



Designation: D7265 – 23

Standard Specification for Hydrogen Thermophysical Property Tables¹

This standard is issued under the fixed designation D7265; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The thermophysical property tables for normal hydrogen are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of hydrogen for process design and operations, particularly as they relate to hydrogen fuel cell applications. Tables are provided for gaseous hydrogen at temperatures between 50 K and 500 K at pressures to 500 MPa. These tables were developed by the National Institute of Standards and Technology from a Standard Reference Database product REFPROP, version 10.0².

1.2 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*³

D4150 Terminology Relating to Gaseous Fuels

3. Applicability

3.1 These tables apply directly only to pure gaseous hydrogen. However, it is expected that they may find substantial use in mathematical models and tables for the thermophysical properties of mixtures containing hydrogen.

¹ This specification is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.08 on Thermophysical Properties.

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² Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Terminology

4.1 *Definitions*—For definitions of general terms used in D03 Gaseous Fuels standards, refer to Terminology D4150.

5. Tables

5.1 The tabulated thermophysical properties are:

ρ , molar density ($\text{mol}\cdot\text{L}^{-1}$)

V , molar volume ($\text{L}\cdot\text{mol}^{-1}$)

H , molar enthalpy ($\text{J}\cdot\text{mol}^{-1}$)

S , molar entropy ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)

C_v , constant volume molar heat capacity ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)

C_p , constant pressure molar heat capacity ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)

c , speed of sound ($\text{m}\cdot\text{s}^{-1}$)

η , viscosity ($\mu\text{Pa}\cdot\text{s}$)

λ , thermal conductivity ($\text{mW}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$)

5.2 These tables were produced by equations from a computer package, “NIST Standard Reference Database 23; Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 10.0.” A wide selection of units (SI units, engineering units, chemical units) is available with this program.

6. Additional Information

6.1 The Reference States for enthalpy and entropy have been updated in this version of the Standard.

6.2 Reference state properties are required to calculate certain of the thermodynamic properties (enthalpy, entropy, etc.) from an equation of state formulation.

6.3 The reference state properties used to generate the tables in this specification are: enthalpy, H , and entropy, S , at 298.15 K and 0.101325 MPa ($H = 10018 \text{ J/mol}$ and $S = 186.266 \text{ J/(mol K)}$). The molar mass of hydrogen is 2.0159 g/mol.

6.4 Two new tables have been added at 35 Mpa (350 Bar) and 70 Mpa (700 Bar). These are the most common fuel pressures used for vehicles using hydrogen fuel cells.

7. Keywords

7.1 hydrogen gas tables; thermodynamic properties of hydrogen; transport properties of hydrogen