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$(A_{n-2} + (A_{n-1} + A_n/T)\frac{1}{T})$

L—7

VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS OF INTEREST IN CRYOGENICS BELOW 1-ATM PRESSURE

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INTRODUCTION

A series of research reports were prepared several years ago for the National Bureau of Standards in which the vapor pressure and heats of vaporization and sublimation of liquids and solids of cryogenic interest below 1-atm pressure were computed as functions of the thermodynamic temperature from appropriate thermodynamic relations using what was then considered to be the best available physical property data. The results of these calculations were presented in tabular form as a function of absolute temperature from approximately the normal boiling point of the condensed gas to approximately the temperature at which the vapor pressure of the solid is about 10^{-15} torr. The original reports referred to in the references for this paper should be consulted for details.

The thermodynamic relations used for computing the vapor pressure and heats of vaporization and sublimation are not new, being explicitly given or implied in the published literature [1-7]. The thermodynamic relations employed are described in the report giving the results for ethylene [8]. These relations make use of a known point on the vapor pressure curve, usually the normal boiling point or triple point. The thermodynamic data needed for such computations are (1) the heat capacity and volume of the saturated condensed phase as a function of temperature over the temperature range of interest; (2) one heat of vaporization or sublimation at a known temperature and pressure (e.g., the normal boiling point); (3) the heats and temperatures of all condensed phase transitions, including the triple point; (4) the heat capacity of the gas phase or thermodynamic functions of the ideal gas calculated from statistical mechanics; and (5) an equation of state for the gas phase.

The use of such thermodynamic relations requires that all temperatures be expressed on the thermodynamic temperature scale. This is important since the necessary calorimetric data are often based on different actual temperature scales. Similarly, the energy quantities must be converted to a uniform basis. The ice point used in the present work corresponds to 273.15 K. The energy quantity used is the defined calorie (1 cal = 4.184 J).

Muijlwijk, Moussa, and van Dijk [9] have discussed the vapor pressure calculations for liquid oxygen made in this study and Moussa *et al.* [10] and Moussa [11] have discussed the corresponding calculations for liquid nitrogen and have made similar calculations from thermodynamic considerations. The agreement between the two sets of calculations is reported by them to be very good. These authors have also compared the calculations with new experimental vapor pressure measurements which they made for liquid oxygen and liquid nitrogen.

EMPIRICAL VAPOR PRESSURE RELATIONS

Table I gives a summary of the calculations made in the original reports. Table II gives a summary of the least square fits of these tabular data for vapor pressures using the general polynomial in $(1/T)$ of the form

$$\ln P_{vp}(\text{torr}) = A_0 + A_1/T + A_2/T^2 + - + A_n/T^n \qquad (1)$$

Standard deviations (s.d.) and deviations from the input data were computed for polynomials with $n = 2, 3, 4, 5, 6$ for each physical state (liquid or particular crystalline modification). The standard deviation for each fit was computed by using

$$\text{s.d.} = \frac{[\sum^N (\sigma_i)^2]^{1/2}}{N - n} \qquad (2)$$

where N is the number of tabular data points used, n is the degree of the polynomial, and σ_i is the difference between each input vapor pressure and that computed from the polynomial fit. For the vapor pressure fits the standard deviation is primarily determined by the deviations near the highest pressure in the set of data. Thus a small standard deviation implies a good fit of the higher-pressure data.

When a very wide range of pressure is to be fitted by the polynomial (e.g., solid krypton from 115.76 K (tp) to 12 K accompanied by a vapor pressure change from 547.82 torr to 1.73×10^{-42} torr) the degree of fit has been examined at the low-pressure end by considering the percentage deviation $(\sigma_i/P_i) \times 100$ at each temperature.

The degree of the polynomial chosen to best represent the data in each instance is given in Table II together with the coefficients of (1) in Table III, the standard deviation for the fit from (2) and the percentage deviation of the equation chosen from the lowest pressure point expressed as $(\sigma_i/P_i) \times 100$. The maximum absolute deviation of the polynomial fit is also shown in Table II. This maximum deviation usually occurs in the temperature range of maximum absolute pressure. The polynomial given in Table III is believed to represent the vapor pressure of the substances within the uncertainty of the physical data used in the original tabular calculations.

EMPIRICAL EXPRESSIONS FOR HEAT OF VAPORIZATION AND SUBLIMATION

Polynomial expressions of the form

$$\Delta H_v \text{ (or } \Delta H_s) = A_0 + A_1 T + A_2 T^2 + - + A_n T^n \qquad (3)$$

have been developed to represent the heat of vaporization of the liquid and the heat of sublimation of the solid phases in cal/gm mol presented in the original reports in tabular form. A least-squares fitting technique was used and fits were obtained for polynomials of $n = 2, 3, 4, 5, 6$.

1 torr = 1.33322 x 10^3 μbar

Table I. Physical State and Temperature Range of Tabular Data Used in Polynomial Fits

Substance	Reference to tabulated data	Physical state	Temperature range, K	Pressure range, torr	Polynomial designation in Tables II, III, IV, V
p-H_2*	(12, 13)	Liquid	22–13.813(tp)	1223.23–52.89	$(p\text{-}H_2)_1$
		Solid	13.813(tp)–1.0	5.289(+1)†–8.255(−39)	$(p\text{-}H_2)_2$
O_2	(14, 15)	Liquid	100–54.532(tp)	1908.43–1.098	$(O_2)_1$
		γ-Solid	54.532(tp)–43.772(tr)	1.098–1.2937(−2)	$(O_2)_2$
		β-Solid	43.772(tr)–23.781(tr)	1.2937(−2)–7.24(−12)	$(O_2)_3$
		α-Solid	23.781(tr)–20.0	7.24(−12)–1.007(−15)	$(O_2)_4$
N_2	(16, 17)	Liquid	77.347(nbp)–63.152(tp)	760–94.120	$(N_2)_1$
		β-Solid	63.152(tp)–35.62(tr)	94.12–3.147(−3)	$(N_2)_2$
		α-Solid	35.62(tr)–10	3.147(−3)–1.062(−30)	$(N_2)_3$
F_2	(16, 17)	Liquid	85.03(nbp)–53.54(tp)	760–1.919	$(F_2)_1$
		β-Solid	53.54(tp)–45.55(tr)	1.919–7.86(−2)	$(F_2)_2$
		α-Solid	45.55(tr)–14.0	7.86(−2)–7.86(−25)	$(F_2)_3$
CO	(18)	Liquid	81.638(nbp)–68.127(tp)	760–1.155(+2)	$(CO)_1$
		β-Solid	68.127(tp)–61.544(tr)	115.5–28.09	$(CO)_2$
		α-Solid	61.544(tr)–14.0	28.09–1.473(−23)	$(CO)_3$
CO_2	(18)	Solid	194.694–40.0	760–7.16(−26)	$(CO_2)_1$
Ne	(19, 20)	Liquid	30–27.102(nbp)		
			27.102(nbp)–24.552(tp)	760–3.224(+2)	$(Ne)_1$
		Solid	24.552(tp)–2.5K	3.244(2)–1.01(−35)	$(Ne)_4$
			24.552(tp)–12.5	3.224(+2)–1.292(−2)	$(Ne)_2$
			13.3 K–3.7 K	4.383(−2)–1.456(−22)	$(Ne)_3$
Ar	(21, 22)	Liquid	88.00–83.80(tp)	818.68–516.84	$(Ar)_1$
		Solid	83.80(tp)–20.0	516.84–4.54(−14)	$(Ar)_2$
Kr	(23)	Liquid	119.786–115.76(tp)	760–547.92	$(Kr)_1$
		Solid	115.76(tp)–12.0	547.92–1.73(−42)	$(Kr)_2$
Xe	(24)	Liquid	165.02(nbp)–161.37(tp)	760–612.45	$(Xe)_1$
		Solid	161.37(tp)–20.0	612.45–1.05(−34)	$(Xe)_2$
CH_4	(25)	Liquid	111.648(nbp)–90.64(tp)	760–87.625	$(CH_4)_1$
		Solid	90.64–20.4	87.625–1.89(−18)	$(CH_4)_2$
C_2H_4	(8)	Liquid	169.40–103.97	760–9.11(−1)	$(C_2H_4)_1$
		Solid	103.97–20	9.11(−1)–8.32(−43)	$(C_2H_4)_2$
C_2H_6	(26)	Liquid	184.52(nbp)–89.89(tp)	760–7.33(−3)	$(C_2H_6)_1$
		Solid	89.89(tp)–20.0	7.33(−3)–1.04(−45)	$(C_2H_6)_2$

* Parahydrogen.
† Numbers in parentheses represent power of ten by which preceding number is to be multiplied; thus $(-39) = 10^{-39}$.

These thermal quantities are much less dependent upon varying temperature than is the vapor pressure. However at sufficiently low temperature the heat of sublimation is expected to exhibit a maximum. Such maxima are present in the tabular data for all the substances at sufficiently low temperatures (see Table VI).

The temperature range and physical state of the condensed gas is the same as that given in Table I and the polynomial fit chosen to represent the heat of vaporization for liquids and heat of sublimation for solids is given in Table I and the polynomial fit chosen to represent the heat of vaporization for liquids and heat of sublimation for solids is given in Tables IV and V. The maximum deviation D_r for the fit chosen is also given in Table V. Here D_r is equal to the ΔH from input values and the ΔH calculated from the polynomial. The polynomial fit chosen is believed to represent the original tabular data to within the probable uncertainty of the tabular data.

Table II. Characteristics of Chosen Vapor Pressure Polynomials

Polynomial designation*	Number of data points, N	Degree of polynomial, n	Standard deviation, torr	Maximum deviation, σ_r, torr	Percent deviation $\sigma_r \times 100/P$, at lowest pressure
$(p\text{-}H_2)_1$	11	4	9.113(−3)†	1.11(−2)	1.52(−3)
$(p\text{-}H_2)_2$	14	5	2.274(−1)	6.32(−1)	2.52(−4)
$(O_2)_1$	25	5	2.250(−2)	7.71(−2)	3.23(−3)
$(O_2)_2$	8	3	4.841(−6)	7.26(−6)	3.92(−4)
$(O_2)_3$	12	3	8.549(−6)	2.40(−6)	7.86(−2)
$(O_2)_4$	3	2	—	0	0
$(N_2)_1$	14	3	6.847(−3)	1.38(−2)	1.84(−3)
$(N_2)_2$	16	4	3.073(−3)	7.75(−3)	6.80(−3)
$(N_2)_3$	15	4	5.481(−6)	1.63(−5)	2.04(−1)
$(F_2)_1$	18	4	2.542(−2)	7.13(−2)	1.91(−3)
$(F_2)_2$	10	3	7.466(−5)	1.05(−4)	1.39(−3)
$(F_2)_3$	17	4	1.064(−4)	3.65(−4)	1.00(−5)
$(CO)_1$	15	3	4.477(−3)	1.03(−2)	9.95(−4)
$(CO)_2$	9	3	2.524(−4)	1.40(−4)	6.73(−4)
$(CO)_3$	25	5	4.482(−2)	0.186	8.23(−2)
$(CO_2)_1$	79	5	2.531(−1)	1.50	2.64(−1)
$(Ne)_1$	14	2	4.816(−3)	9.09(−3)	1.35(−3)
$(Ne)_2$	32	4	2.901(−2)	9.91(−2)	3.05(−2)
$(Ne)_3$	25	3	6.717(−5)	2.86(−4)	6.24(−1)
$(Ar)_1$	7	3	1.807(−2)	2.47(−2)	2.26(−4)
$(Ar)_2$	33	4	7.423(−2)	1.52(−1)	1.09(−1)
$(Kr)_1$	6	3	3.374(−3)	3.19(−3)	4.19(−4)
$(Kr)_2$	53	6	1.276(−1)	4.30(−1)	3.65(−2)
$(Xe)_1$	6	3	1.762(−3)	1.65(−3)	3.46(−5)
$(Xe)_2$	72	5	1.916(−1)	1.47	1.45(−1)
$(CH_4)_1$	12	3	6.658(−3)	1.32(−2)	1.39(−3)
$(CH_4)_2$	16	4	8.487(−2)	2.17(−1)	1.09(−1)
$(C_2H_4)_1$	35	4	2.901(−2)	0.119	3.72(−3)
$(C_2H_4)_2$	19	4	5.918(−3)	2.04(−2)	0.255
$(C_2H_6)_1$	50	5	2.376(−2)	0.104	8.36(−3)
$(C_2H_6)_2$	37	5	1.263(−5)	6.49(−5)	2.0(−1)

* See Table I.
† Number in parentheses represents power of ten by which preceding number is to be multiplied; thus $(-3) = 10^{-3}$.

Table III. Coefficients for Vapor Pressure Polynomials

Polynomial designation	Degree of polynomial, n	A_0	A_1	A_2	A_3	A_4	A_5
$(p\text{-}H_2)_1$	4	1.45630617(+1)†	−2.26432905(+2)	1.99555865(+3)	−1.60268497(+4)	5.16956659(+4)	0
$(p\text{-}H_2)_2$	5	1.36887982(+1)	−1.48563572(+2)	2.32321363(+2)	−5.60206869(+2)	6.64125808(+2)	−2.89055530(+2)
$(O_2)_1$	5	1.71336026(+1)	−1.36602459(+3)	8.51376154(+4)	−6.24443382(+6)	2.08056584(+8)	−2.69254364(+9)
$(O_2)_2$	3	1.68028804(+1)	−8.03467047(+2)	−7.08041963(+3)	7.55348282(+4)	0	0
$(O_2)_3$	3	1.99679122(+1)	−1.01165888(+3)	−2.97093494(+3)	2.92619141(+4)	0	0
$(O_2)_4$	2	2.20288779(+1)	−1.14795757(+3)	+3.34863994(+2)	0 60206869(+2)	0	0
$(N_2)_1$	3	1.51050147(+1)	−6.15496072(+2)	−2.31314834(+3)	−5.89850934(+4)	0	0
$(N_2)_2$	4	1.64302619(+1)	−6.50497257(+2)	−8.52432256(+3)	1.55914234(+5)	−1.06368300(+6)	0
$(N_2)_3$	4	1.88550118(+1)	−8.57102332(+2)	−1.01891053(+3)	1.28466570(+4)	−4.82177497(+4)	0
$(F_2)_1$	4	1.63087559(+1)	−9.10000401(+2)	1.75286014(+4)	−1.07436162(+6)	1.82831429(+7)	0
$(F_2)_2$	3	1.66943372(+1)	−7.10892317(+2)	−1.01666142(+4)	1.20007689(+5)	0	0
$(F_2)_3$	4	2.05872356(+1)	−1.01498819(+3)	−2.52102215(+3)	3.95605211(+4)	−1.97714048(+5)	0
$(CO)_1$	3	1.50598052(+1)	−6.27448768(+2)	−4.07696150(+3)	−7.02090082(+4)	0	0
$(CO)_2$	3	1.68655152(+1)	−7.48151471(+2)	−5.84330795(+3)	3.93853859(+4)	0	0
$(CO)_3$	5	1.80741183(+1)	−7.69842078(+2)	−1.21487759(+4)	2.73500950(+5)	−2.90874670(+6)	1.20319418(+7)
$(CO_2)_1$	5	2.13807649(+1)	−2.57064700(+3)	−7.78129489(+4)	4.32506256(+6)	−1.20671368(+8)	1.34966306(+9)
$(Ne)_1$	2	1.45683287(+1)	−2.08649277(+2)	−1.73607188(+2)	0	0	0
$(Ne)_2$	4	1.72295003(+1)	−3.08555051(+2)	9.86024302(+2)	−9.06932715(+3)	3.51416575(+4)	0
$(Ne)_3$	3	1.65060974(+1)	−2.69940222(+2)	1.28274063(+2)	−1.62408198(+2)	0	0
$(Ar)_1$	3	1.82972086(+1)	−1.48779324(+3)	6.34472744(+4)	−1.95982504(+6)	0	0
$(Ar)_2$	4	1.73112008(+1)	−8.93214985(+2)	−3.56668827(+3)	6.57373795(+4)	−4.28042314(+5)	0
$(Kr)_1$	3	1.64082338(+1)	−1.34140150(+3)	3.52417925(+4)	−1.77497419(+6)	0	
$(Kr)_2$*	6	1.73869419(+1)	−1.22288850(+3)	−8.90261648(+3)	2.63516848(+5)	−4.26010812(+6)	3.57476939(+7)
$(X_e)_1$	3	4.10767257	4.21521262(+3)	−9.25502035(+5)	4.92889945(+7)	0	0
$(X_e)_2$	5	1.76049992(+1)	−1.73748839(+3)	−1.33211030(+4)	4.34885865(+5)	−7.02713974(+6)	4.4465022(+7)
$(CH_4)_1$	3	1.55435098(+1)	−9.85407490(+2)	1.46936882(+3)	−2.8121803(+5)	0	0
$(CH_4)_2$	4	1.71271658(+1)	−1.11039009(+3)	−4.34060967(+3)	1.03503576(+5)	−7.91001903(+5)	0
$(C_2H_4)_1$	4	1.58306581(+1)	−1.52734894(+3)	1.95021058(+4)	−5.41035842(+6)	2.07603207(+8)	0
$(C_2H_4)_2$	4	2.02358004(+1)	−2.20575427(+3)	−1.21633511(+4)	2.84286242(+5)	−2.20328651(+6)	0
$(C_2H_6)_1$	5	1.60208290(+1)	−1.81278616(+3)	7.40134346(+4)	−1.60402392(+7)	1.09078781(+9)	−2.67185096(+10)
$(C_2H_6)_2$	5	2.17346655(+1)	−2.20745699(+3)	−2.41126545(+4)	7.74440633(+5)	−1.16152931(+7)	6.76330698(+7)

* $A_6 = -1.21027218(+8)$.

† Number in parentheses represents power of ten by which preceding number is to be multiplied; thus $(+1) = 10^{+1}$.

Table IV. Characteristics of the Polynomials Chosen to Represent the Heat of Vaporization and Sublimation

Polynomial designation	Number of data points, N	Degree of polynomial, n	Standard deviation, cal/g-mol	Maximum deviation, D, cal/g-mol
$(p\text{-}H_2)_1$	11	3	6.352(−3)*	1.21(−2)
$(p\text{-}H_2)_2$	14	4	8.394(−3)	1.06(−2)
$(O_2)_1$	25	3	7.470(−2)	1.44(−1)
$(O_2)_2$	8	2	3.238(−2)	4.5(−2)
$(O_2)_3$	12	3	4.292(−2)	6.04(−2)
$(O_2)_4$†	3	2	—	0
$(N_2)_1$	14	3	2.501(−2)	3.87(−2)
$(N_2)_2$	16	3	1.274(−1)	2.04(−2)
$(N_2)_3$	14	3	8.207	5.89
$(F_2)_1$	18	3	5.274(−2)	7.17(−2)
$(F_2)_2$	10	2	2.719(−2)	4.29(−2)
$(F_2)_3$	16	2	1.507(−1)	2.82(−1)
$(CO)_1$	15	3	2.495(−2)	3.62(−2)
$(CO)_2$	9	2	3.866(−2)	6.16(−2)
$(CO)_3$	25	5	2.171(−1)	3.41(−1)
$(CO_2)_1$	76	4	5.056(−1)	1.5
$(Ne)_1$	14	2	2.22(−2)	3.78(−3)
$(Ne)_4$	58	3	2.23(−1)	6.3(−1)
$(Ar)_1$	7	2	2.948(−2)	2.53(−2)
$(Ar)_2$	33	4	1.307(−1)	2.78(−1)
$(Kr)_1$	6	2	2.061(−2)	2.28(−2)
$(Kr)_2$	53	5	3.462(−1)	9.8(−1)
$(Xe)_1$	6	2	2.372(−2)	2.47(−2)
$(Xe)_2$	69	5	2.788(−1)	1.04
$(CH_4)_1$	12	4	1.028(−2)	1.30(−2)
$(CH_4)_2$	16	4	4.711(−1)	7.55(−1)
$(C_2H_4)_1$	35	4	2.816(−2)	6.16(−2)
$(C_2H_4)_2$	19	5	7.126(−1)	1.46
$(C_2H_6)_1$	50	4	3.712(−2)	7.69(−2)
$(C_2H_6)_2$	36	4	2.591(−1)	6.7(−1)

* Number in parentheses represents power of ten by which preceding number is to be multiplied; thus $(-3) = 10^{-3}$.

† This polynomial was fitted exactly to the three available data points.

Table V. Coefficients for Polynomials for Representation of Heats of Vaporization and Sublimation

Polynomial designation	Degree of polynomial, n	A_0	A_1	A_2	A_3	A_4	A_5
$(p\text{-}H_2)_1$	3	2.00648718(+2)*	−7.68491547(−1)	2.86608401(−1)	−1.05677175(−2)	0	0
$(p\text{-}H_2)_2$	4	1.82341589(+2)	5.04655475	−2.78851470(−2)	3.75516040(−3)	−3.21874215(−4)	0
$(O_2)_1$	3	2.28686318(+3)	−1.16726709(+1)	9.90903451(−2)	−5.59355862(−4)	0	0
$(O_2)_2$	2	2.17982755(+3)	−3.93880325	−1.42928214(−3)	0		
$(O_2)_3$	3	2.10631042(+3)	5.51297832	−3.23295954(−2)	−1.23333898(−3)	0	0
$(O_2)_4$	2	2.03935971(+3)	1.37906641(+1)	−2.51682479(−1)	0	0	0
$(N_2)_1$	3	1.93567073(+3)	−1.23956813(+1)	1.29835257(−1)	−9.05113142(−4)	0	0
$(N_2)_2$	3	1.74787117(+3)	−1.66883920	2.80155636(−2)	−5.52325058(−4)	0	0
$(N_2)_3$	3	1.76584691(+3)	−1.12048675(+1)	8.99945336(−1)	1.74859427(−2)	0	0
$(F_2)_1$	3	2.41901080(+3)	−1.97136996(+1)	2.13593494(−1)	−1.18043213(−3)	0	0
$(F_2)_2$	2	1.99456104(+3)	2.44341324	−7.28491147(−2)	0	0	0
$(F_2)_3$	2	1.99260786(+3)	9.42167232	−1.41156515(−1)	0	0	0
$(CO)_1$	3	2.28057230(+3)	−1.74014373(+1)	1.62183373(−1)	−9.13957774(−4)	0	0
$(CO)_2$	2	1.85501140(+3)	3.25281178	−6.83327351(−2)	0	0	0
$(CO)_3$	5	1.89343094(+3)	7.33091373	1.09658103(−2)	−6.06576657(−3)	1.16607568(−4)	−7.89570711(−7)
$(CO_2)_1$	4	6.26891952(+3)	9.87685955	−1.30996632(−1)	6.27346551(−4)	−1.26990433(−6)	0
$(Ne)_1$	2	4.10014396(+2)	6.45783223	−2.29854677(−1)	0	0	0
$(Ne)_4$	3	4.48121436(+2)	5.45707298	−4.83467001(−2)	−2.85169107(−3)	0	0
$(Ar)_1$	2	1.80361227(+3)	1.07629316	−4.64775453(−2)	0	0	0
$(Ar)_2$	4	1.83343436(+3)	8.04184233	−2.15909035(−1)	2.48858202(−3)	−1.22749798(−5)	0
$(Kr)_1$	2	2.61380902(+3)	−6.33777250(−1)	−2.67548825(−2)	0	0	0
$(Kr)_2$	5	2.67388195(+3)	5.38112239	−1.47093834(−1)	1.60777468(−3)	−8.35972360(−6)	1.23132564(−8)
$(Xe)_1$	2	3.63039899(+3)	−2.73782505(−1)	−2.07569185(−2)	0	0	0
$(Xe)_2$	5	3.83005277(+3)	2.77745931	−7.54373551(−2)	6.87360893(−4)	−3.06131850(−6)	4.31942106(−9)
$(CH_4)_1$	4	1.70221507(+3)	2.67601059(+1)	−4.70352164(−1)	3.26628435(−3)	−9.12879608(−6)	0
$(CH_4)_2$	4	2.18042941(+3)	2.08564398	−1.25597469(−1)	8.20425270(−4)	−2.78035132(−6)	0
$(C_2H_4)_1$	4	4.78014203(+3)	−8.97349929	−2.44425948(−2)	2.92601344(−4)	−9.03503556(−7)	0
$(C_2H_4)_2$	5	4.57648408(+3)	5.91638354	1.23926494(−1)	−5.28773642(−3)	5.76289852(−5)	−2.23387324(−7)
$(C_2H_6)_1$	4	2.96774928(+3)	−5.97889705	−3.81206626(−2)	2.99362648(−4)	−8.02583563(−7)	0
$(C_2H_6)_2$	4	4.78487682(+3)	1.39585485(+1)	−2.11697992(−1)	1.28437856(−3)	−4.46166506(−6)	0

* Number in parentheses represents power of ten by which preceding number is to be multiplied; thus $(+2) = 10^2$.

Table VI. Temperatures of Maximum in Heat of Vaporization or Sublimation

Substance	ΔH_t, K	ΔH_v, K
p-H_2	17	
O_2		30
N_2		27
F_2		33
CO		35
CO_2		58
Ne		21
Ar		35
Kr		30
Xe		28
CH_4		55
C_2H_4		53
C_2H_6		51

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