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Flow metering of renewable gases (Biogas, biomethane, hydrogen, syngas and mixtures with natural gas)

Technical Report

Criteria and proposals for EMC tests on Ultrasonic meters with Non-Conventional Gases

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Contributing partners: ITRON, METERSIT, NEL

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1 FOREWORD

The NEWGASMET project has the overall objective to increase knowledge about the accuracy and durability of commercially available gas meters after exposure to renewable gases. This should lead to the improvement of existing meter designs and flow calibration standards.

One of the recently released results is a proposal for a set of test gases, to represent the range of non-conventional gases, in the scope of the revision of the gas meter standards. In details these were proposed to be used in the CEN/TC237 standards and the OIML-R137:2014.

During the project meetings, concerns have been raised regarding the applicability of such test gases to EMC tests for static meters.

Today such tests are performed in air, but there is a clear agreement that the behaviour of the meter during EMC tests can be influenced by the renewable gas type. At least, this agreement exists for the ultrasonic measurement technology, while further discussion might be needed for the mass flow.

However, it is not simply possible to redesign the current EMC tests by replacing air with the defined gas mixtures, as this would be quite impractical, especially considering the explosive nature of the test gases.

2 TECHNICAL ASPECTS

Considering the current measurement technology, a greater attenuation of the ultrasonic signal is expected with the defined test mixtures, which also determines a poorer signal to noise ratio (SNR).

Knowing that the issue is related to SNR, one possibility would be that the manufacturers define the minimum accepted SNR to ensure MPE and repeatability under EM disturbances. However, the minimum SNR is difficult to test and any manipulation of this characteristic would require intrusive tests or even additional features of the meter firm ware (FW) to manipulate the signal e.g., by reducing the transmit power or adding a correlated noise source.

While in this approach it would be possible to predict the SNR based on gas composition, pressure and temperature and simulate (or modify the signal amplification) accordingly, this however would not allow to define a standard test, due to the possible different manufacturers' implementation.

In case actual gas mixtures are used, safety concerns would also suggest reducing the number of tests to a minimum, trying to determine the most significant ones in this context.

In several discussions with field matter experts, it appears that a very critical condition is the zero-flow test.

This situation combines the lowest signal reference value (correlated with the time-of-flight resolution) to be detected, an increased attenuation of the signal due to the gas mixture, and fluctuations induced by EM disturbances, leading to the worst SNR conditions; it seems to be then the worst case to handle for the meter firmware.

An advantage of this test is that the meter would not need an actual gas flow; the meter could be filled with the relevant gas composition and completely sealed, thus avoiding any leakage.

In this context, the most critical situation appears to be the RF susceptibility test: the RF influence would lead to a perturbated "time of flight" measurement and thus to an incorrect flow measurement.

It would be important, during this test, to monitor the gas flow rate during the RF exposure and not (only) the meter index due to its limited resolution.

We might include a conducted disturbance test for meters that have external connection interfaces (e.g. wired).

The gas composition selected for the test represents the “worst” case among the listed test gases for natural gas/hydrogen mixtures. Meters intended to measure pure hydrogen need also to be further considered, but they are currently out of scope of this proposal.

3 PROPOSAL FOR EMC TESTING

The EMC testing of static gas meters (electronic gas meters) may be carried out without flow if a test mode allows to check the influence of EMC quantities on the accuracy by analysing the “zero flow rate” (flow rate or flow velocity indication with closed inlet and outlet). The EMC testing shall be carried out with the most critical gas in respect to expected SNR. The manufacturer shall provide information to the NB in order to decide which test gas is most appropriate. The meter will be filled with the test gas.

Remark 1: From the view of explosion protection, in case of technically tight devices, a test in the EMC test chamber is permitted even if the meter is filled with combustible gas. A purging with nitrogen in front of filling the meter with the test gas is necessary in order to avoid explosive mixtures. A purging with test gas by at least 50 times the volume of the meter volume V_{body} is recommended before starting the EMC test. In order to detect the tightness of the meter, a small gauge pressure may be inside the meter, which may be monitored by a mechanical pressure gauge. The pressure shall be not higher than p_e = 10 mbar.

In order to carry out the EMC testing an appropriate test mode shall be available. If the test mode is switched on,

- the meter shall determine the flow rate with a sufficiently high metering frequency in comparison to the exposure time by certain influence quantities like a certain radiation frequency,
- the low flow cut off shall be switched off,
- the resolution of the index shall be such, that a flow rate of 2 % of Q_{min} is detectible,
- the index shall allow to observe flow rate variations manually (by eye) for instance by averaging the flow rate during some seconds or a reading by an electronical interface shall be available,
- the meter shall not switch off the test mode and switch off the index automatically over a sufficiently long period to avoid the need of an often activation of the test mode.

Remark 2: The duration of applying certain radiation frequencies follows from the total number of steps. In a frequency range between 80 MHz and 2 GHz roughly 1050 steps and until 3 GHz 1070 steps are necessary (after a step the radiation frequency will be changed by 1%). That means in case of 10 s radiation exposure the test will last 3 h.

Remark 3: In order to avoid an unintended discharge of battery by activating the test mode frequently, the test mode may be limited additionally if the verification switch is on (operation after putting on the market).

Usually, the flow rate shows variations around zero even if no flow rate exists (by electrical noise etc.). Nevertheless, if the flow rate is averaged, the deviation from zero may be sufficient low to fulfil the requirements for the meter accuracy.

The EMC testing may be carried out in 2 steps

STEP 1:

- visual observation of the index or reading of the flow rates via interface without any disturbance, the average is the undisturbed zero flow rate Q_0
- visual observation of the index or reading of the flow rates via interface during the application of the influence values
- in case of variations of the flow rate indication, which is larger than the typical variation without disturbances, these values of influence quantities shall be investigated in more depth

Remark 4: In order to allow a visual observation during step 1 the meter index shall provide averaged values (over some seconds) or gliding min/max values. Alternatively, the flow rate may be read out via an electronical interface.

The flow rate indication should be sufficiently sensitive. That means, in test mode the resolution of the flow rate index should be around 0,01...0,02 Q_{min}.

In case of a G4 meter with Q_{min} = 25 l/h. the resolution of the flow rate index need to be 0,2 l/h or smaller.

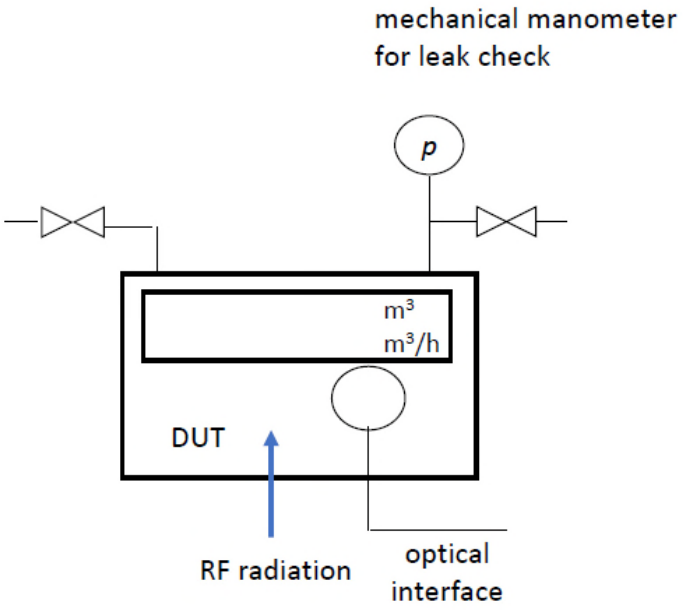

Figure 1. Test set up for RF EMC testing

STEP 2

For disturbances, which show unusual variations of the zero flow rate during step 1 (for instance a certain frequency of radiation), the influence of the disturbance shall be determined during a sufficient period of time. The most sensitive behaviour of the meter shall be determined, for instance in case of RF testing by a finetuning of the radiation frequency.

CRITERIA OF ACCEPTANCE (COA) IN CASE OF UNTYPICAL VARIATIONS OF FLOW RATE CAUSED BY EM DISTURBANCES DURING STEP 1

The reading may take place via a camera or via an optical interface. The change of the average of the flow rate with respect to the average flow rate without disturbance shall be

$| Q_{EMC} | < 0{,}03\ Q_{min}$ (for class 1,5 meter)

$| Q_{EMC} | < 0{,}02\ Q_{min}$ (for class 1 meter)

The average zero flow rate during the application of the test mode without disturbance shall be used as baseline for the application of the COA.

3.1 Remarks on current text of standard EN 14236:2018

"Add one test after 13.3 of EN 14236:2018.

Test requirements derived from 13.3.1 a) the meter index shall neither increment nor decrement."

Remark: The requirement currently in 13.3.1 a) is not sufficient because in case of a duration of $t_{disturb}$ = 10 s of a radiation of a certain frequency the last digit will increase only if the radiation lead to flow rate

$Q_{disturb} \geq V_{lastdigit} / t_{disturb}$.

In case the last digit of the display represents 1 l an influence is detectable only if it leads to a flow rate of $Q_{disturb}$ = 360 l/h. The MPE for Q_{min} is 3%, hence an influence larger than $Q_{disturb} = 0{,}03\ Q_{min}$ is not acceptable. In case of a G4 meter with Q_{min} = 25 l/h, the maximum influence of a disturbance shall be less than $Q_{disturb}$ = 0,75 l/h.

3.2 Proposal for testing in EN 14236:2018.

Test conditions derived from 13.3.2 a). The test shall be performed under no flow conditions and with the meter filled with the most critical gas or gas mixture, in respect to expected SNR, for instance CH_4 + 30% H_2 as most critical gas mixture and shall be sealed to be gas tight.

The meter shall be switched in a test mode, which allows to investigate the flow rate changes caused by disturbances with a sufficient resolution and without low flow cut off.

Investigate the flow rate without disturbance as the baseline for no flow condition. Without any disturbance, the base average zero flow rate shall be determined, the value is defined as Q_0.

Subject the meter to the tests below:

Test the meter in accordance with EN 61000-4-3, under the classification E1:

- frequency band: 80 MHz to 3 GHz[1]
- test field strength: 10 V/m
- amplitude modulation: 80 %, 1 kHz sine wave

If a meter is influenced by a disturbance, the reading will deviate from Q_0. The average of the reading in this case is defined as $Q_{disturb}$. The influence of a disturbance on the meter reading follows from

$$Q_{EMC} = Q_{disturb} - Q_0$$

COA:

The change of the average of the flow rate compared with the average flow rate without disturbance (base line) shall be

$| Q_{EMC} | < 0{,}03\ Q_{min}$ (for class 1,5 meter)

$| Q_{EMC} | < 0{,}02\ Q_{min}$ (for class 1 meter)

[1] 2 GHz might be sufficient, depending on the normative document applied