

MOLLIER CHART OF THE THERMODYNAMIC PROPERTIES OF ARGON-FREE AIR IN DISSOCIATION EQUILIBRIUM: $T = 100 \text{ K}$ TO $T = 6\,000 \text{ K}$

1. NOTATION AND UNITS

		<i>SI</i>	<i>British</i>
a	speed of sound	m/s	ft/s
i	specific enthalpy	J/kg	ft lbf/slug
p	static pressure	N/m ²	lbf/ft ²
R	gas constant	J/kg K	ft lbf/slug K
s	specific entropy	J/kg K	ft lbf/slug K
T	temperature	K	K
Z	real gas factor, $p/\rho RT$		
ρ	density	kg/m ³	slug/ft ³

Constants for argon-free air used in this Item

a_0	=	332.0 m/s, 1089 ft/s
p_0	=	$1.013 \times 10^5 \text{ N/m}^2$, 2117 lbf/ft ² ($1.013 \times 10^6 \text{ dyne/cm}^2$, 76 cm Hg)
R_0	=	288.3 J/kg K, 3103 ft lbf/slug K ($6.886 \times 10^{-2} \text{ cal/g K}$)
T_0	=	273.16 K
ρ_0	=	1.288 kg/m^3 , $2.498 \times 10^{-3} \text{ slug/ft}^3$

2. NOTES

The Mollier chart gives values of speed of sound ratio, a/a_0 , pressure ratio, p/p_0 , density ratio, ρ/ρ_0 , temperature, T , and real gas factor, Z , as functions of dimensionless enthalpy $i/R_0 T_0$ and entropy s/R_0 . At temperatures where dissociation is present, it is assumed that the air is in dissociation equilibrium and that the perfect gas laws apply to each component. In the high pressure, low temperature region, the effects of the onset of liquefaction have been taken into account.

In drawing the chart, constants appropriate to argon-free air have been used in order to make the information contained in the Item consistent with that of Item No. Aero 00.01.11.

Three sources of data have been used, Derivation 2, which regards air as a mixture of nitrogen, oxygen, argon, carbon dioxide and neon in the proportion 0.78084:0.20946:0.00934:0.00033: 0.00003, has provided lines of constant density at temperatures greater than 1500 K. Derivation 4, which in turn is based on Derivation 1, regards air as a mixture of nitrogen, oxygen, argon and carbon dioxide in the ratio 0.7809:0.2095:0.0093:0.0003. This Derivation has provided lines of constant pressure (at pressures greater than 1 atmosphere), of constant density, of real gas factor, and of temperature at temperatures below 1500 K. All other data are from Derivation 3, in which the air is assumed to have the same constituents as in Derivation 2. Comparisons have been made of the results from the three sources of data at temperatures where they overlap, and when allowance has been made for the fact that Derivation 3 uses a base enthalpy that differs from that of Derivations 1 and 2, all three sources are in agreement.

A small-scale reproduction of the Mollier chart in which the variables are presented at extended intervals is presented in Figure 1. A full-scale chart (1 m × 0.7 m) is available on request from ESDU.

The thermodynamic properties of air at temperatures from 2 000 K to 13 000 K may be obtained from Item No. Aero 00.01.11.

Examples in the use of the Mollier chart are given in Item No. Aero S.00.03.27.

3. DERIVATION

1. HILSENATH, J.
et al. *Tables of thermodynamic and transport properties.*
Pergamon Press, 1960. (Originally published as National Bureau of Standards Circular 564, 1955.)
2. HILSENATH, J.
KLEIN, M.
WOOLLEY, H.W. *Tables of thermodynamic properties of air including dissociation and ionization from 1500°K to 15,000°K.*
Arnold Engineering Development Center, tech. Rep-59-20, 1959.
3. EVERED, R.D.
METCALF, H.
MCINTYRE, R.W. *Tables of the equilibrium composition and the thermodynamic properties of air up to 6000°K.*
Bristol Siddeley Engines Ltd, Ramjet dept. Rep. 3304, 1961.
4. HUMPHREY, R.L.
MEEL, C.A. *Tables of thermodynamic properties of air from 90 to 1500°K.*
Arnold Engineering Development Center, tech. Note-61-103, 1961.