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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 30491.2-2024

**Natural gas - Calculation of thermodynamic properties - Part 2:
Single-phase properties(gas, liquid, and dense fluid)for
extended ranges of application**

天然气 热力学性质计算 第2部分：扩展应用范围的单相（气相、液相和稠密相）
流体性质

(English Translation)

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Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part 1: Structure and drafting rules for standardization documents" Drafting.

This document is Part 2 of GB/T 30491 "Calculation of Thermodynamic Properties of Natural Gas". GB/T 30491 has been published for the following part.

--- Part 1: Gas phase properties in gas transmission and distribution;

--- Part 2: Properties of single-phase (gas, liquid and dense phase) fluids with extended application range.

This document is equivalent to ISO 20765-2:2015 "Calculation of thermodynamic properties of natural gas - Part 2: Single-phase with extended application range" Properties of Fluids (Gas, Liquid and Dense Phases).

Introduction

GB/T 30491 gives the calculation method of natural gas thermodynamic properties, mainly involving the single-phase (gas phase, liquid phase, supercritical the calculation of the migration properties of natural gas, such as the thermodynamic properties of natural gas phase, the thermodynamic properties of natural gas gas-liquid phase, the Joule-Thomson coefficient of natural gas, and viscosity.

Compared with GB/T 17747.2 and GB/T 30491.1, which are based on the AGA8-92 DC state equation, the scope of application of the method recommended in this document is the applicable range of pressure and temperature is extended to 0.0MPa~70.0MPa and 60.0K~700.0K, and the applicable range of mole fraction is it has also been expanded to include mole fractions of methane as low as 0.30, nitrogen as high as 0.55, and carbon dioxide as high as 0.30, ethane up to 0.25, propane up to 0.14, hydrogen up to 0.40, and hydrogen sulfide up to 0.

Thermodynamic properties of natural gas such as density and sound velocity with fractions as high as 0.27 have good calculation accuracy, which is applicable to different compositions, Accurate calculation of the thermodynamic properties of natural gas in different phases is crucial to ensuring efficient development of natural gas, fair and just gathering and transportation measurement, and the natural gas industry.

It has a positive role in promoting the rapid and healthy development of at present, the ISO 20765 series of standards has released Part 1, Part 2 and Part 5, and Part 3 and Part 4 are

still under development.

Therefore, GB/T 30491 is intended to consist of the following 5 parts.

--- Part 1: Gas phase properties in gas transmission and distribution. The purpose is to specify natural gas, natural gas containing artificial admixtures and other similar mixtures A method for calculating the volumetric and thermal properties of a substance when it exists only in a gaseous state.

--- Part 2: Properties of single-phase (gas, liquid and dense phase) fluids with an extended range of application. The purpose is to specify natural gas, synthetic fuel Methods for calculating the volumetric and thermal properties of gases and similar mixtures in single-phase states (homogeneous gas, liquid and dense states).

--- Part 3: Two-phase properties (gas-liquid equilibrium state). The purpose is to specify the gas-liquid equilibrium state of natural gas, synthetic fuel gas and similar mixtures.

Methods for calculating properties of two phases in equilibrium.

--- Part 4: Calculation of natural gas properties using physical property values. The purpose is to specify the use of natural gas calorific value, relative density and other parameters to obtain physical properties the method of calculating the parameter.

--- Part 5: Calculation of viscosity, Joule-Thomson coefficient and isentropic index. The purpose is to specify the viscosity, Joule-Thomson coefficient and isentropic index of natural gas (power) Simplified algorithms for Thomson coefficient and isentropic index.

Calculation of Thermodynamic Properties of Natural Gas Part 2: Single-phase with extended range of applications (Gas, liquid and dense phase) fluid properties

1 Scope

This document specifies the volumes of natural gas, synthetic fuel gas and similar mixtures in single-phase state (homogeneous gaseous, liquid and dense state).

Properties and thermal properties calculation methods.

NOTE 1 Although this document is primarily applicable to natural gas, artificial fuel gases and similar mixtures, the methods described are also applicable to various natural gas High-precision calculation (within experimental uncertainties) of the properties of (pure) components and mixtures with other binary and multi-component mixtures.

The methods recommended in this document apply to volumetric properties (compressibility factor and density) and thermal properties (e.g. enthalpy, heat capacity, joule-the accuracy of this method is at least as good as that of the Thomson coefficient and the speed of sound in the applicable pressure, temperature and composition ranges of ISO 20765-1 [1].

The calculation method described in ISO 20765-1 is equivalent. In some cases, such as at temperatures between 250K and 275K, the calculation method is the accuracy is significantly improved compared to ISO 20765-1. Generally speaking, the calculation uncertainty of volume properties and sound velocity of this method is less than or equal to 0.1%.

The model structure of this method is more complex than that mentioned in ISO 20765-1, and it can more accurately describe the homogeneous gas, liquid, supercritical fluid (thick dense fluid) and the volumetric and thermal properties of gas-liquid equilibrium systems.

Note 2: All uncertainties mentioned in this document are expanded uncertainties with a coverage interval of 95% (coverage factor $k=2$).

This method can also be used over temperature, pressure and composition ranges not applicable to ISO 20765-1 without increasing the calculation uncertainty.

For example, it is suitable for methane mole fractions as low as 0.30, nitrogen mole fractions as high as 0.55, carbon dioxide mole fractions as high as 0.30, ethane the method can also be used for natural gas with a mole fraction as high as 0.25, a propane mole fraction as high as 0.14, and a high hydrogen mole fraction.

Calculation of properties of high CO₂ concentration mixtures for carbon storage.

The model for calculating the thermodynamic properties of mixtures presented in this paper is applicable over the entire fluid region.

The calculation uncertainty of the thermodynamic properties of natural gas in the liquid and supercritical fluid (dense fluid) regions cannot be clearly given.

For liquefied natural gas (LNG), the uncertainty of the calculation of saturated liquid density is (0.1~ 0.3)%, which is comparable to the uncertainty of the test data. For various binary mixtures of compressed fluids, the model has a high pressure of 40 MPa.

The calculated uncertainty of density is within $\pm(0.1\%\sim 0.2\%)$, which is also comparable to the uncertainty of the test data. The model described in this document is the high-precision state equation developed based on the binary mixture system is currently the most accurate one used to calculate the thermodynamic properties of liquid and supercritical natural gas.

Accurate model.

2 Normative references

The contents of the following documents constitute the essential clauses of this document through normative references in this document.

For referenced documents without a date, only the version corresponding to that date applies to this document; for referenced documents without a date, the latest version