2.24 Methane(Friend, Ely and Ingham)

Equations for thermodynamic properties have been cited from Friend et al. [1], surface tension from Miller et al. [2], and pressure and temperature on melting line from the IUPAC [3].

2.24.1 Temperature Scale

International practical temperature scale 1968 (IPTS-1968)

2.24.2 The Names of Substance, Library File and Single Shot Program

Name of Substance:	Methane
Library File for UNIX:	libjch42.a
Library File for DOS,Windows95/NT:	JCH42.LIB
Single Shot Program for UNIX:	ch42-ss
Single Shot Program for DOS,Windows95/NT:	CH42–SS.EXE

2.24.3 Important Constants and Others

Molecular Formula:	CH_4
Relative Molecular Mass:	16.043
Gas Constant:	518.264 J/(kg·K)

Critical Constants:

Critical Pressure:	4.5992×10^{6}Pa (45.992 bar)
Critical Temperature:	190.551 K (−82.599°C)
Critical Specific Volume:	$6.1478\times10^{-3}\mathrm{m}^3$/kg

Triple Point:

Pressure:	0.011696×10^{6}Pa (0.11696 bar)
Temperature:	90.6854 K (−182.4646°C)

Reference State:

At 1.01325bar (1 atm) and 25 °C(298.15 K), 186.266 J/(K.mol) is assigned to the specific entropy of the ideal gas, and 10.0177 kJ/mol assigned to the specific enthalpy of the ideal gas.

2.24.4 Formula

Equation of State:

Equation (1) in a function form of $A = A(\rho, T)$ in reference [1]. Here A=molar Helmholtz energy, ρ=density and T=Temperature.

Vapor Pressure:

Table 7 in reference [1].

Properties at Vapor-Liquid Equilibrium:

Equation (4) and equation (5) in reference [1] for saturation density of liquid and vapor respectively, equation (3) in reference [1] for pressure at saturation.

Pressure and Temperature on Melting Line:

Equation (52) in the reference [3].

Transport Properties:

Equation (8) and equation (9) in reference [1] for viscosity and thermal conductivity respectively.

The Other Properties:
Equation (23-1) in reference [2] for surface tension.

References

[1] D.G.Friend, J.F.Ely, and H.Ingham, Thermal Properties of Methane, J. Phys. Chem. Ref. Data, Vol.18, No.2, 1989, pp.583-638.
[2] J.W.Miller, Jr. and C.L.Yaws, Chem. Eng.,83-23, (1976), p.127.
[3] S.Angus and K.M.de Reuck, International Thermodynamic Table of the Fluid State-5 Methane, IUPAC, vol.5, (1976).

Table II–2.24–1 Methane Function

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
1	AIPPT(P,T)		
94	AJTPT(P,T)	AJTPT: Joule-Thomson Coefficient [K/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] TMLP(P)≤T≤600 [K] $40\times10^6<P\leq10^9$ [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
8A	AKPD(P)		
8B	AKPDD(P)		
82	AKPT(P,T)	AKPT: Isentropic Exponent [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] TMLP(P)≤T≤600 [K] $40\times10^6<P\leq10^9$ [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
8C	AKTD(T)		
8D	AKTDD(T)		
2	ALAPP(P)		
3	ALAPT(T)		
4	ALHP(P)	ALHP: Latent Heat of Vaporization [J/kg] P∗: Pressure [Pa], [bar]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
6	ALMPD(P)		
7	ALMPDD(P)		
8	ALMPT(P,T)	ALMPT: Thermal Conductivity [W/(m·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$P\leq70\times10^6$ [Pa] 91≤T≤600 [K] P≤1000 [bar] -182.15≤T≤326.85 [°C]
9	ALMTD(T)		
10	ALMTDD(T)		
11	AMUPD(P)	AMUPD: Coefficient of Viscosity of Saturated Liquid [Pa·s] P∗: Pressure [Pa], [bar]	PST(95K)≤P≤4.5992×10^6 [Pa] PST(−178.15°C)≤P≤45.992 [bar]
12	AMUPDD(P)	AMUPDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] P∗: Pressure [Pa], [bar]	PST(95K)≤P≤4.5992×10^6 [Pa] PST(−178.15°C)≤P≤45.992 [bar]
13	AMUPT(P,T)	AMUPT: Coefficient of Viscosity [Pa·s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	P≤55$times10^6$ 91≤T≤400 [K] P≤550 [bar] −182.25≤T≤136.85 [°C]

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
14	AMUTD(T)	AMUTD: Coefficient of Viscosity of Saturated Liquid [Pa·s] T∗: Temperature [K], [°C]	95≤T≤190.551 [K] −178.15≤T≤−82.599 [°C]
15	AMUTDD(T)	AMUTDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] T∗: Temperature [K], [°C]	95≤T≤190.551 [K] −178.15≤T≤−82.599 [°C]
92	BPPT(P,T)	BPPT: Volumetric Coefficient of Expansion [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
90	BSPT(P,T)	BSPT: Isentropic Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
91	BTPT(P,T)	BTPT: Isothermal Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
93	BVPT(P,T)	BVPT: Pressure Coefficient [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
16	CPPD(P)	CPPD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar]
17	CPPDD(P)	CPPDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar]
18	CPPT(P,T)	CPPT: Isobaric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
19	CPTD(T)	CPTD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
20	CPTDD(T)	CPTDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
21	CRP('A')	CRP: Critical Constants H: 'A'='H': 1.36097×10^{5} [J/kg] Specific Enthalpy P∗: 'A'='P': 4.5992×10^{6} [Pa], 45.992 [bar] Pressure S: 'A'='S': 5.19385×10^{3} [J/(kg·K)] Specific Entropy T∗: 'A'='T': 190.551 [K], −82.599 [°C] Temperature V: 'A'='V': 6.1478×10^{-3} [m^3/kg] Specific Volume	one of 'H', 'P', 'S', 'T' and 'V'
7A	CVPD(P)		
76	CVPDD(P)	CVPDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	11.696×10^{3}≤P≤4.5992×10^{6} [Pa] 0.11696≤P≤45.992 [bar]
77	CVPT(P,T)	CVPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^{3}≤P≤40×10^{6} [Pa] TMLP(P)≤T≤600 [K] 40×10^{6}<P≤10^{9} [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
7B	CVTD(T)		
78	CVTDD(T)	CVTDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
2A	EPSPD(P)		
2B	EPSPDD(P)		
22	EPSPT(P,T)		
2C	EPSTD(T)		
2D	EPSTDD(T)		
89	FC('A')	FC: Fundamental Constants M: 'A'='M': 16.043 Relative Molecular Mass R: 'A'='R': 518.25 [J/(kg·K)] Gas Constant	one of 'M' and 'R'
9A	GAMPD(P)		
96	GAMPDD(P)	GAMPDD: Ratio of Specific Heats of Saturated Vapor [–] P∗: Pressure [Pa], [bar]	11.696×10^{3}≤P≤4.5992×10^{6} [Pa] 0.11696≤P≤45.992 [bar]
95	GAMPT(P,T)	GAMPT: Ratio of Specific Heats [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^{3}≤P≤40×10^{6} [Pa] TMLP(P)≤T≤600 [K] 40×10^{6}<P≤10^{9} [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
9B	GAMTD(T)		
97	GAMTDD(T)	GAMTDD: Ratio of Specific Heats of Saturated Vapor [–] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
23	HPD(P)	HPD: Specific Enthalpy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	11.696×10^{3}≤P≤4.5992×10^{6} [Pa] 0.11696≤P≤45.992 [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	11.696×10^{3}≤P≤4.5992×10^{6} [Pa] 0.11696≤P≤45.992 [bar]

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] SPT(P,TMLP(P))≤S≤ SPT(P,600K) [J/(kg·K)] $40\times10^6<P\leq10^9$ [Pa] SPT(P,TMLP(P))≤S≤ SPT(P,470K) [J/(kg·K)] 0.11696≤P≤400 [bar] SPT(P,TMLP(P))≤S≤ SPT(P,326.85°C) [J/(kg·K)] 400<P≤10000 [bar] SPT(P,TMLP(P))≤S≤ SPT(P,196.85°C) [J/(kg·K)]
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] TMLP(P)≤T≤600 [K] $40\times10^6<P\leq10^9$ [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar] 0≤X≤1.0 [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C] 0≤X≤1.0 [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'CH4' Molecular Formula S: 'A'='S': 'METHANE' Name of Substance V: 'A'='V': '11.1' Version Number	one of 'C', 'S' and 'V'
66	PLDT(T)		
68	PMLT(T)	PMLT∗: Pressure on Melting Curve [Pa], [bar] T∗: Temperature [K], [°C]	90.6854≤T≤260 [K] −182.4646≤T≤−13.15 [°C]
85	PRPD(P)		
86	PRPDD(P)		
81	PRPT(P,T)	PRPT: Prandtl Number [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$100\times10^3\leq P\leq50\times10^6$ [Pa] 300≤T≤423.15 [K] 1.0≤P≤500 [bar] 26.85≤T≤150 [°C]
87	PRTD(T)		
88	PRTDD(T)		
99	PSBT(T)		
30	PST(T)	PST∗: Saturation Pressure [Pa], [bar] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
72	PSTD(T)		
73	PSTDD(T)		
31	SIGP(P)	SIGP: Surface Tension [N/m] P∗: Pressure [Pa], [bar]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar]

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
32	SIGT(T)	SIGT: Surface Tension [N/m] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar]
35	SPT(P,T)	SPT: Specific Entropy [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar] 0≤X≤1.0 [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C] 0≤X≤1.0 [–]
67	TLDP(P)		
69	TMLP(P)	TMLP∗: Temperature on Melting Curve [K], [°C] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤10^9 [Pa] 0.11696≤P≤10000 [bar]
64	TPH(P,H)	TPH∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] H: Specific Enthalpy [J/kg]	11.696×10^3≤P≤40×10^6 [Pa] HPT(P,TMLP(P))≤H≤ HPT(P,600K) [J/kg] 40×10^6<P≤10^9 [Pa] HPT(P,TMLP(P))≤H≤ HPT(P,470K) [J/kg] 0.11696≤P≤400 [bar] HPT(P,TMLP(P))≤H≤ HPT(P,326.85°C) [J/kg] 400<P≤10000 [bar] HPT(P,TMLP(P))≤H≤ HPT(P,196.85°C) [J/kg]
6H	TPH2(P,H)		

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
65	TPS(P,S)	TPS∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] SPT(P,TMLP(P))≤S≤ SPT(P,600K) [J/(kg·K)] $40\times10^6<P\leq10^9$ [Pa] SPT(P,TMLP(P))≤S≤ SPT(P,470K) [J/(kg·K)] 0.11696≤P≤400 [bar] SPT(P,TMLP(P))≤S≤ SPT(P,326.85°C) [J/(kg·K)] 400<P≤10000 [bar] SPT(P,TMLP(P))≤S≤ SPT(P,196.85°C) [J/(kg·K)]
6S	TPS2(P,S)		
98	TPSEUP(P)	TPSEUP∗: Pseudo Boiling Point [K], [°C] P∗: Pressure [Pa], [bar]	$4.5992\times10^6<P\leq50\times10^6$ [Pa] 45.992<P≤500 [bar]
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] VPT(P,TMLP(P))≤V≤ VPT(P,600K) [m^3/kg] $40\times10^6<P\leq10^9$ [Pa] VPT(P,TMLP(P))≤V≤ VPT(P,470K) [m^3/kg] 0.11696≤P≤400 [bar] VPT(P,TMLP(P))≤V≤ VPT(P,326.85°C) [m^3/kg] 400<P≤10000 [bar] VPT(P,TMLP(P))≤V≤ VPT(P,196.85°C) [m^3/kg]
41	TRPL('A')	TRPL∗: Properties at Triple Point P∗: 'A'='P': 11.696×10^3 [Pa],0.11696 [bar] Pressure T∗: 'A'='T': 90.6854 [K],−182.4646 [°C] Temperature	one of 'P' and 'T'
100	TSBP(P)		
40	TSP(P)	TSP∗: Saturation Temperature [K], [°C] P∗: Pressure [Pa], [bar]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar]
79	UPS(P,S)		
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$11.696\times10^3\leq P\leq40\times10^6$ [Pa] TMLP(P)≤T≤600 [K] $40\times10^6<P\leq10^9$ [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$11.696\times10^3\leq P\leq4.5992\times10^6$ [Pa] 0.11696≤P≤45.992 [bar] 0≤X≤1.0 [–]

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
46	UTD(T)	UTD: Specific Internal Energy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C] 0≤X≤1.0 [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar]
80	VPS(P,S)		
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar] 0≤X≤1.0 [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	90.6854≤T≤190.551 [K] −182.4646≤T≤−82.599 [°C] 0≤X≤1.0 [–]
8E	WPD(P)		
8F	WPDD(P)		
83	WPT(P,T)	WPT: Velocity of Sound [m/s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	11.696×10^3≤P≤40×10^6 [Pa] TMLP(P)≤T≤600 [K] 40×10^6<P≤10^9 [Pa] TMLP(P)≤T≤470 [K] 0.11696≤P≤400 [bar] TMLP(P)≤T≤326.85 [°C] 400<P≤10000 [bar] TMLP(P)≤T≤196.85 [°C]
8G	WTD(T)		
8H	WTDD(T)		
56	XPH(P,H)	XPH: Dryness Fraction [–] P∗: Pressure [Pa], [bar] H: Specific Enthalpy of Mixture [J/kg]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar] HPD(P)≤H≤HPDD(P) [J/kg]
57	XPS(P,S)	XPS: Dryness Fraction [–] P∗: Pressure [Pa], [bar] S: Specific Entropy of Mixture [J/(kg·K)]	11.696×10^3≤P≤4.5992×10^6 [Pa] 0.11696≤P≤45.992 [bar] SPD(P)≤S≤SPDD(P) [J/(kg·K)]

Table II–2.24–1 Methane Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
58	XPU(P,U)	XPU: Dryness Fraction [–] P∗: Pressure [Pa], [bar] U: Specific Internal Energy of Mixture [J/kg]	$11.696\times10^3 \le P \le 4.5992\times10^6$ [Pa] $0.11696 \le P \le 45.992$ [bar] UPD(P)≤U≤UPDD(P) [J/kg]
59	XPV(P,V)	XPV: Dryness Fraction [–] P∗: Pressure [Pa], [bar] V: Specific Volume of Mixture [m^3/kg]	$11.696\times10^3 \le P \le 4.5992\times10^6$ [Pa] $0.11696 \le P \le 45.992$ [bar] VPD(P)≤V≤VPDD(P) [m^3/kg]
60	XTH(T,H)	XTH: Dryness Fraction [–] T∗: Temperature [K], [°C] H: Specific Enthalpy of Mixture [J/kg]	$90.6854 \le T \le 190.551$ [K] $-182.4646 \le T \le -82.599$ [°C] HTD(T)≤H≤HTDD(T) [J/kg]
61	XTS(T,S)	XTS: Dryness Fraction [–] T∗: Temperature [K], [°C] S: Specific Entropy of Mixture [J/(kg·K)]	$90.6854 \le T \le 190.551$ [K] $-182.4646 \le T \le -82.599$ [°C] STD(T)≤S≤STDD(T) [J/(kg·K)]
62	XTU(T,U)	XTU: Dryness Fraction [–] T∗: Temperature [K], [°C] U: Specific Internal Energy of Mixture [J/kg]	$90.6854 \le T \le 190.551$ [K] $-182.4646 \le T \le -82.599$ [°C] UTD(T)≤U≤UTDD(T) [J/kg]
63	XTV(T,V)	XTV: Dryness Fraction [–] T∗: Temperature [K], [°C] V: Specific Volume of Mixture [m^3/kg]	$90.6854 \le T \le 190.551$ [K] $-182.4646 \le T \le -82.599$ [°C] VTD(T)≤V≤VTDD(T) [m^3/kg]