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Natural gas — Calculation of compression factor —

Part 1: Introduction and guidelines

Gaz naturel — Calcul du facteur de compression —

Partie 1: Introduction et directives

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12213-1 was prepared by Technical Committee ISO/TC 193, *Natural gas*, Subcommittee SC 1, *Analysis of natural gas.*

ISO 12213 consists of the following parts, under the general title *Natural gas — Calculation of compression factor*:

— *Part 1: Introduction and guidelines*

— *Part 2: Calculation using molar-composition analysis*

— *Part 3: Calculation using physical properties*

Annex A forms an integral part of this part of ISO 12213. Annexes B and C are for information only.

Natural gas — Calculation of compression factor —

Part 1:
Introduction and guidelines

1 Scope

This International Standard specifies methods for the calculation of compression factors of natural gases, natural gases containing a synthetic admixture and similar mixtures at conditions under which the mixture can exist only as a gas.

The standard is in three parts: part 1 gives an introduction and provides guidelines for the methods of calculation described in parts 2 and 3.

Part 2 gives a method for use where the detailed molar composition of the gas is known. Part 3 gives a method for use where a less detailed analysis, comprising superior calorific value (volumetric basis), relative density, carbon dioxide content and (if non-zero) hydrogen content, is available.

Both methods are applicable to dry gases of pipeline quality within the range of conditions under which transmission and distribution, including metering for custody transfer or other accounting purposes, are normally carried out. In general, such operations take place at temperatures between about 263 K and 338 K (approximately – 10 °C to 65 °C) and pressures not exceeding 12 MPa (120 bar). Within this range, the uncertainty of prediction of both methods is about ± 0,1 % provided that the input data, including the relevant pressure and temperature, have no uncertainty.

NOTE — Pipeline quality gas is used in this International Standard as a concise term for gas which has been processed so as to be suitable for use as industrial, commercial or domestic fuel. Although there is no formal international agreement upon the composition and properties of a gas which complies with this concept, some quantitative guidance is provided in 5.1.1. A detailed gas quality specification is usually a matter for contractual arrangements between buyer and seller.

The method given in part 2 is also applicable (with increased uncertainty) to broader categories of natural gas, including wet or sour gases, within a wider range of temperatures and to higher pressures, for example at reservoir or underground storage conditions or for vehicular (NGV) applications.

The method given in part 3 is applicable to gases with a higher content of nitrogen, carbon dioxide or ethane than normally found in pipeline quality gas. The method may also be applied over wider ranges of temperature and pressure but with increased uncertainty.

For the calculation methods described to be valid, the gas must be above its water and hydrocarbon dewpoints at the prescribed conditions.

The standard gives all of the equations and numerical values needed to implement both methods. Verified computer programmes are available (see annex B).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12213. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12213 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6976:1995, *Natural gas — Calculation of calorific values, density, relative density and Wobbe index from composition*.

ISO 13443:1996, *Natural gas — Standard reference conditions*.

3 Definitions

For the purposes of the various parts of this International Standard, the following definitions apply.

3.1 compression factor, Z: The ratio of the volume of an arbitrary mass of gas, at a specified pressure and temperature, to the volume of the same mass of gas under the same conditions as calculated from the ideal-gas law, as follows:

$$Z = V_m(\text{real})/\ V_m(\text{ideal}) \quad \text{. . . (1)}$$

where $$V_m(\text{ideal}) = RT/p \quad \text{. . . (2)}$$

Thus, $$Z(p, T, y) = pV_m(p, T, y)/(RT) \quad \text{. . . (3)}$$

where

- p is the absolute pressure;
- T is the thermodynamic temperature;
- y is a set of parameters which uniquely characterizes the gas (in principle, the latter may be the complete molar composition or a distinctive set of dependent physico-chemical properties, or a mixture of both);
- V_m is the molar volume of the gas;
- R is the molar gas constant in coherent units.

The compression factor is a dimensionless quantity usually close to unity.

NOTE — The terms “compressibility factor” and “Z-factor” are synonymous with compression factor.

3.2 density, ρ: The mass of a given quantity of gas divided by its volume at specified conditions of pressure and temperature.

3.3 molar composition: The term used when the proportion of each component in a homogeneous mixture is expressed as a mole (or molar) fraction, or mole (molar) percentage, of the whole.

Thus the mole fraction x_i of component i is the ratio of the number of moles of component i in a given volume of a mixture to the total number of moles of all the components in the same volume of the mixture. One mole of any chemical species is the amount of substance which contains the relative molecular mass in grams. A table of recommended values of relative molecular masses is given in ISO 6976.

For an ideal gas, the mole fraction (or percentage) is identical to the volume fraction (or percentage), but this is not in general a sufficiently accurate approximation to real-gas behaviour for the purposes of this International Standard.