

WP 2 - Impact of water quality on the performance of cold water meters: Derivation of requirements for the test regime – development of test waters

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Metrology for Real-World
Domestic Water Metering

TOPICS

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- 2 Flow profile
- 3 Model waters
- 4 Measurement infrastructure
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Introduction

- Water quality is suspected to have a significant impact on the accuracy of water meters, especially mechanical meters
 - Parameters under scrutiny are mainly water hardness and particle load
- ISO 4064:2014 or OIML R 49: 2013 (E) describe two type of durability tests for water meters without considering the water quality
 - Discontinuous test for 100,000 on-off cycles (flow rate: Q_3 , 15s)
 - Continuous test for a maximum flow rate of Q_4 over a period of 100h
- **Objective: Develop and conduct laboratory tests (accelerated wear tests) to examine cold water meters for water quality related impacts**

Introduction

Water meter calibration
before the test

Determination of
measurement errors at six
flow rates

Wear test

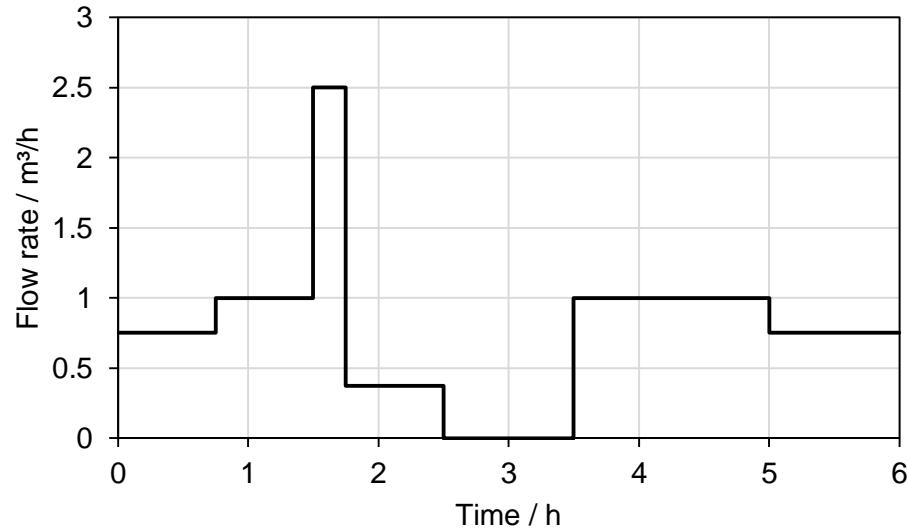
- Defined water quality (model water)
- defined flow rate(s) and test period

Water meter calibration
after the test

Determination of
measurement errors at six
flow rates

Flow profile

- Focus on domestic cold water meters of size $Q_3 = 2.5 \text{ m}^3/\text{h}$



Flow profile

- The profile was repeated continuously for 11 days in each wear test until a total throughput of 189 m³ was reached.
 - 189 m³: average total throughput for cold water meters of size $Q_3 = 2.5 \text{ m}^3/\text{h}$ in 6 years (Germany)
- The dynamic flow profile was used by two partners. Four partners, on the other hand, used the mean flow of the dynamic profile as constant flow rate for the wear tests.
 - Constant flow rate 750 – 800 l/h

Model water

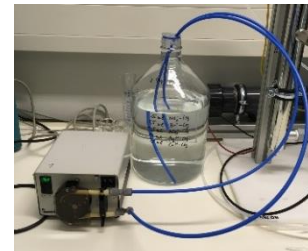
- Based on a European survey on tap water quality and the EU Drinking Water Directive, the **target values** for the model waters were derived.

Parameter under investigation	Target values
pH	6.5, 7.7, 9.5
Total hardness	1 mmol/L (soft water) 2 mmol/L (medium-hard water) 3 mmol/L (hard water)
Particle load	2.8 mg/L, 6.2 mg/L and 20 mg/L of Quartz sand in two grain size ranges (0 – 63 μm and 60 μm – 300 μm)

Base model water

Substance name	Substance formula	Concentration Stock solution (SL)	Ion	Ion concentration in SL	SL dosing	Model water (MW) ion concentration
		g/l		g/l	ml(SL)/l(MW)	mg/l
Calcium chloride dihydrate	$\text{CaCl}_2 \times 2 \text{H}_2\text{O}$	86.9	Cl^-	41.9	0.5	21.0
			Ca^{2+}	23.7		11.8
Magnesium sulfate heptahydrate	$\text{MgSO}_4 \times 7 \text{H}_2\text{O}$	77.9	SO_4^{2-}	30.4	2	60.7
			Mg^{2+}	7.7		15.4
Sodium bicarbonate	NaHCO_3	67.2	HCO_3^-	48.8	2.5	122.0

- Characteristics of the base model water:
 - pH \approx 8.4
 - Total hardness \approx 1 mmol/L



Model water

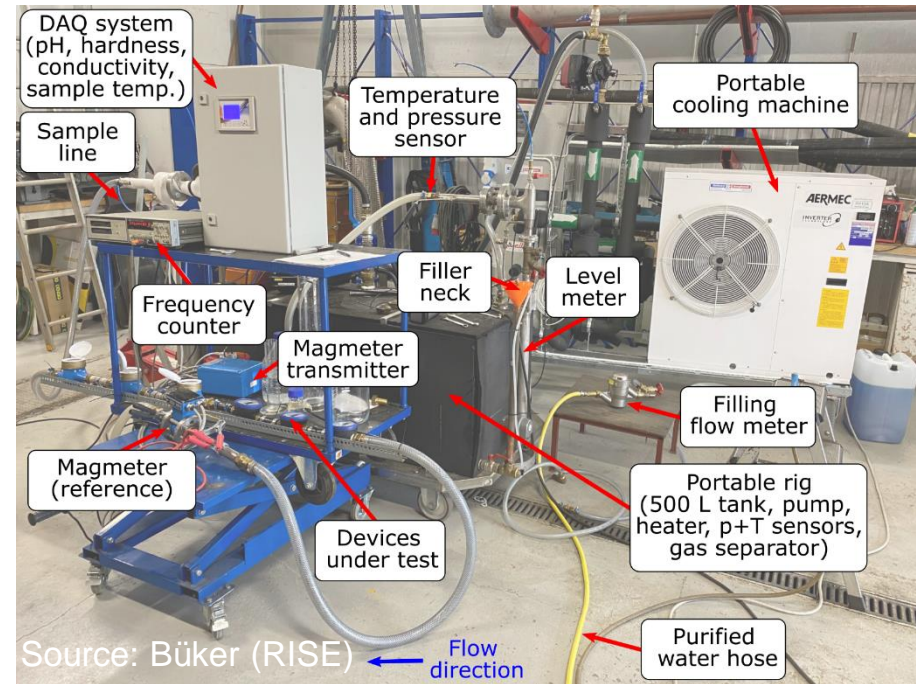
Parameter under investigation	Target value	Breakdown of model water recipes
pH	6.5, 7.7	Base model water + two buffer solutions (Di-Sodium hydrogen phosphate and Potassium dihydrogen phosphate)
	9.5	Base model water + sodium hydroxide (NaOH)
Total hardness	1 mmol/L	Base model water
	2 mmol/L, 3 mmol/L	Base model water with adjusted concentrations of CaCl_2 and MgSO_4
Particle load	3 concentrations, 2 grain sizes	Base model water + Quartz sand (varying concentrations and grain sizes)

Model water

- Most partners conducted all the experiments related to pH and total hardness
- Only PTB performed the experiments related to particle load
- In addition PTB extended their test set by wear tests with:
 - High total hardness,
 - Extended test duration,
 - Higher particle loads,
 - Combinations of the above.

Measurement infrastructure

- 4 partners deployed test rigs for the wear tests
- 2 partners installed small-scale model networks



Investigated water meters

- 187 cold water meters of size $Q_3 = 2.5 \text{ m}^3/\text{h}$ were investigated

Manu- facturer	Single- Jet R80	Single -jet R160	Multi- jet R100	Multi- jet R160	Piston R160	Magn.- ind. R160	Ultra- sonic R100	Ultra- sonic R160	Ultra- sonic R250	Ultra- sonic R400
A	11									
B	4		4		4			4		12
C		18		18					18	
D				3						
E				19						
F				18						
G					3					
H				3	13	14				
I							18		3	

Summary

Water meter calibration
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Wear test

- Defined water quality (model water)
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Water meter calibration
after the test

Determination of
measurement errors at six
flow rates

- Testing of 187 water meters ($Q_3 = 2.5 \text{ m}^3/\text{h}$) of different types
- Focus on pH, total hardness and particles
- Model waters based on mixing recipes
- Experiment duration: approx. 11 days
- Dynamic flow profile or constant flow
- Monitoring of key parameters (pressure, temperature, pH, ...)

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