



H2 High Pressure Coriolis Flow Meters Challenges in approval and design

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11-09-2019

Possible OIML standards for H2 Coriolis approval process

- OIML R137 Gas meters (CNG excluded)
- OIML R139 Compressed gaseous fuel measuring system for vehicles including flow meter (incl. CNG)

>for OIML R137 and OIML R139 only type approval available now

>national standards may be different

>only NMi has accreditation for OIML R139 now. FORCE DK to finish in 2020

- NIST to be observed



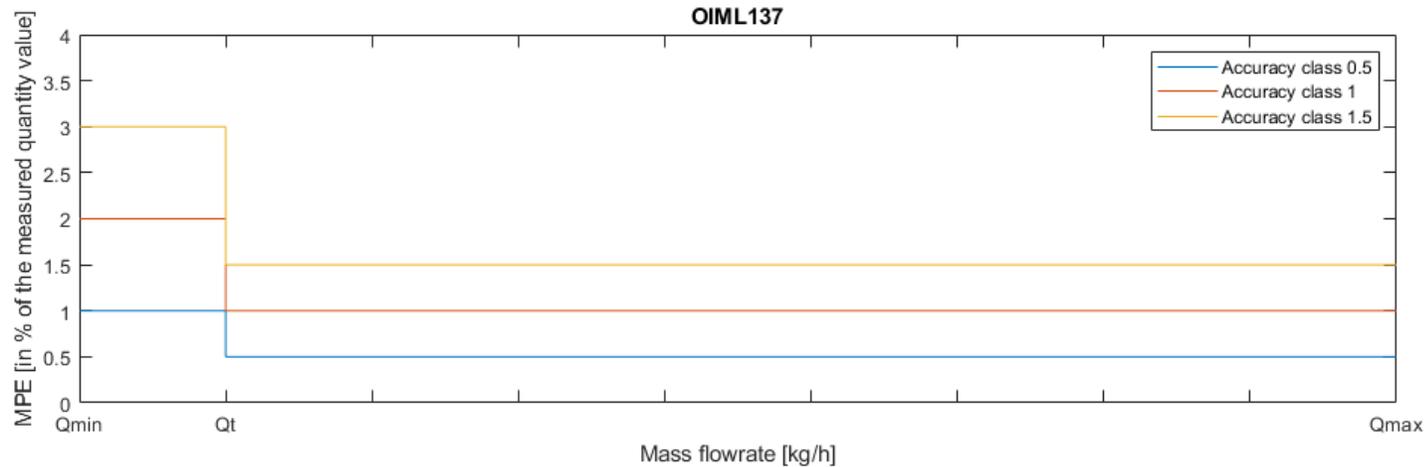
Review EMC Test Program OIML R 137/139

Disturbance	R137 Required immunity	R139 Required immunity	Applicable standards
Radiated, RF, electromagnetic fields	10 V/m, up to 3 GHz	10 V/m, up to 3 GHz	IEC 61000-4-3 IEC 61000-4-20
Conducted (common mode) currents generated by RF EM fields	10 V (e.m.f.), up to 80 MHz	10 V (e.m.f.), up to 80 MHz	IEC 61000-4-6
Electrostatic discharges	6 kV contact discharge 8 kV air discharge	6 kV contact discharge 8 kV air discharge	IEC 61000-4-2
Bursts (transients) on signal, data and control lines	Amplitude 1 kV Repetition rate 5 kHz	Amplitude 1 kV Repetition rate 5 kHz	IEC 61000-4-4
Surges on signal, data and control lines	Unsymmetrical lines: - line to line 0.5 kV - line to ground 1.0 kV Symmetrical lines: - line to line NA - line to ground 1.0 kV Shielded I/O and communication lines: - line to line NA - line to ground 0.5 kV	Unsymmetrical lines: - line to line 1.0 kV [DNV-GL] - line to ground 2.0 kV [DNV-GL] Symmetrical lines: - line to line NA - line to ground 2.0 kV [DNV-GL]	IEC 61000-4-5
Bursts (transients) on AC and DC mains	Amplitude 2 kV Repetition rate 5 kHz	Amplitude 2 kV Repetition rate 5 kHz	IEC 61000-4-4
Surges on AC and DC mains	Line to line 1.0 kV Line to ground 2.0 kV	Line to line 1.0 kV Line to ground 2.0 kV	IEC 61000-4-5

Review Environmental Test Programm OIML R137/139

Disturbance	R137 Required immunity	R139 Required immunity	Applicable standards
Dry heat	Upper temperature specified, 2 hours	Upper temperature specified, 2 hours	IEC 60068-2-2 IEC 60068-3-1
Cold	Lower temperature specified, 2 hours	-25 °C or -10 °C, 2 hours	IEC 60068-2-1 IEC 60068-3-1
Damp heat, cyclic (condensing)	Upper temperature, specified 93 % relative humidity	Upper temperature, specified 93 % relative humidity	IEC 60068-2-30 IEC 60068-3-4
Vibrations (random)	Total frequency range: 10 Hz – 150 Hz Total RMS level: 7 m/s² ASD level 10 Hz–20 Hz: 1 m²/s³ ASD level 20 Hz–150 Hz: -3dB/octave Gas meters having a maximum mass of 10 kg are submitted to vibrations shocks test. For gas meters exceeding this weight only the electronic part of the meter is to be tested.	Total frequency range: 10 Hz – 150 Hz Total RMS level: 1.6 m/s² [DNV-GL] ASD level 10 Hz–20 Hz: 0.05 m²/s³ ASD level 20 Hz–150 Hz: -3dB/octave Acceptance of SIMULATIONS???	IEC 60068-2-47 IEC 60068-2-64
Mechanical shock	50 mm	NA	IEC 60068-2-31
DC mains voltage dips and short interruptions	40 % and 70 % of the rated voltage during 0.1 s and 0 % of rated voltage during 0.01 s	40 % and 70 % of the rated voltage during 0.1 s and 0 % of rated voltage during 0.01 s and 85 % and 120 % of the rated voltage during 10 s	IEC 61000-4-29
DC mains voltage variation		DC mains voltage changes between upper and lower limit	IEC 60654-2
Ripple on DC mains power	2 % of nominal DC voltage	2 % of nominal DC voltage	IEC 61000-4-17

Accuracy requirements OIML R137/139

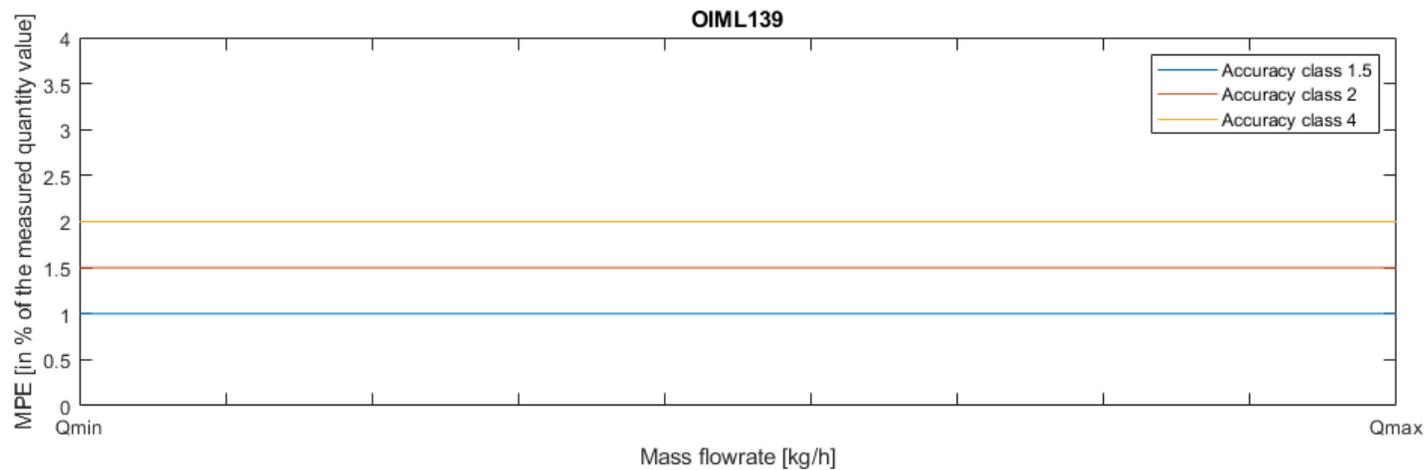


OIML R 137

The flow rate characteristics of a gas meter shall be defined by the values of Q_{max} , Q_t and Q_{min}

Their ratios and relations shall be within the ranges as:

Q_{max} / Q_{min}	Q_{max} / Q_t
≥ 50	≥ 10
≥ 5 and < 50	≥ 5



OIML R 139

The ratio between the maximum flow rate and the minimum flow rate shall be at least 10.

Q_t is not requested for the OIML R139

Difference in Standards

OIML R 139

The minimum measured quantity (MMQ) shall be specified by the manufacturer of the measuring system.

It shall have the format 1×10^n , 2×10^n or 5×10^n kg, where n is a positive or negative whole number or zero and it shall satisfy the conditions of use of the measuring system.

The maximum value of the MMQ for all types of hydrogen CGF measuring systems is 1 kg.



Measuring systems having a maximum flow rate less than or equal to 4 kg/min shall have a minimum measured quantity not exceeding 0.5 kg.

Measuring systems having a maximum flow rate greater than 4 kg/min but not greater than 12 kg/min shall have a minimum measured quantity not exceeding 1.0 kg.

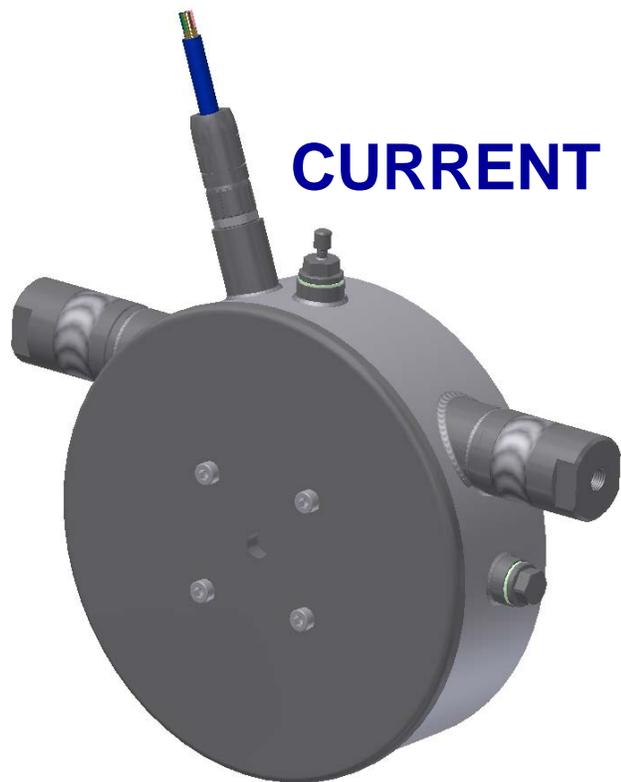


Different approval Requirements may cause different Coriolis design

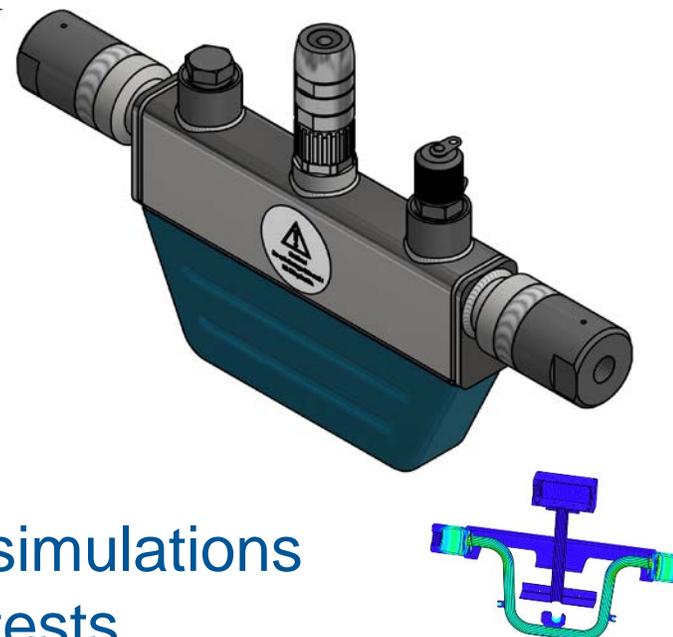
- With OIML R137 type approved meter ($Q_{\min} - Q_t - Q_{\max}$)
>>How could the meter be accepted for OIML R139 ($Q_{\min} - Q_{\max}$)
- Could there be any compromise in terms of EMC and environmental testing?
(e.g. same specs. for both approvals)
- Vibration testing – for the manufacturers it would be cost saving if simulations could be an alternative to expensive vibration tests.
(For ship or offshore components this state of the art)

Change in standards requires new sensors

CURRENT DESIGN



NEW DESIGN



- new simulations
- new tests
- new approvals (ATEX/ IEC Ex / NEPSI / CSA / UL etc.)
- additional costs

Availability of a TEST RIG

- Existing test rigs: Air Liquide – not available for other manufacturer, METAS / CH
In preparation: Justervesenet NOR, VSL NL
- Is there any common specification for all of these devices
>>accuracy differences
- Costs for the manufacturer up to 3000 €/ day (costs in awareness of current market)
- Test rig for H₂ flow test measurements not existing worldwide



Summary – Difference in Requirements OIML R137 - 139

- EMC TESTS
- ENVIRONMENTAL TESTS (Simulations)
- ACCURACY TESTS ($Q_t - Q_{min} - Q_{max}$)
- MMQ (NIST)
- AVAILABILITY OF A TEST TIG (costs)
- ACCREDITATION OF NOTIFIED BODIES for OIML R137 / 139
- DIFFERENT NATIONAL STANDARDS (at least for Europe should be harmonized)

- **WISH -> make Life less complicated for manufacturers**

[Acknowledgements...]

THANK YOU



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