2.20 Ammonia (Stewart, Jacobsen and Renoncello)

Equations for thermodynamic properties are based on the formulations by Stewart, Jacobsen and Renoncello used in a monograph from American Society of Heating, Refrigerating and Air-Conditioning Engineers [1]. The Equation for viscosity has been cited from Fenghour, Wakeham, Vesovic, Watson, Millat and Vogel [2], that for thermal conductivity from Yata [3], and that for surface tension from Liley and Desai [4].

2.20.1 Temperature Scale

International practical temperature scale 1968 (IPTS-1968)

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

Name of Substance:	Ammonia
Library File for UNIX:	libjnh3.a
Library File for DOS,Windows95/NT:	JNH3.LIB
Single Shot Program for UNIX:	nh3-ss
Single Shot Program for DOS,Windows95/NT:	NH3–SS.EXE

2.20.3 Important Constants and Others

Molecular Formula:	NH_3
Relative Molecular Mass:	17.03026
Gas Constant:	488.18 J/(kg·K)

Critical Constants:

Critical Pressure:	11.304×10^6Pa (113.04 bar)
Critical Temperature:	405.4 K (132.25°C)
Critical Specific Volume:	4.255×10^{-3}m^3/kg

Triple Point:

Pressure:	6.063×10^3 Pa (0.06063 bar)
Temperature:	195.48 K (−77.67°C)

Reference State:

Ideal gas value of internal energy is defined as $U^0_{0\mathrm{K}} = 0$ J/kg at 0 K (−273.15 °C).

2.20.4 Formula

Equation of State:

Equations (6.1.1)-(6.1.4) in a function form of $A = A(\rho, T)$ in reference [1]. Here A=specific helmholtz function, ρ=density and T=temperature.

Vapor Pressure:

Equation (6.1.12) in reference [1].

Properties at Vapor-Liquid Equilibrium:

Equations (6.1.12) and (6.1.5) for specific volume, equation (6.1.6) for specific entropy, and equation (6.1.8) for specific enthalpy. All of these have been cited from reference [1].

Transport Properties:

Viscosiy, thermal conductivity and surface tension are cited from reference [2], [3] and [4], respectively.

References

[1] R. B. Stewart, R. T. Jacobsen and S. G. Renoncello, ASHRAE Thermodynamic Properties of Refrigerants, American Society of Heating, Refrigerating and Air-Conditioning Engineers, (1986), pp.93–97, pp.262–282.
[2] A. Fenghour, W. A. Wakeham, V. Vesovic, J. T. R. Watson, J. Millat and E. Vogel, J. Phys. Chem. Ref. Data, Vol. 24, 5, (1995), pp.1649.
[3] J. Yata, Private communication.
[4] P. E. Liley and P. D. Desai, Thermophysical Properties of Refrigerants (Inch–Pound Edition), American Society of Heating, Refrigerating and Air-Conditioning Engineers, (1993), pp.204.

Table II–2.20–1 Ammonia Function

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
1	AIPPT(P,T)		
94	AJTPT(P,T)		
8A	AKPD(P)		
8B	AKPDD(P)		
82	AKPT(P,T)		
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]	$6.063\times10^3 \leq P \leq 11.2939\times10^6$ [Pa] $0.06063 \leq P \leq 112.939$ [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	$195.48 \leq T \leq 405.35$ [K] $-77.67 \leq T \leq 132.20$ [°C]
6	ALMPD(P)	ALMPD: Thermal Conductivity of Saturated Liquid [W/(m·K)]	$40.8339\times10^3 \leq P \leq 10.4652\times10^6$ [Pa] $0.408339 \leq P \leq 104.652$ [bar]
7	ALMPDD(P)	ALMPDD: Thermal Conductivity of Saturated Vapor [W/(m·K)]	$40.8339\times10^3 \leq P \leq 9.7034\times10^6$ [Pa] $0.408339 \leq P \leq 97.034$ [bar]
8	ALMPT(P,T)	ALMPT: Thermal Conductivity [W/(m·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0 < P \leq 50.0\times10^6$ [Pa] $223.15 \leq T \leq 573.15$ [K] $0 < P \leq 500$ [bar] $-50.0 \leq T \leq 300$ [°C] out of range: $395.0 < T < 430.0$ [K] $112.5 < \rho < 337.5$ [kg/m^3]
9	ALMTD(T)	ALMTD: Thermal Conductivity of Saturated Liquid [W/(m·K)] T∗: Temperature [K], [°C]	$223.15 \leq T \leq 401.064$ [K] $-50.0 \leq T \leq 127.914$ [°C]
10	ALMTDD(T)	ALMTDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	$223.15 \leq T \leq 396.8669$ [K] $-50.0 \leq T \leq 123.7169$ [°C]
11	AMUPD(P)	AMUPD: Coefficient of Viscosity of Saturated Liquid [Pa·s] P∗: Pressure [Pa], [bar]	$6.06\times10^3 \leq P \leq 11.2939\times10^6$ [Pa] $6.06\times10^{-2} \leq P \leq 112.939$ [bar]
12	AMUPDD(P)	AMUPDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] P∗: Pressure [Pa], [bar]	$6.06\times10^3 \leq P \leq 11.2939\times10^6$ [Pa] $6.06\times10^{-2} \leq P \leq 112.939$ [bar]
13	AMUPT(P,T)	AMUPT: Coefficient of Viscosity [Pa·s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0 < P \leq 50.0\times10^6$ [Pa] $196.0 \leq T \leq 700.0$ [K] $0 < P \leq 500$ [bar] $-77.15 \leq T \leq 426.85$ [°C]
14	AMUTD(T)	AMUTD: Coefficient of Viscosity of Saturated Liquid [Pa·s] T∗: Temperature [K], [°C]	$195.48 \leq T \leq 405.35$ [K] $-77.67 \leq T \leq 132.2$ [°C]
15	AMUTDD(T)	AMUTDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] T∗: Temperature [K], [°C]	$195.48 \leq T \leq 405.35$ [K] $-77.67 \leq T \leq 132.2$ [°C]
92	BPPT(P,T)		
90	BSPT(P,T)		
91	BTPT(P,T)		
93	BVPT(P,T)		
16	CPPD(P)		
17	CPPDD(P)		
18	CPPT(P,T)		
19	CPTD(T)		
20	CPTDD(T)		

Table II–2.20–1 Ammonia Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
21	CRP('A')	CRP: Critical Constants P∗: 'A'='P': 11.304×10^6[Pa], 113.04 [bar] Pressure T∗: 'A'='T': 405.4 [K], 132.25 [°C] Temperature V: 'A'='V': 4.255×10^{-3} [m^3/kg] Specific Volume	one of 'P', 'T' and 'V'
7A	CVPD(P)		
76	CVPDD(P)		
77	CVPT(P,T)		
7B	CVTD(T)		
78	CVTDD(T)		
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': 17.03026 Relative Molecular Mass R: 'A'='R': 488.18 [J/(kg·K)] Gas Constant	one of 'M' and 'R'
9A	GAMPD(P)		
96	GAMPDD(P)		
95	GAMPT(P,T)		
9B	GAMTD(T)		
97	GAMTDD(T)		
23	HPD(P)	HPD: Specific Enthalpy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$6.063\times10^3\leq P\leq11.2939\times10^6$ [Pa] $0.06063\leq P\leq112.939$ [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$6.063\times10^3\leq P\leq11.2939\times10^6$ [Pa] $0.06063\leq P\leq112.939$ [bar]
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.01\times10^6\leq P\leq15\times10^6$ [Pa] SPT(P,208.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $15\times10^6<P\leq150\times10^6$ [Pa] SPT(P,218.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $150\times10^6<P\leq500\times10^6$ [Pa] SPT(P,(0.4×10^{-6})P+158.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] 0.001≤P≤150 [bar] SPT(P,−65°C)≤S≤ SPT(P,480°C) [J/(kg·K)] 150<P≤1500 [bar] SPT(P,−55°C)≤S≤ SPT(P,480°C) [J/(kg·K)] 1500<P≤5000 [bar] SPT(P,0.04P−115°C)≤S≤ SPT(P,480C) [J/(kg·K)]
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.01\times10^6\leq P\leq15\times10^6$ [Pa] 208.15≤T≤753.15 [K] $15\times10^6<P\leq150\times10^6$ [Pa] 218.15≤T≤753.15 [K] $150\times10^6<P\leq500\times10^6$ [Pa] (0.4×10^{-6})P+158.15≤T≤753.15 [K] 0.001≤P≤150 [bar] −65.0≤T≤480 [°C] 150<P≤1500 [bar] −55.0≤T≤480 [°C] 1500<P≤5000 [bar] 0.04P−115≤T≤480 [°C]

Table II–2.20–1 Ammonia Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar] $0 \le X \le 1.0$ [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] $0 \le X \le 1.0$ [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'NH3' Molecular Formula S: 'A'='S': 'AMMONIA' Name of Substance V: 'A'='V': '10.1' Version Number	one of 'C', 'S' and 'V'
66	PLDT(T)		
68	PMLT(T)		
85	PRPD(P)		
86	PRPDD(P)		
81	PRPT(P,T)		
87	PRTD(T)		
88	PRTDD(T)		
99	PSBT(T)		
30	PST(T)	PST∗: Saturation Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
72	PSTD(T)		
73	PSTDD(T)		
31	SIGP(P)	SIGP: Surface Tension [N/m] P∗: Pressure [Pa], [bar]	$10.8207\times10^3 \le P \le 11.2939\times10^6$ [Pa] $10.8207\times10^{-2} \le P \le 112.939$ [bar]
32	SIGT(T)	SIGT: Surface Tension [N/m] T∗: Temperature [K], [°C]	$203.0 \le T \le 405.40$ [K] $-70.15 \le T \le 132.25$ [°C]
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar]
35	SPT(P,T)	SPT: Specific Entropy [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] $208.15 \le T \le 753.15$ [K] $15\times10^6 < P \le 150\times10^6$ [Pa] $218.15 \le T \le 753.15$ [K] $150\times10^6 < P \le 500\times10^6$ [Pa] $(0.4\times10^{-6})P+158.15 \le T \le 753.15$ [K] $0.001 \le P \le 150$ [bar] $-65.0 \le T \le 480$ [°C] $150 < P \le 1500$ [bar] $-55.0 \le T \le 480$ [°C] $1500 < P \le 5000$ [bar] $0.04P-115 \le T \le 480$ [°C]

Table II–2.20–1 Ammonia Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar] $0 \le X \le 1.0$ [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] $0 \le X \le 1.0$ [–]
67	TLDP(P)		
69	TMLP(P)		
64	TPH(P,H)	TPH∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] H: Specific Enthalpy [J/kg]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] HPT(P,208.15K)≤H≤ HPT(P,753.15K) [J/kg] $15\times10^6 < P \le 150\times10^6$ [Pa] HPT(P,218.15K)≤H≤ HPT(P,753.15K) [J/kg] $150\times10^6 < P \le 500\times10^6$ [Pa] HPT(P,(0.4×10^{-6})P+158.15K)≤H≤ HPT(P,753.15K) [J/kg] $0.001 \le P \le 150$ [bar] HPT(P,−65°C)≤H≤ HPT(P,480°C) [J/kg] $150 < P \le 1500$ [bar] HPT(P,−55°C)≤H≤ HPT(P,480°C) [J/kg] $1500 < P \le 5000$ [bar] HPT(P,0.04P−115°C)≤H≤ HPT(P,480°C) [J/kg]
6H	TPH2(P,H)		
65	TPS(P,S)	TPS∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] SPT(P,208.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $15\times10^6 < P \le 150\times10^6$ [Pa] SPT(P,218.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $150\times10^6 < P \le 500\times10^6$ [Pa] SPT(P,(0.4×10^{-6})P+158.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $0.001 \le P \le 150$ [bar] SPT(P,−65°C)≤S≤ SPT(P,480°C) [J/(kg·K)] $150 < P \le 1500$ [bar] SPT(P,−55°C)≤S≤ SPT(P,480°C) [J/(kg·K)] $1500 < P \le 5000$ [bar] SPT(P,0.04P−115°C)≤S≤ SPT(P,480°C) [J/(kg·K)]
6S	TPS2(P,S)		
98	TPSEUP(P)		

Table II–2.20–1 Ammonia Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] VPT(P,208.15K)≤V≤ VPT(P,753.15K) [m^3/kg] $15\times10^6 < P \le 150\times10^6$ [Pa] VPT(P,218.15K)≤V≤ VPT(P,753.15K) [m^3/kg] $150\times10^6 < P \le 500\times10^6$ [Pa] VPT(P,(0.4×10^{-6})P+158.15K)≤V≤ VPT(P,753.15K) [m^3/kg] 0.001≤P≤150 [bar] VPT(P,−65°C)≤V≤ VPT(P,480°C) [m^3/kg] 150<P≤1500 [bar] VPT(P,−55°C)≤V≤ VPT(P,480°C) [m^3/kg] 1500<P≤5000 [bar] VPT(P,0.04P−115°C)≤V≤ VPT(P,480°C) [m^3/kg]
41	TRPL('A')	TRPL∗: Properties at Triple Point P∗: 'A'='P': 6.063×10^3 [Pa], 0.06063 [bar] Pressure T∗: 'A'='T': 195.48 [K], −77.67 [°C] Temperature	one of 'P' and 'T'
100	TSBP(P)		
40	TSP(P)	TSP∗: Saturation Temperature [K], [°C] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] 0.06063≤P≤112.939 [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] 0.06063≤P≤112.939 [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] 0.06063≤P≤112.939 [bar]
79	UPS(P,S)	UPS: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] SPT(P,208.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $15\times10^6 < P \le 150\times10^6$ [Pa] SPT(P,218.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $150\times10^6 < P \le 500\times10^6$ [Pa] SPT(P,(0.4×10^{-6})P+158.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] 0.001≤P≤150 [bar] SPT(P,−65°C)≤S≤ SPT(P,480°C) [J/(kg·K)] 150<P≤1500 [bar] SPT(P,−55°C)≤S≤ SPT(P,480°C) [J/(kg·K)] 1500<P≤5000 [bar] SPT(P,0.04P−115°C)≤S≤ SPT(P,480°C) [J/(kg·K)]

Table II–2.20–1 Ammonia Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] $208.15 \le T \le 753.15$ [K] $15\times10^6 < P \le 150\times10^6$ [Pa] $218.15 \le T \le 753.15$ [K] $150\times10^6 < P \le 500\times10^6$ [Pa] $(0.4\times10^{-6})P+158.15 \le T \le 753.15$ [K] $0.001 \le P \le 150$ [bar] $-65 \le T \le 480$ [°C] $150 < P \le 1500$ [bar] $-55 \le T \le 480$ [°C] $1500 < P \le 5000$ [bar] $0.04P-115 \le T \le 480$ [°C]
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar] $0 \le X \le 1.0$ [–]
46	UTD(T)	UTD: Specific Internal Energy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] $0 \le X \le 1.0$ [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar]
80	VPS(P,S)	VPS: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] SPT(P,208.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $15\times10^6 < P \le 150\times10^6$ [Pa] SPT(P,218.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $150\times10^6 < P \le 500\times10^6$ [Pa] SPT(P,(0.4×10^{-6})P+158.15K)≤S≤ SPT(P,753.15K) [J/(kg·K)] $0.001 \le P \le 150$ [bar] SPT(P,−65°C)≤S≤ SPT(P,480°C) [J/(kg·K)] $150 < P \le 1500$ [bar] SPT(P,−55°C)≤S≤ SPT(P,480°C) [J/(kg·K)] $1500 < P \le 5000$ [bar] SPT(P,0.04P−115°C)≤S≤ SPT(P,480°C) [J/(kg·K)]

Table II–2.20–1 Ammonia Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.01\times10^6 \le P \le 15\times10^6$ [Pa] $208.15 \le T \le 753.15$ [K] $15\times10^6 < P \le 150\times10^6$ [Pa] $218.15 \le T \le 753.15$ [K] $150\times10^6 < P \le 500\times10^6$ [Pa] $(0.4\times10^{-6})P+158.15 \le T \le 753.15$ [K] $0.001 \le P \le 150$ [bar] $-65 \le T \le 480$ [°C] $150 < P \le 1500$ [bar] $-55 \le T \le 480$ [°C] $1500 < P \le 5000$ [bar] $0.04P-115 \le T \le 480$ [°C]
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar] $0 \le X \le 1.0$ [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] $0 \le X \le 1.0$ [–]
8A	WPD(P)		
8B	WPDD(P)		
83	WPT(P,T)		
8C	WTD(T)		
8D	WTDD(T)		
56	XPH(P,H)	XPH: Dryness Fraction [–] P∗: Pressure [Pa], [bar] H: Specific Enthalpy of Mixture [J/kg]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [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)]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [bar] SPD(P)≤S≤SPDD(P) [J/(kg·K)]
58	XPU(P,U)	XPU: Dryness Fraction [–] P∗: Pressure [Pa], [bar] U: Specific Internal Energy of Mixture [J/kg]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [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]	$6.063\times10^3 \le P \le 11.2939\times10^6$ [Pa] $0.06063 \le P \le 112.939$ [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]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] HPD(T)≤H≤HPDD(T) [J/kg]
61	XTS(T,S)	XTS: Dryness Fraction [–] T∗: Temperature [K], [°C] S: Specific Entropy of Mixture [J/(kg·K)]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] SPD(T)≤S≤SPDD(T) [J/(kg·K)]
62	XTU(T,U)	XTU: Dryness Fraction [–] T∗: Temperature [K], [°C] U: Specific Internal Energy of Mixture [J/kg]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] UPD(T)≤U≤UPDD(P) [J/kg]
63	XTV(T,V)	XTV: Dryness Fraction [–] T∗: Temperature [K], [°C] V: Specific Volume of Mixture [m^3/kg]	$195.48 \le T \le 405.35$ [K] $-77.67 \le T \le 132.20$ [°C] VPD(T)≤V≤VPDD(T) [m^3/kg]