MEDC11 (6207)P3- Part 3: Flow measurement of natural gas by rotary piston meters
Flow measurement of natural gas by rotary piston meters

0 Foreword

Natural gas has been utilized by humankind for several numbers of years. Natural gas sector in the country started early 2004 where by the exploration and constructions of gas plants commissioned. After the establishment of the Government petroleum act in 2015, the need for the development of the standards which will be used during formulation of rules and regulations rises.

Due to these reasons EWURA requested Tanzania Bureau of Standards to put in place the standards on this sector to accomplish the government in full operation in the Natural gas sector.

During the preparation of this draft Standard, assistance was derived from:

IS 15673:2006- Flow measurement of natural gas by rotary piston meters.

Reference

For the purpose of this draft Tanzania standard the following references shall apply:

MEDC11 (6212) P3 - Gas Volume Meters, Part 1: General requirements

1 Scope

This standard specifies the requirements for construction, methods of pressure tapping, working ranges with nominal values of minimum / maximum flow rates and permissible errors for rotary piston meters.

2 TERMINOLOGIES

For the purpose of this standard, the following terminology shall apply.

2.1 Rotary piston meters

Are those, in which internal walls defining the measuring chambers are set in rotation and the number of revolutions of these walls represents a measurement of the volume of the gas passed.

3 WORKING RANGE

The nominal values of the maximum flowrates and the corresponding minimum flowrates of rotary piston meters are given in Table 1
4 MATERIALS FOR CONSTRUCTION

4.1 Material

The material for construction of the gas meters and its components shall be as specified in MEDC11 (6212) P3

4.2 Details of construction

4.2.1 Rotary piston meters shall have a static pressure tapping at the inlet and at the outlet, close to the connection (flange) for measuring the pressure absorption, the pressure measured upstream shall be constitute the metering pressure. Length between the ends of its inlet and outlet connection shall be less than or equal to 5 times nominal connection.

4.2.2 Rotary piston gas meters may include a manual device for allowing the pistons to be turned, provided that it cannot be improperly used in a way to interfere with correct functioning of the gas meter.

4.2.3 Notwithstanding the requirements given in 9 of MEDC11 (6212) P3 the bearings of the shafts of the rotating pistons of gas meters (roots type) of a size greater than ‘G160’ may be constructed in a such away as to allow them to replace without damaging the protective seals.

4.3 Pressure tappings

4.3.1 The bores for pressure tappings shall have a diameter of at least 3mm. In case of slit-shaped pressure tappings, slits shall have a width of at least 2mm in the direction of the flows and a cross-section of at least 10mm²

4.3.2 Pressure tappings shall be provided with a means of closure so as to make them gas-tight.

4.3.3 The pressure tappings for the metering pressure shall be clearly and indelibly marked ‘ρ_m’ and other pressure tappings as ‘ρ’.

4.4 Built-in Conversion device

4.4.1 Rotary piston gas meters may have a built-in conversion device which converts the volume at metering temperature to that at base temperature or which converts the volume at metering conditions to that at base conditions.
4.4.2 The indicating device for the volume at base conditions shall have a sufficient number of digits to ensure that the volume passed during 2000h at maximum flow rate, minimum temperature and, if applicable, maximum pressure does not move or switch all the digits to their initial positions.

5. TEST ELEMENTS

5.1 When the gas meter has a mechanical test element according to 5.2.2 of MEDC11 (6212) P3, the scale interval and the scale numbering shall be according to Table 2

Table 2 Scale Intervals and numbering

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Gas Meter Designation G</th>
<th>$q_{	ext{max}}$ m$^3$/h</th>
<th>Working Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1:10</td>
</tr>
<tr>
<td>i)</td>
<td>10</td>
<td>16</td>
<td>1.6</td>
</tr>
<tr>
<td>ii)</td>
<td>16</td>
<td>25</td>
<td>2.5</td>
</tr>
<tr>
<td>iii)</td>
<td>25</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>iv)</td>
<td>40</td>
<td>65</td>
<td>6</td>
</tr>
<tr>
<td>v)</td>
<td>65</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>vi)</td>
<td>100</td>
<td>160</td>
<td>16</td>
</tr>
<tr>
<td>vii)</td>
<td>160</td>
<td>250</td>
<td>16</td>
</tr>
<tr>
<td>viii)</td>
<td>250</td>
<td>400</td>
<td>25</td>
</tr>
<tr>
<td>ix)</td>
<td>400</td>
<td>650</td>
<td>40</td>
</tr>
<tr>
<td>x)</td>
<td>650</td>
<td>1000</td>
<td>65</td>
</tr>
<tr>
<td>xi)</td>
<td>1000</td>
<td>1600</td>
<td>160</td>
</tr>
</tbody>
</table>

5.2 The scale interval of the test element of the indicating device for base condition shall be less than 0.1 percent of converted volume counted in 3 min with the maximum flow rate at maximum temperature and, if applicable, minimum pressure.

6 MAXIMUM PERMISSIBLE ERRORS

7.1 Under the conditions laid down in 7 of MEDC11 (6212) P3, the maximum permissible errors applicable to all the gas meters shall be as follows:

<table>
<thead>
<tr>
<th>Flow rate $q$ m$^3$/h</th>
<th>Maximum Permissible Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q_{\text{min}} \leq q \leq q_l$</td>
<td>±2 (On Initial verification, percent)</td>
</tr>
<tr>
<td>$q_l \leq q \leq q_{\text{max}}$</td>
<td>±3</td>
</tr>
</tbody>
</table>

NOTES

In service, values are recommended values.

The values for the transitional flowrate 'q_l' are as follows:
<table>
<thead>
<tr>
<th>Working range</th>
<th>$q_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:10</td>
<td>0.20 $q_{Max}$</td>
</tr>
<tr>
<td>1:20</td>
<td>0.20 $q_{Max}$</td>
</tr>
<tr>
<td>1:30</td>
<td>0.15 $q_{Max}$</td>
</tr>
<tr>
<td>1:50</td>
<td>0.10 $q_{Max}$</td>
</tr>
</tbody>
</table>

6.2 On initial verification at one set of metering conditions, the gas meter shall be adjusted so that the weighted mean error (WME) is as close to zero as the adjustment and the maximum permissible errors allow.

$$WME = \frac{\sum (q_i/q_{Max}) \times E_i}{\sum (q_i/q_{Max})}$$

Where

$q_i/q_{Max}$ = weighing factor, and

$E_i$ = Error at the flowrate $q_i$ as specifies in 9.2.1 (where $q_i = q_{Max}$ a weighing factor of 0.4 instead of 1 shall be used)

The WME shall have a value between -0.4 percent and +0.4 percent.

The maximum permissible errors on initial verification apply to new meters and to meters submitted for verification after the protective seals have been damage.

**NOTE** After changing the adjustment, it is not necessary to repeat all tests. It is sufficient to repeat a test at one flowrate and calculate the other new $E_i$ values from the previous ones.

6.3 When the maximum torques indicated on the gas volume meter according to 4.3.2.1 and 4.3.2.2 of MEDC11 (6212) P2 are applied to the drive shafts, the indication of the gas volume meter at $q_{Min}$ when tested with atmospheric aid (of density 1.2 kg/m$^3$) shall not shift more than the values given below

<table>
<thead>
<tr>
<th>Value of $q_{Min}$</th>
<th>Permissible Shift of the Indication at 'Min'</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02 $q_{Max}$</td>
<td>1</td>
</tr>
<tr>
<td>0.03 $q_{Max}$</td>
<td>1</td>
</tr>
<tr>
<td>0.05 $q_{Max}$</td>
<td>1</td>
</tr>
<tr>
<td>0.10 $q_{Max}$</td>
<td>0.5</td>
</tr>
</tbody>
</table>

7. **PATTERN APPROVAL**

7.1 Request for pattern Approval

7.1.1 Manufacturer shall submit the sample for pattern approval to the appropriate authority. Manufacturer shall place two to six samples manufactured in conformity with the pattern at the disposal of the authority responsible for examination.

7.1.2 If so requested by the authority responsible for the examination, these meters should include more than one size, if simultaneous approval of those sizes is required.

7.1.3 Depending on the results of the tests, additional sample meters may be requested.
7.1.4 Notwithstanding the above requirements, the sample meters may be submitted at different times, but the decision regarding pattern approval will be given only when all these sample meters have been received and examined.

7.2 Tests

7.2.1 General

The pattern and its sample meters shall comply with the requirement of MEDC11 (6212) P3 and 5, 6, 7 and 8 of this standards.

In addition, for flowrates, between \(0.4q_{\text{max}}\) and \(q_{\text{max}}\) the difference between the maximum and minimum of the error curve as a function of the flowrate \(q\) shall not exceed 1 percent for each meter.

7.2.2 Disturbance Test for Rotary piston meters.

Rotary piston meters shall be subjected to a test for the influence of flow disturbances as specifies in annex A. During the test the shift of the error curve shall not exceed 0.33 percent.

If the design of a rotary piston meter pattern is similar for all the pipe size, disturbance tests with gas meters of two sizes shall suffice.

7.2.3 Durability test

The pattern and samples of rotary piston gas meters shall be subject to a durability test. This test shall be carried out as far as possible at the maximum flowrate and with air or gas. The duration of the durability test shall be such that each gas meter measures a volume of air or gas corresponding to 1000 hours of operation of the gas meter at the maximum flowrate. The test shall be completed within two months.

After the durability test, the gas meters, when tested with air of density 1.2 kg/m\(^3\), using the same standard instruments as those used in the test resulting from 7.2.1 shall comply with following requirements.

a) The values of the errors determined at the flowrates specified in 8.2.1 shall not differ by more than 0.5 percent from the errors noted during the test resulting from 7.2.1

b) For flowrates between \(0.4q_{\text{max}}\) and \(q_{\text{max}}\) the difference between the maximum and minimum of the error curves as a function of the flowrates \(q\) shall not exceed 1.5 percent.

7.2.4 Gas meter with drive shaft

In the case of rotary piston gas meters having one or more drive shafts, at least three meters of each size shall be tested with air at a density of 1.2 kg/m\(^3\) for compliance with the requirements of 4.3.2.4 of MEDC11 (6212) P3 and 7.4 of this standard.

In case of rotary piston gas meters having several drive shafts, the test shall be carried out on the drive shaft which gives the least favourable result.

Where a pattern embraces gas meters of various sizes, the torque test need be carried out only on the meters of the smallest size, provided that the same torque is specified for the larger gas meters and that the output shafts of the latter have the same or greater output constants.

In the case of gas meters with several values for \(q_{\text{min}}\) only the test described in 7.2.1 for the least of \(q_{\text{min}}\) need be carried out. The permissible torques for the other working ranges may be calculated from that test result.

Conversion to other \(q_{\text{min}}\) values is governed by the following rules:

a) Where the flow is constant, the variation in the error is proportional to the torque, and
b) Where torque is constant, the variation in error for rotary piston gas meters is inversely proportional to the flowrate, and for turbine gas meters it is inversely proportional to the square of the flowrate.

8. INITIAL VERIFICATION AND SUBSEQUENT VERIFICATION

8.1 Examination

8.1.1 Gas meters shall be examined and tested to ascertain whether they conform in general to their approved patterns. They shall comply with the requirements of MEDC11 (6212) P3 as well as the requirements of this standard.

8.1.2 Gas meters shall be submitted in working order and shall be provided with the required sites for the application of the verification and protective marks.

8.1.3 If gas meters are intended to incorporate ancillary devices operated by the output shafts, these devices shall be attached, unless attached after verification is expressly authorized.

8.2 Accuracy test and calibration

8.2.1 A gas meter shall be considered to comply with the requirements concerning the maximum permissible errors, if these are met at the following flowrates:

a) For gas meters with a working range of 1:10 to 1:30: $q_{\text{min}}$, $0.05 q_{\text{max}}$, and $0.1 q_{\text{max}}$ when these values are larger than $q_{\text{min}}$, $0.25 q_{\text{max}}$, $0.40 q_{\text{max}}$, $0.70 q_{\text{max}}$, and $q_{\text{max}}$

b) For gas meters with a working range of 1:50: $q_{\text{min}}$, $0.05 q_{\text{max}}$, $0.15 q_{\text{max}}$, $0.25 q_{\text{max}}$, $0.40 q_{\text{max}}$, $0.70 q_{\text{max}}$, and $q_{\text{max}}$

If these tests are done at other flowrates, they shall be at least as effective as those mentioned above.

8.2.2 A gas meter may be verified using a gas other than air, and or at other than near ambient conditions.

8.3 Additional Marking

The density range in which the errors are required to comply with the maximum permissible errors may be indicated on the data plate, expressed as:

$P = \text{to } \text{kg/m}^3$

This marking shall replace the range of metering pressure (5.1(i) of MEDC11 (6212) P3. Unless the pressure marking refers to a built-in conversion device.

9. MARKING

Each gas meter shall bear the markings conforming to MEDC11 (6212) P3.

10. PACKING

The gas meter shall be wrapped in dust proof paper and placed in the wooded, metallic, and plastic box with sufficient packing material all around to prevent any risk of damage or deformation during transit.
a) Before preparation for packing, each meter shall be dried and cleaned.
b) Meter openings shall be covered to prevent the entry of dirty and other foreign matter, threaded and machined surfaces shall be well covered with rust preventative coatings.
c) Flanges and exposed thread connections shall be well protected over their entire surface by providing the suitable protectors.

11. INSTRUCTIONS FOR INSTALLATION AND MAINTENANCE

Installation and maintenance instructions, including for routine checks, shall be provided by manufacturer.
ANNEX A

DISTURBANCE TEST FOR ROTARY PISTON METERS

A-1 The test specified in this annex shall be carried out with air at clause to ambient conditions at flowrates of $0.25 q_{max}$, $0.4 q_{max}$ and $q_{max}$.

A.1.2 If the design of the pattern of the gas meter is similar for all pipe sizes, it is sufficient to perform the test on two sizes. Similarity of sizes is assumed if the values of $H/D$ and $S/L$ (see Fig.1) for any size of meter are equal to or less than those for the tested meters.

A-2 MILD DISTURBANCES

A-2.1 The piping configurations (see Fig.2(a) and 2(b)) consist of a pipe with a nominal diameter $DN_1$ and a length of 5 $DN_1$, two elbows with radius $DN_1$ in the same plane and a concentric expander with diameter $DN_1$ and $DN$ and a length between $DN$ and 1.5$DN$.

The values of $DN_1$ in relation to the values of $DN$ are listed below:

<table>
<thead>
<tr>
<th>$DN$ (Meter)</th>
<th>$DN_1$ (Pipe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
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<td>150</td>
<td>100</td>
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<td>200</td>
<td>150</td>
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<td>250</td>
<td>200</td>
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<td>300</td>
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<td>400</td>
<td>300</td>
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<tr>
<td>500</td>
<td>400</td>
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<tr>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>750</td>
<td>600</td>
</tr>
<tr>
<td>1000</td>
<td>750</td>
</tr>
</tbody>
</table>

A-2.2 The test shall be carried out with the piping configurations as described in A-2.1 installed 2 $DN$ upstream of the meter inlet (see Fig.2(c)) or with a longer upstream straight pipe and / or flow conditioner, if so specified by the manufacturer.

In the latter case the necessary upstream straight pipe and / or flow conditioner shall be considered part of the approved pattern and specified in the approval certificate.

A-2.3 During the test the shift of the error curve of the meter shall not exceed 0.33 percent.

A-3 SEVERE DISTURBANCE

A-3.1 The same piping configuration as specified in A-2.1 is used with the addition of a half pipe area plate as shown Fig.3 installed between the two elbows with the opening toward the outside radius of the first bend.

A-3.2 The provisions of A-2.2 and A-2.3 shall apply accordingly.
Fig. 1 Design pattern of gas meter

Fig. 2 PIPING CONFIGURATIONS
FIG. HALF PIPE PLATE