Measurement of Water Density by Coriolis Flow Meters Under Different Test Conditions

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Objectives

- Assess current/new technologies for LNG density measurement by performing measurements under **ambient** and cryogenic conditions:
  - Coriolis flow meters
  - INRIM's density sensor (simultaneous density and SoS measurements)
- Suggest improvements to measurement accuracy
- Develop an improved SI-traceable calibration procedure for LNG density

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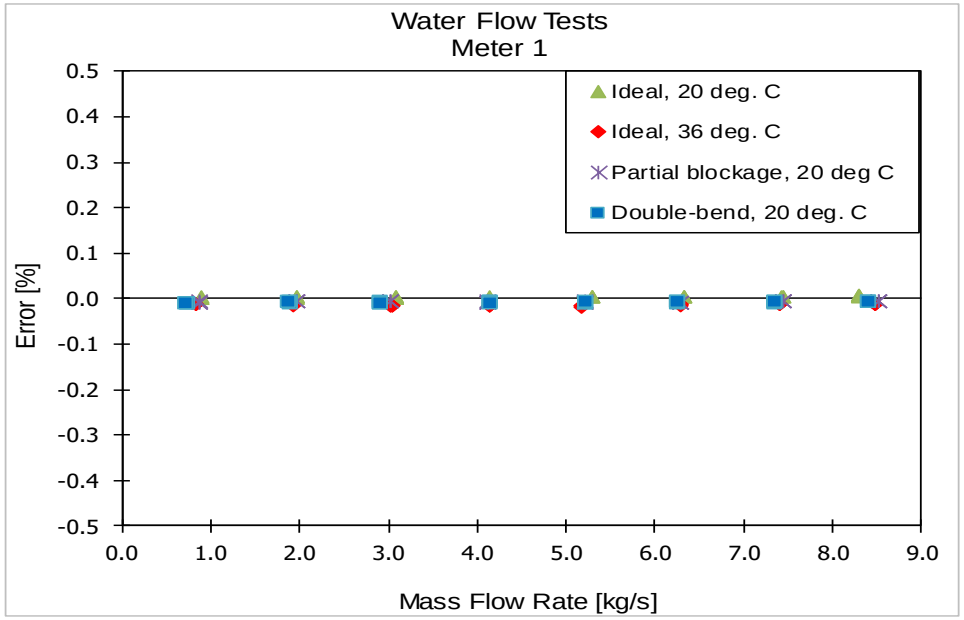
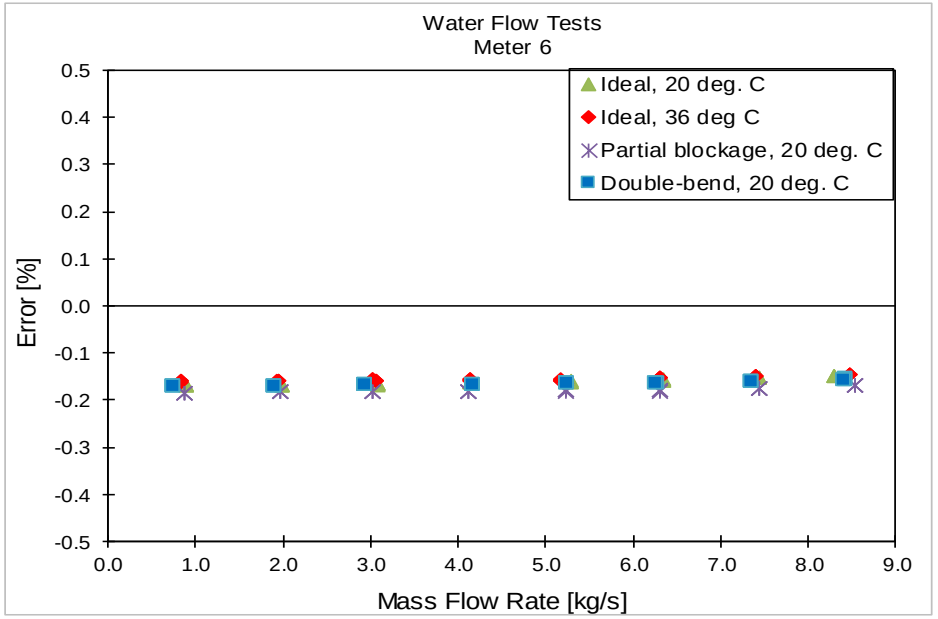
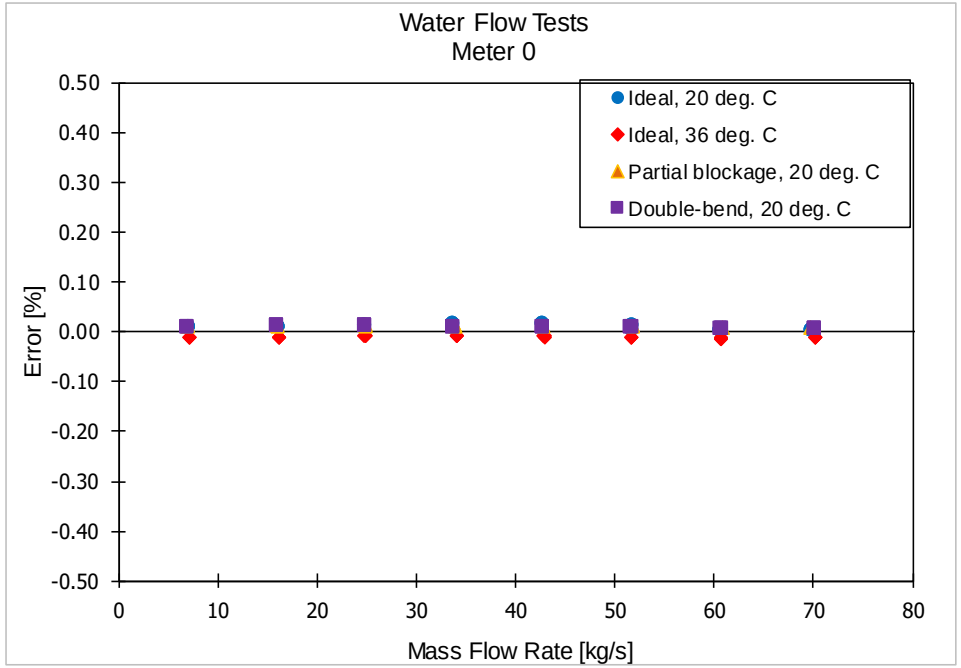
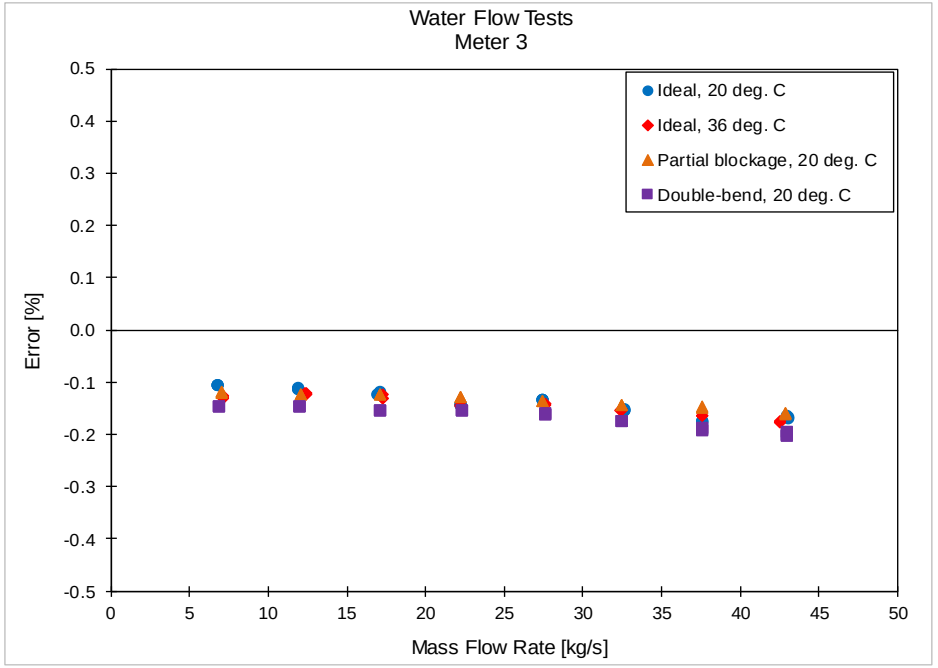
- This short presentation focuses on **ambient** (water) density measurements carried out at NEL using Coriolis meters.
- Information on test conditions, test configurations and test facilities were presented earlier in WP1 session.

Test Results









Summary Table

Meter	Ideal, 20 °C		Ideal, 36 °C		Partial block., 20 °C		Double-bend, 20 °C	
	Ave. % Err. In density (min.)	Ave. % Err. In density (max.)	Ave. % Err. In density (min.)	Ave. % Err. In density (max.)	Ave. % Err. In density (min.)	Ave. % Err. In density (max.)	Ave. % Err. In density (min.)	Ave. % Err. In density (max.)
1	**0.00**	0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01
6	-0.15	-0.17	-0.15	-0.16	-0.17	-0.19	-0.16	-0.17
0	0.00	0.01	-0.01	-0.01	0.01	0.01	0.00	0.01
3	-0.11	**-0.18**	-0.12	-0.17	-0.11	-0.16	-0.14	-0.20

Conclusions

- The influence of the tested flow disturbances on measured water density is insignificant
- Since all meters were tested "as found" with no change to their settings, the fixed deviation (error) exhibited by meters 3 and 6 is likely to be related to their original calibration and can be fixed by recalibrating them at the appropriate conditions
- All test meters showed excellent repeatability of density measurement (better than 0.005%) under all test conditions, this has led to
- A combined measurement uncertainty of 0.03% (k = 2) for all test cases which is the same uncertainty in the facility reference density.
- It can be concluded from this work that the water density is measured by the Coriolis flow meters tested in this project with uncertainty better than 0.05% (k = 2).