

Nomenclature, Conversions, Physical Constants, and Fixed Points for Argon

Nomenclature

- P – absolute pressure
 T – absolute temperature
 V – specific volume
 ρ – density = $1/V$
 R – universal gas constant
 Z – compressibility factor = PV/RT
 U – specific internal energy
 H – specific enthalpy
 S – specific entropy
 C_p – specific heat capacity at constant pressure
 C_v – specific heat capacity at constant volume
 μ – Joule-Thomson coefficient
 B – second virial coefficient
 G – Gibbs function
 A – Helmholtz function
 \bar{A} – residual work content
 E – potential energy
 r – distance of molecular separation
 σ – molecular separation for $E = 0$
 ϵ – Maximum energy of attraction
 k – Boltzmann constant
 N – Avogadro constant
 r^* – reduced distance = r/σ
 T^* – reduced temperature = kT/ϵ
 b_0 – reducing parameter = $2\pi N\sigma^3/3$
 B^* – reduced second virial coefficient = B/b_0
 ρ_0 – distance between cores for minimum energy
 h – Planck constant
 a – radius of core
 m – mass of molecule
 $\bar{\lambda}^*$ – de Broglie wave length = $h/(\sigma \sqrt{m\epsilon})$
- Superscripts:
 o – ideal gas property
 $*$ – real or ideal gas property at very low pressures (P approaching 0) except as noted in symbols above
 l – saturated liquid property
 g – saturated vapor property

Subscripts:

- c – critical point
 o – reference state property
 sat – property at saturation
 t – triple point
 $expr$ – experimentally determined property value
 $calc$ – calculated property value
 $melt$ – melting line property
Subscripts on partial derivatives and integrals indicate which property is being held constant.

Conversions and Physical Constants

1 thermochemical calorie = 4.184 joules
0° C = 273.15 K (Triple point of water = 273.16 K)
Gas constant, $R = 0.0820535$ liter-atm/g-mole K
Planck constant, $h = 6.6256 \times 10^{-34}$ joule-sec
Boltzmann constant, $k = 1.38054 \times 10^{-23}$ joule/K
Avogadro constant, $N = 6.02252 \times 10^{23}$ per mole
Molecular weight of argon = 39.948g/g-mole (based on the carbon-12 scale where the isotope C¹² = 12.000. . .).

Fixed Points for Argon

Critical pressure = 48.34* atmospheres
Critical density = 300.4* Amagat = 13.41 g-mole/liter
Critical temperature = 150.86* K
Normal boiling point = 87.280 ± 0.015** K
Triple point temperature = 83.80** K
Triple point pressure = 0.68005** atmospheres.

* These fixed points are those listed by Michels et al. [1]. Some recent investigations indicate the critical temperature and pressure may be in error. However, these values appear to be the best estimate available at this writing. In reference [1] the Amagat unit of density is given as 4.4647×10^{-5} moles/cm³, based on the chemical scale. In this work the physical scale is used, resulting in an Amagat density unit of 4.4659×10^{-5} moles/cm³.

** These fixed points are those listed by Ziegler et al. [2]. The value of the normal boiling point calculated by the vapor pressure equation developed in this work agrees with that listed by Ziegler [2]. The value of the triple point temperature calculated by the vapor pressure equation developed in this work deviates from Ziegler's reported value by 0.0045 percent.