SLOVENSKI STANDARD
SIST EN 12405:2004

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Plinomeri - Elektronski korektorji

Gas meters - Gas-volume electronic conversion devices

Gaszähler - Elektronische Zustands-Mengenumwerter

Compteurs de gaz - Dispositifs électroniques de conversion de volume de gaz

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91.140.40 Sistemi za oskrbo s plinom Gas supply systems

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Gas meters - Gas-volume electronic conversion devices

Compteurs de gaz - Dispositifs électroniques de conversion de volume de gaz

Gaszähler - Elektronische Zustands-Mengenumwerter

This European Standard was approved by CEN on 25 March 2002.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Foreword

This document EN 12405:2002 has been prepared by Technical Committee CEN/TC 237 "Gas meters", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2003, and conflicting national standards shall be withdrawn at the latest by January 2003.

In the preparation of this European Standard, the content of OIML Publication, “International Document 11”, “International Recommendations 6” and “International Recommendations 32” and the content of member bodies' national standards on gas-volume electronic conversion devices have been taken into account.

The metrological aspects of this European Standard may be subject to amendments to bring it into line with the proposed Measuring Instruments Directive (MID).

Annex A is normative and annex B is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the requirements and tests for the construction, performance, safety and conformity of gas-volume electronic conversion devices associated to gas meters, used to measure volumes of fuel gases of the 1st and 2nd families according to EN 437.

Only three kinds of conversion are treated in this standard:

— conversion as a function of temperature only (called T conversion);

— conversion as a function of the pressure and of the temperature with constant compressibility factor (called PT conversion);

— conversion as a function of the pressure, the temperature and taking into account the compressibility factor (called PTZ conversion).

These gas-volume conversion devices consist of a calculator and a temperature transducer or a calculator, a temperature transducer and a pressure transducer locally installed.

Any conversion device can provide an error curve correction for a gas meter.

NOTE When rendering an account to an end user the readings from the conversion device can be used in conjunction with the readings from a gas meter conforming to EN 1359, prEN 12480, or prEN 12261, as appropriate, or to any other appropriate and relevant international or national standard for gas meters, without prejudice of national regulations.

This standard is intended for type testing.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 437, *Test gases - Test pressures - Appliance categories*.

EN 1776, *Gas supply systems - Natural gas measuring stations - Functional requirements*.

EN 50014, *Electrical apparatus for potentially explosive atmospheres - General requirements*.

EN 50015, *Electrical apparatus for potentially explosive atmospheres - Oil immersion "o"*.

EN 50016, *Electrical apparatus for potentially explosive atmospheres - Pressurized apparatus "p*".

EN 50017, *Electrical apparatus for potentially explosive atmospheres - Powder filling "q".*

EN 50018, *Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure "d".*

EN 50019, *Electrical apparatus for potentially explosive atmospheres - Increased safety "e".*

EN 50020, *Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i".*

EN 50039, *Electrical apparatus for potentially explosive atmospheres - Intrinsically safe electrical systems*.

EN 55011, *Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurement (CISPR 11:1997, modified)*.

EN 60068-2-1, *Environmental testing - Part 2: tests - Tests A: Cold (IEC 60068-2-1:1990).*

EN 60068-2-2, *Basic environmental testing procedures - Part 2: Tests - Tests B: Dry heat (IEC 60068-2-2:1974 + IEC 68-2-2A:1976).*

EN 60068-2-30, *Environmental testing - Part 2: Tests - Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle) (IEC 60068-2-30:1980 + A1:1985).*

EN 60068-2-31, *Basic environmental testing procedures - Part 2: Tests - Test Ec: Drop and topple, primarily for equipment-type specimens (IEC 60068-2-31:1969 + A1:1982).*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989).*

EN 60950, *Safety of information technology equipment.*

EN 61000-4-2, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test - Basic EMC publication (IEC 61000-4-2:1995).*

EN 61000-4-3, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3:1995, modified).*

EN 61000-4-4, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic EMV publication (IEC 61000-4-4:1995).*

EN 61000-4-6, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:1996).*

ISO 12213-1, *Natural gas - Calculation of compression factor - Part 1: Introduction and guidelines.*

ISO 12213-2, *Natural gas - Calculation of compression factor - Part 2: Calculation using molar composition analysis.*

ISO 12213-3, *Natural gas - Calculation of compression factor - Part 3: Calculation using physical properties.*

IEC 60068-2-3, *Basic environmental testing procedures - Part 2: Tests - Test Ca: Damp heat, steady state.*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purpose of this European Standard, the following terms and definitions apply.

3.1.1
gas-volume conversion device
device that computes, integrates and indicates the volume increments measured by a gas meter if it were operating at base conditions, using as inputs the volume at measurement conditions as measured by the gas meter, and other parameters such as gas temperature and gas pressure

NOTE The conversion device can also compensate for the error curve of a gas meter and associated measuring transducers.

NOTE The deviation from the ideal gas law can be compensated by the compressibility factor.

3.1.1.1
conversion device type 1 (complete system)
conversion device with a specific type of transducer for temperature and/or pressure. The assessment of errors of conversion are based on the overall conversion factor

3.1.1.2
conversion device type 2 (separate component)
conversion device with external approved transducers for temperature and/or pressure and separate calculator. The assessment of errors of conversion are based on the individual transducer and calculator errors

3.1.2
measurement conditions
conditions of the gas whose volume is measured at the point of measurement (e.g. the temperature and the pressure of the gas)

3.1.3
base conditions
fixed conditions used to express the volume of gas independently of the measurement conditions

EXAMPLES temperature of 273,15 K and absolute pressure of 1,013 25 bar[1] or temperature of 288,15 K and absolute pressure of 1,013 25 bar.

3.1.4
sensor
element of a measuring instrument or measuring chain that is directly affected by the measurand

3.1.5
measuring transducer
device that provides an output quantity having a determined relationship to the input quantity

3.1.6
calculator
electronic device that receives the output signals from the associated gas meter and transducers and processes them

3.1.7
indicating device
part of a measuring instrument that displays an indication (alphanumeric string)

3.1.8
display
element or assembly of elements of the indicating device on which the results of measurement and memorized values are displayed

3.1.9
conversion factor
factor equal to the volume at base conditions divided by the corrected volume, or if there is no gas meter correction, equal to the volume at base conditions divided by the volume at measurement conditions

3.1.10
calculator conversion
conversation factor provided by the gas volume conversion device when its inputs are simulated by signals in accordance with the manufacturer's specification of interfaces

3.1.11
reference conversion factor
factor equal to the volume at base conditions divided by the volume at measurement conditions (i.e. having no error, as described in 9.1)

[1] 1 bar = 1 000 mbar = 10^5 Pa

3.1.12
specified measuring range of transducers
set of values of measurands (the pressure for the pressure transducer or temperature for the temperature transducer) for which the errors of the conversion device are intended to lie within the limits specified in the standard

NOTE The upper and lower limits of the specified measuring range are called maximum value and minimum value respectively.

EXAMPLE maximum absolute pressure: 12 bar; minimum absolute pressure: 4 bar.

3.1.13
specified field of measurement of a conversion device
set of values at measurement conditions for which the errors of the conversion device are within specified limits

NOTE 1 A conversion device has a measuring range for every quantity that it processes.

NOTE 2 The specified field of measurement applies to the characteristic quantities of the gas that are used to determine the conversion factor.

3.1.14
influence quantity
quantity that is not a measurand but that affects the result of the measurement (e.g. ambient temperature)

3.1.15
rated operating conditions
conditions of use for which specified metrological characteristics of a measuring instrument are intended to lie within defined limits

NOTE The rated operating conditions generally specify ranges or rated values of the measurand and of the influence quantities.

3.1.16
reference conditions
condition of use prescribed for testing the performance of a measuring instrument or for inter-comparison of results of measurements

3.1.17
durability
ability of an instrument to maintain its performance characteristics over a specified period of use

3.1.18
error of indication
indication of a measuring instrument minus the (conventional) true value of the corresponding input quantity

3.1.19
intrinsic error
error of a measuring instrument, determined under reference conditions

3.1.20
environmental class
class referring to the ambient temperature, humidity and power supply

3.1.21
volume
volume without specifying whether it is a corrected volume at measurement conditions or an uncorrected volume at measurement conditions

3.1.22
corrected volume
volume at measurement conditions corrected for the error curve of the gas meter

3.1.23
correction
value added algebraically to the uncorrected result of a measurement to correct the systematic error

3.1.24
correction factor
numerical factor by which the uncorrected result of a measurement is multiplied to correct the error curve of the gas meter

3.1.25
disturbances
influence quantity having a value within the limits specified but outside the specified rated operating conditions of the measurement instrument

3.1.26
uncertainty of measurement
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

3.1.27
error of the calculator unit
error of the indicated volume at base conditions V_b, when the gas volume, pressure and temperature are simulated by signals, in accordance with the manufacturer's specification of interfaces

3.1.28
error of the pressure transducer
difference between the measured output signals from the pressure transducer and the nominal signal at the applied physical value, expressed as a percentage error of the conversion factor

3.1.29
error of the temperature transducer
difference between the measured output signals from the temperature transducer and the nominal signal at the applied physical value, expressed as a percentage error of the conversion factor

3.1.30
error of conversion
difference between the conversion factor C displayed by a conversion device and the reference conversion factor C_r, expressed as a percentage of the reference conversion factor

3.2 Symbols

The symbols used in this European Standard are listed in Table 1.

Table 1 – Symbols

Symbols	Represented quantity	Units
V	volume : V_m or V_c	m^3
V_m	volume at measurement conditions	m^3
V_c	corrected volume (gas meter error)	m^3
V_b	volume at base conditions	m^3
C	conversion factor	-
C_c	Calculator conversion	-
C_r	reference conversion factor (i.e. conversion factor with zero error)	-
C_f	correction factor	-
f(Q)	correction function	-
K or K'	coefficients	-
p	absolute pressure at measurement conditions	bar
p_b	absolute pressure at base conditions	bar
p_g	gauge pressure	bar
p_r	reference pressure (i.e. the pressure with no errors)	bar
T	absolute temperature at measurement conditions	K
T_b	absolute temperature at base conditions	K
T_{min}	minimum absolute temperature	K
T_{max}	maximum absolute temperature	K
T_r	reference temperature ((i.e. the temperature with no errors)	°C
Z	compressibility factor of the gas at measurement conditions	-
Z_b	compressibility factor of the gas at base conditions	-
p_{atm}	atmospheric pressure	bar
p_{max}	maximum absolute gas pressure	bar
p_{min}	minimum absolute gas pressure	bar
Q	flowrate	m^3/h
Q_{max}	maximum flowrate	m^3/h
Q_{min}	minimum flowrate	m^3/h
t_{am}	ambient temperature	°C
$t_{am,max}$	maximum ambient temperature	°C
$t_{am,min}$	minimum ambient temperature	°C
t	gas temperature	°C
t_{max}	maximum gas temperature	°C
t_{min}	minimum gas temperature	°C
U_{nom}	nominal supply voltage	V
f_{nom}	nominal supply frequency	Hz
e	total conversion factor error	%
e_1	error on the calculation of conversion factor	%
e_2	error on the pressure measurement	%
e_3	error on the temperature measurement	%
e_c	error on the conversion factor	%

4 Principle of measurement

4.1 Conversion as a function of temperature

In this case the conversion device consists of a calculator and a temperature transducer and it converts the volume to the base temperature conditions only.

The volume at base conditions is obtained from the relationship:

$$V_b = C \cdot V$$

C is the conversion factor given from the relationship:

$$C = \frac{K}{T}$$

K is a fixed value obtained from the relationship:

$$K = \frac{p}{p_b} \cdot T_b \cdot \frac{Z_b}{Z}$$

The pressure is not measured, but may be included as a fixed value in the processing of the conversion factor.

The compressibility factor is not calculated, but may be included as a fixed value in the processing of the conversion factor.

The error of a gas volume conversion device, measuring only temperature, is calculated referring to the reference conversion factor as calculated taking into account the compressibility factor at a fixed set pressure and measured temperature.

4.2 Conversion as a function of pressure and temperature

In this case, the conversion device consists of a calculator, a pressure transducer and a temperature transducer.

The compressibility factor may be considered as a fixed value calculated from mean measurement conditions and a determined gas composition.

The volume at base conditions is obtained by the relationship:

$$V_b = C \cdot V$$

C is the conversion factor given from the relationship:

$$C = K' \cdot \frac{p}{T}$$

K' is a fixed value obtained from the relationship:

$$K' = \frac{1}{p_b} \cdot T_b \cdot \frac{Z_b}{Z}$$

An absolute pressure transducer shall be used for absolute pressures below 21 bar.

For absolute pressures equal to or greater than 21 bar a gauge pressure transducer may be used.

In this case the value of the atmospheric pressure shall be the average value calculated taking into account the altitude of the installation site. This value shall be preset.

4.3 Conversion as a function of pressure, temperature and deviation from the ideal gas law

In this case, the conversion device consists of a calculator, a pressure transducer and a temperature transducer.

The general requirements indicated in 4.2 shall be enforced.

The deviation from the ideal gas law is compensated by the calculation of the compressibility factor using an appropriate equation as a function of pressure and temperature:

$$Z = \mathrm{f}(p,T)$$

Settable gas properties and components inputs are used for the compressibility calculation.

The volume at base conditions is obtained from the relationship:

$$V_\mathrm{b} = C \cdot V$$

C is the conversion factor given by the relationship:

$$C = \frac{p}{p_\mathrm{b}} \cdot \frac{T_\mathrm{b}}{T} \cdot \frac{Z_\mathrm{b}}{Z}$$

The manufacturer shall specify the method used for compressibility factor calculation.

4.4 Correction of the volume at measurement conditions

The object of the correction function is to compensate the error of the gas meter, as determined in the test certificate.

The conversion device may be able (optionally) to correct the error of the gas meter.

When using this option it shall be ensured that the error curve to be used is relevant to the actual operational conditions.

If this correction is available, it shall be integrated in the configurations stated in 4.1, 4.2 and 4.3; in those cases, the volume marked as V means V_c.

The correction function of the conversion device shall be able to correct deviations recorded when calibrating the gas meter to which it is connected.

The error curve will be corrected by a correction function f(Q) in such a way that for each operating point:

$$V_\mathrm{c} = V_\mathrm{m} \times \mathrm{f}(Q)$$

The manufacturer shall specify the method used.

If a non-linear interpolation between the calibration points is used, the manufacturer shall provide proof that the method has a better weighted (by flow) accuracy than the linear interpolation.

The choice of the parameters shall be so that the correction function f(Q) remains, at all points, definite, continuous and derivable for rates of flow between Q_min and Q_max.

The correction can only be applied if the gas meter produces at least 10 pulses per second at Q_{min}. Below Q_{min} no correction is allowed and above Q_{max}, the correction factor shall remain at the value obtained at Q_{max}.

5 Rated operating conditions

5.1 Specified field of measurement

The field of measurement of the complete instrument shall be specified by the manufacturer.

5.1.1 Specified measurement range for gas pressure

For an absolute gas pressure above 2 bar the transducer shall be calibrated so that:

$$\frac{p_{max}}{p_{min}} > 2$$

5.1.2 Specified measurement range for gas temperature

The manufacturer shall specify the gas temperature range according to the following:

— normal range: -20 °C to +50 °C;

— limited range: a minimum range of 40 °C anywhere between the limits of the normal range;

— extended range: to be specified by the manufacturer.

5.1.3 Gas characteristics

Fuel gases of the first and second families according to EN 437.

5.2 Environmental class

5.2.1 Ambient temperature range

The manufacturer shall specify the ambient temperature range of the gas-volume conversion device according to the following possibilities:

a) normal ranges:

— Class 1: from +5 °C to +30 °C;

— Class 2: from -10 °C to +40 °C;

— Class 3: from -25 °C to +55 °C;

b) other range specified by the manufacturer.

5.2.2 Humidity range

The instrument shall operate in a relative humidity range of 10 % to 93 %.