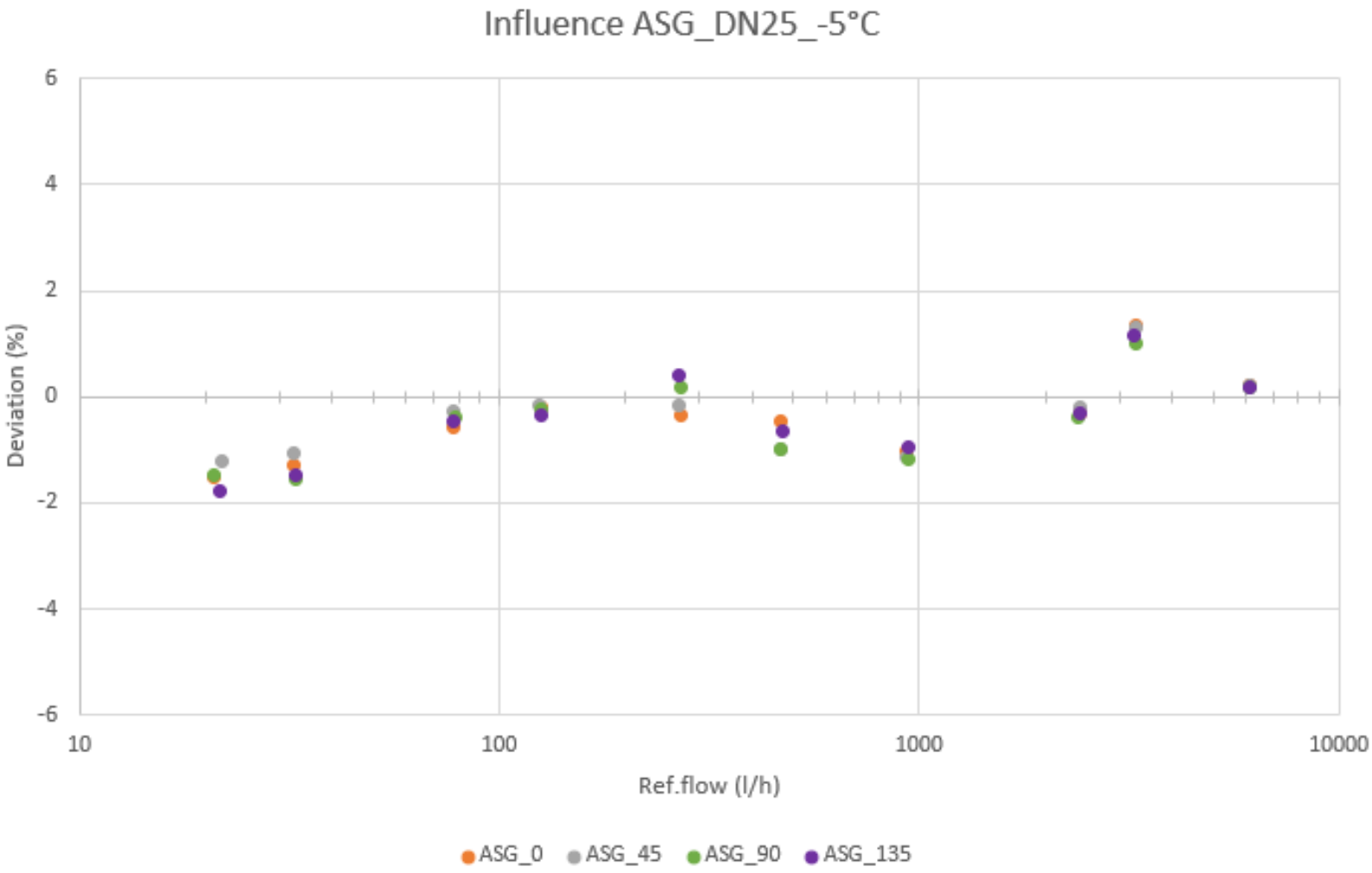
Results - Overview

	DN25	DN15
15°C		
-5°C		

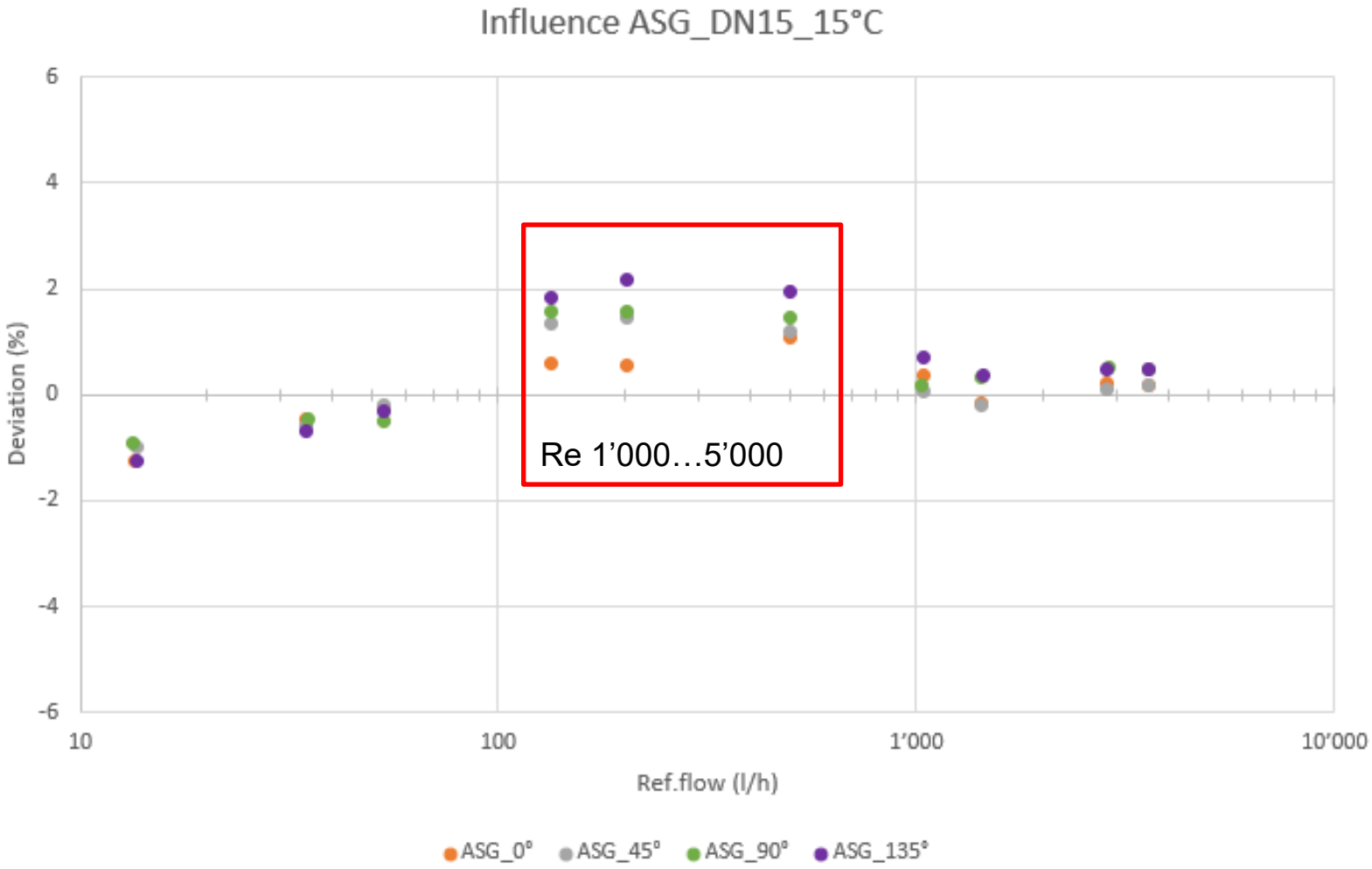
Results DN25



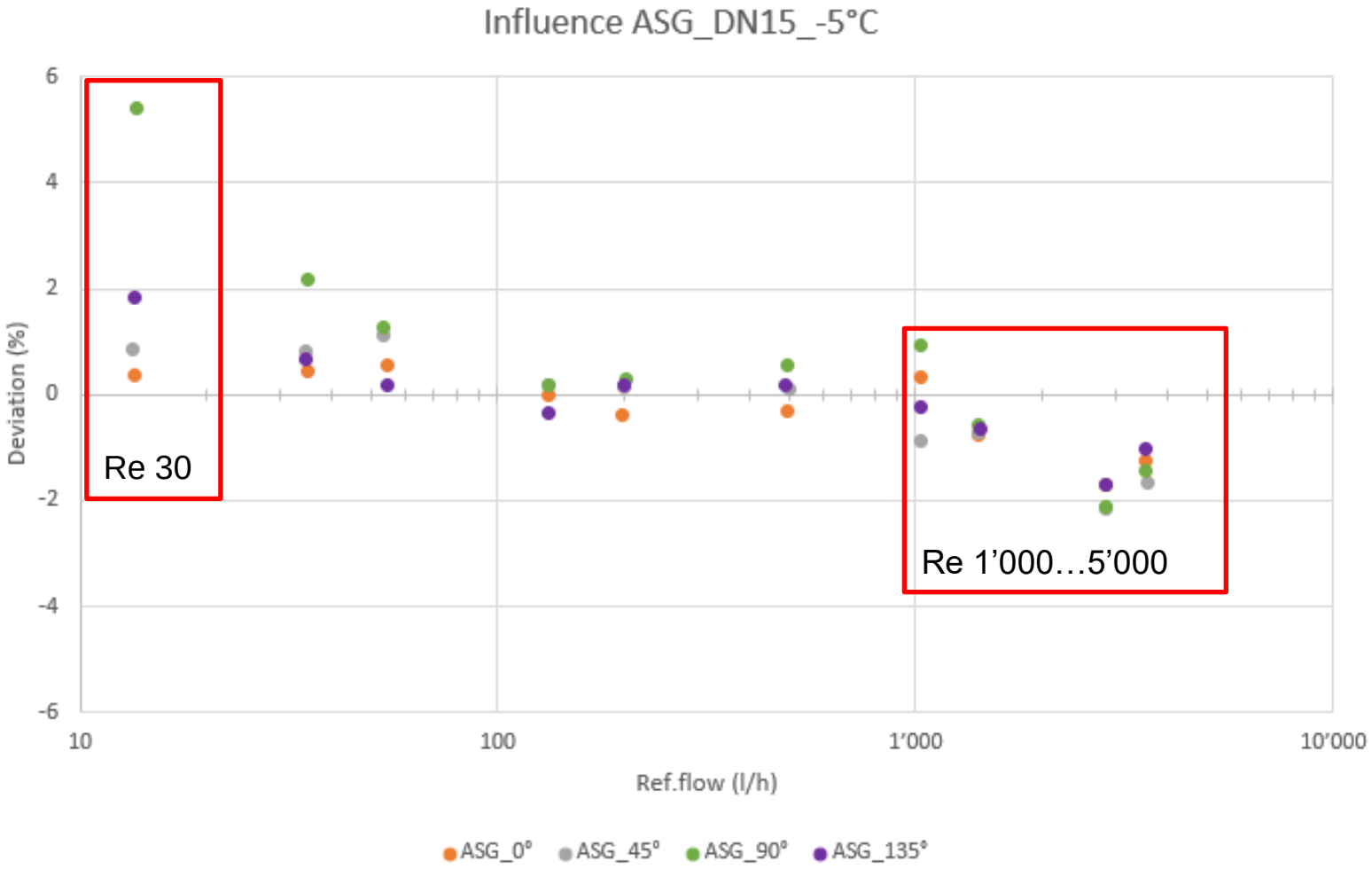
Results DN25



Results DN15



Results DN15



Comparison to water

- At the same Reynolds number there are equal flow situations

  → Is the influence of the ASG then also equal?
  → Is it reasonable to perform the flow disturbance test with water?

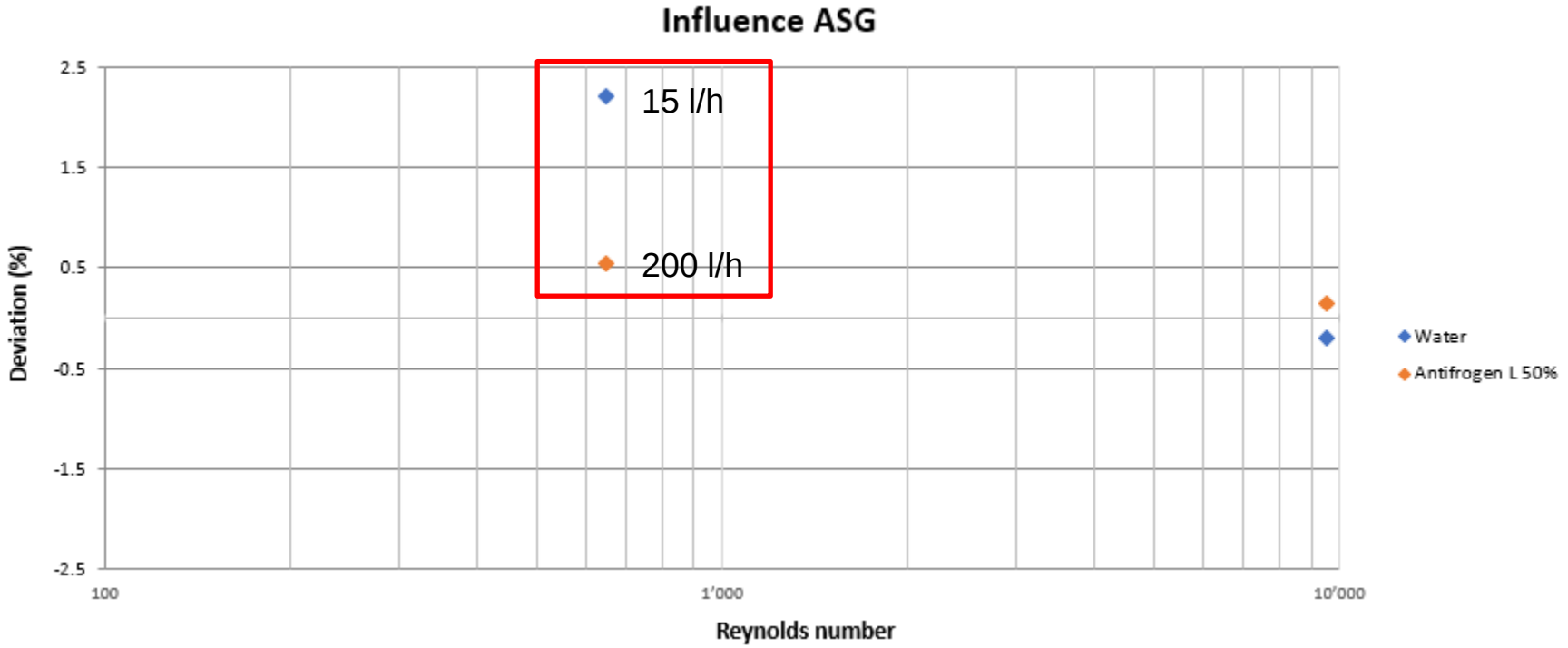
  - DN15: laminar flow @ Re ≈ 650:
    - medium water: 50°C, ≈ 15 l/h
    - Antifrogen L 50%: 15°C, ≈ 200 l/h

  - DN15: turbulent flow @ Re ≈ 9500:
    - medium water: 50°C, ≈ 220 l/h
    - Antifrogen L 50%: 15°C, ≈ 2900 l/h

Comparison to water

- At the same Reynolds number there are equal flow situations

  → Is the influence of the ASG then also equal?



Conclusion

- At a high kinematic viscosity the ASG leads for both sizes to deviations in the range up to ± 2%
- There is no dependency on the orientation of the ASG observable for DN25. DN15 shows slight differences in regards to the orientation
- The comparison between glycol and water at same Reynolds numbers shows that
  - there is only a small difference at turbulent flow
  - the influence of the ASG is bigger with water at laminar flow

Conclusion

- Is it reasonable to perform the flow disturbance test with water?
  - Due to the higher flow rates and associated lower uncertainties at low Reynolds numbers the test shall preferably be performed with the fluid of the higher viscosity

- Extract EN1434:4-2020 (pattern approval tests)

Meters for the use with heat-conveying liquids other than water have to perform the following tests with liquids other than water:

— Flow disturbance test (7.22); the effect of flow disturbances is changing for liquids other than water because the viscosity of the liquid is an additional influence on the flow profile. Therefore, this test shall be carried out at the limits of the foreseen field of operation with regard to viscosity and density- so at the highest and lowest viscosity and density expected with the stated liquids, temperatures and concentrations.

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