2.45 HFC-134a(R134a)

All equations for HFC-134a(R134a) are based on the Table from Japanese Association of Refrigeration and Japan Flon Gas Association[1].

2.45.1 Temperature Scale

International practical temperature scale 1968 (IPTS-1968)

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

Name of Substance:	HFC-134a, R134a, Refrigerant 134a, 1,2,2,2-Tetrafluoroethane
Library File for UNIX:	libjr134a.a
Library File for DOS,Windows95/NT:	JR134A.LIB
Single Shot Program for UNIX:	r134a-ss
Single Shot Program for DOS,Windows95/NT:	R134A–SS.EXE

2.45.3 Important Constants and Others

Molecular Formula:	CH_2FCF_3
Relative Molecular Mass:	102.032
Gas Constant:	81.4892 J/(kg·K)

Critical Constants:

Critical Pressure:	4.064×10^{6}Pa (40.64 bar)
Critical Temperature:	374.30 K (101.15 °C)
Critical Specific Volume:	1.9685×10^{-3}m^3/kg

Reference State:

At 0°C, 1.0000 kJ/(kg·K) and 200.00 kJ/kg are assigned to the specific entropy and the specific enthalpy of saturated liquid, respectively.

2.45.4 Formula

Equation of State:

Equation (IIIA·2·3·3) in a function from of $f = f(\rho, T)$ in reference [1]. Here f=Helmholtz function, ρ=density and T= temperature.

Vapor Pressure:

Equation (IIIA·2·1·1) in reference [1].

Properties at Vapor-Liquid Equilibrium:

Equation of state, Eq.(IIIA·2·3·1), together with the vapor pressure curve for specific volume of both saturated liquid and saturated vapor. Equations (IIIA·2·6·2), (IIIA·2·5·2), and (IIIA·2·7·2) and (IIIA·2·7·4) (IIIA·2·5·6) and (IIIA·2·5·8), and together with these specific volumes for specific entropy, specific enthalpy, isobaric specific heat and isochoric specific heat, respectively. All these equations have been cited from reference [1].

Transport Properties:

Equations (IIIA·3·1·3)∼ (IIIA·3·1·5) in reference [1] for viscosity. Equations (IIIA·3·3·1)∼ (IIIA·3·1·3) in reference [1] for thermal conductivity.

The Other Properties:

Equation (IIIA·2·10·1) in reference [1] for surface tension.

References

[1] Japanese Association of Refrigeration·Japan Flon Gas Association, Thermophysical Properties of Environmentally Acceptable Fluorocarbons (HFC-134a, HCFC-123), (1986).

Table II–2.45–1 HFC-134a (R134a) 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]	$0<P\leq15\times10^6$ [Pa] $240\leq T\leq480$ [K] $0<P\leq150$ [bar] $-33.15\leq T\leq206.85$ [°C]
8A	AKPD(P)		
8B	AKPDD(P)		
82	AKPT(P,T)	AKPT: Isentropic Exponent [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq15\times10^6$ [Pa] $240\leq T\leq480$ [K] $0<P\leq150$ [bar] $-33.15\leq T\leq206.85$ [°C]
8C	AKTD(T)		
8D	AKTDD(T)		
2	ALAPP(P)	ALAPP: Laplace Coefficient [m] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar]
3	ALAPT(T)	ALAPT: Laplace Coefficient [m] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
4	ALHP(P)	ALHP: Latent Heat of Vaporization [J/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
6	ALMPD(P)	ALMPD: Thermal Conductivity of Saturated Liquid [W/(m·K)] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P<3.04\times10^6$ [Pa] $0.7\leq P<30.4$ [bar]
7	ALMPDD(P)	ALMPDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	$0.07\times10^6\leq P<3.04\times10^6$ [Pa] $0.7\leq P<30.4$ [bar]
8	ALMPT(P,T)	ALMPT: Thermal Conductivity [W/(m·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.07\times10^6\leq P\leq20\times10^6$ [Pa] $240\leq T\leq360$ [K] $0.7\leq P\leq200$ [bar] $-33.15\leq T\leq86.85$ [°C]
9	ALMTD(T)	ALMTD: Thermal Conductivity of Saturated Liquid [W/(m·K)] T∗: Temperature [K], [°C]	$240\leq T\leq360$ [K] $-33.15\leq T\leq86.85$ [°C]
10	ALMTDD(T)	ALMTDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	$240\leq T\leq360$ [K] $-33.15\leq T\leq86.85$ [°C]
11	AMUPD(P)	AMUPD: Coefficient of Viscosity of Saturated Liquid [Pa·s] P∗: Pressure [Pa], [bar]	$0.117\times10^6\leq P\leq2.061\times10^6$ [Pa] $1.17\leq P\leq20.61$ [bar]
12	AMUPDD(P)		
13	AMUPT(P,T)	AMUPT: Coefficient of Viscosity [Pa·s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$298.15\leq T\leq370.208$ [K] $0.07\times10^6\leq P\leq$PST(T) [Pa] $370.208<T\leq423.15$ [K] $0.07\times10^6\leq P\leq(0.446\times$ $(T-273.15)$[K]$-5.8577)\times10^5$ [Pa] $25\leq T\leq97.058$ [°C] $0.7\leq P\leq$PST(T) [bar] $97.058<T\leq150$ [°C] $0.7\leq P\leq0.446\times T$[°C]$-5.8577$ [bar]
14	AMUTD(T)	AMUTD: Coefficient of Viscosity of Saturated Liquid [Pa·s] T∗: Temperature [K], [°C]	$250\leq T\leq342$ [K] $-23.15\leq T\leq68.85$ [°C]
15	AMUTDD(T)		

Table II–2.45–1 HFC-134a (R134a) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
92	BPPT(P,T)	BPPT: Volumetric Coefficient of Expansion [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq 15\times 10^6$ [Pa] $240\leq T\leq 480$ [K] $0<P\leq 150$ [bar] $-33.15\leq T\leq 206.85$ [°C]
90	BSPT(P,T)	BSPT: Isentropic Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq 15\times 10^6$ [Pa] $240\leq T\leq 480$ [K] $0<P\leq 150$ [bar] $-33.15\leq T\leq 206.85$ [°C]
91	BTPT(P,T)	BTPT: Isothermal Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq 15\times 10^6$ [Pa] $240\leq T\leq 480$ [K] $0<P\leq 150$ [bar] $-33.15\leq T\leq 206.85$ [°C]
93	BVPT(P,T)	BVPT: Pressure Coefficient [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq 15\times 10^6$ [Pa] $240\leq T\leq 480$ [K] $0<P\leq 150$ [bar] $-33.15\leq T\leq 206.85$ [°C]
16	CPPD(P)	CPPD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$0.07\times 10^6\leq P<4.0404\times 10^6$ [Pa] $0.7\leq P<40.404$ [bar]
17	CPPDD(P)	CPPDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$0.07\times 10^6\leq P<4.0404\times 10^6$ [Pa] $0.7\leq P<40.404$ [bar]
18	CPPT(P,T)	CPPT: Isobaric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq 15\times 10^6$ [Pa] $240\leq T\leq 480$ [K] $0<P\leq 150$ [bar] $-33.15\leq T\leq 206.85$ [°C]
19	CPTD(T)	CPTD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$240\leq T<374$ [K] $-33.15\leq T<100.85$ [°C]
20	CPTDD(T)	CPTDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$240\leq T<374$ [K] $-33.15\leq T<100.85$ [°C]
21	CRP('A')	CRP: Critical Constants H: 'A'='H': 0.39101×10^6 [J/kg] Specific Enthalpy P∗: 'A'='P': 4.064×10^6 [Pa], 40.64 [bar] Pressure S: 'A'='S': 1.5659×10^3 [J/(kg·K)] Specific Entropy T∗: 'A'='T': 374.30 [K], 101.15 [°C] Temperature V: 'A'='V': 1.9685×10^{-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]	$0.07\times 10^6\leq P\leq 4.064\times 10^6$ [Pa] $0.7\leq P\leq 40.64$ [bar]
77	CVPT(P,T)	CVPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq 15\times 10^6$ [Pa] $240\leq T\leq 480$ [K] $0<P\leq 150$ [bar] $-33.15\leq T\leq 206.85$ [°C]
7B	CVTD(T)		
78	CVTDD(T)	CVTDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$240\leq T\leq 374.3$ [K] $-33.15\leq T\leq 101.15$ [°C]
2A	EPSPD(P)		
2B	EPSPDD(P)		
22	EPSPT(P,T)		

Table II–2.45–1 HFC-134a (R134a) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
2C	EPSTD(T)		
2D	EPSTDD(T)		
89	FC('A')	FC: Fundamental Constants M: 'A'='M': 102.032 Relative Molecular Mass R: 'A'='R': 81.4892 [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]	$0.07\times10^6 \le P < 4.064\times10^6$ [Pa] $0.7 \le P < 40.64$ [bar]
95	GAMPT(P,T)	GAMPT: Ratio of Specific Heats [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0 < P \le 15\times10^6$ [Pa] $240 \le T \le 480$ [K] $0 < P \le 150$ [bar] $-33.15 \le T \le 206.85$ [°C]
9B	GAMTD(T)		
97	GAMTDD(T)	GAMTDD: Ratio of Specific Heats of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$240 \le T < 374$ [K] $-33.15 \le T < 100.85$ [°C]
23	HPD(P)	HPD: Specific Enthalpy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] $0.7 \le P \le 40.64$ [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] $0.7 \le P \le 40.64$ [bar]
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.07\times10^6 \le P \le 0.072979\times10^6$ [Pa] SPD(P)≤S≤SPT(P,480K) [J/(kg·K)] $0.072979\times10^6 < P \le 15\times10^6$ [Pa] SPT(P,240K)≤S≤ SPT(P,480K) [J/(kg·K)] $0.7 \le P \le 0.72979$ [bar] SPD(P)≤S≤ SPT(P,206.85°C) [J/(kg·K)] $0.72979 < P \le 150$ [bar] SPT(P,−33.15°C)≤S≤ SPT(P,206.85°C) [J/(kg·K)]
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.07\times10^6 \le P \le 15\times10^6$ [Pa] $240 \le T \le 480$ [K] $0.7 \le P \le 150$ [bar] $-33.15 \le T \le 206.85$ [°C]
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] $0.7 \le P \le 40.64$ [bar] $0 \le X \le 1.0$ [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°C]
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°C] $0 \le X \le 1.0$ [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'CH2F-CF3' Molecular Formula S: 'A'='S': 'HFC-134A(R134A)' Name of Substance V: 'A'='V': '10.1' Version Number	one of 'C', 'S' and 'V'
66	PLDT(T)		
68	PMLT(T)		

Table II–2.45–1 HFC-134a (R134a) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
85	PRPD(P)	PRPD: Prandtl Number of Saturated Liquid [–] P∗: Pressure [Pa], [bar]	$0.117\times10^6\leq P\leq2.061\times10^6$ [Pa] $1.17\leq P\leq20.61$ [bar]
86	PRPDD(P)		
81	PRPT(P,T)	PRPT: Prandtl Number [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$298.15\leq T\leq360$ [K] $0.07\times10^6\leq P\leq$PST(T) [Pa] $25\leq T\leq86.85$ [°C] $0.7\leq P\leq$PST(T) [bar]
87	PRTD(T)	PRTD: Prandtl Number of Saturated Liquid [–] T∗: Temperature [K], [°C]	$250\leq T\leq342$ [K] $-23.15\leq T\leq68.85$ [°C]
88	PRTDD(T)		
99	PSBT(T)		
30	PST(T)	PST∗: Saturation Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
72	PSTD(T)		
73	PSTDD(T)		
31	SIGP(P)	SIGP: Surface Tension [N/m] P∗: Pressure [Pa], [bar]	$0.04376\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.4376\leq P\leq40.64$ [bar]
32	SIGT(T)	SIGT: Surface Tension [N/m] T∗: Temperature [K], [°C]	$230\leq T\leq374.3$ [K] $-43.15\leq T\leq101.15$ [°C]
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar]
35	SPT(P,T)	SPT: Specific Entropy [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.07\times10^6\leq P\leq15\times10^6$ [Pa] $240\leq T\leq480$ [K] $0.7\leq P\leq150$ [bar] $-33.15\leq T\leq206.85$ [°C]
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar] $0\leq X\leq1.0$ [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C] $0\leq X\leq1.0$ [–]
67	TLDP(P)		
69	TMLP(P)		
64	TPH(P,H)	TPH∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] H: Specific Enthalpy [J/kg]	$0.07\times10^6\leq P\leq0.072979\times10^6$ [Pa] HPD(P)≤H≤HPT(P,480K) [J/kg] $0.072979\times10^6<P\leq15\times10^6$ [Pa] HPT(P,240K)≤H≤ HPT(P,480K) [J/kg] $0.7\leq P\leq0.72979$ [bar] HPD(P)≤H≤HPT(P,206.85°C) [J/kg] $0.72979<P\leq150$ [bar] HPT(P,−33.15°C)≤H≤ HPT(P,206.85°C) [J/kg]
6H	TPH2(P,H)		

Table II–2.45–1 HFC-134a (R134a) 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)]	$0.07\times10^6 \le P \le 0.072979\times10^6$ [Pa] SPD(P)≤S≤SPT(P,480K) [J/(kg·K)] $0.072979\times10^6 < P \le 15\times10^6$ [Pa] SPT(P,240K)≤S≤ SPT(P,480K) [J/(kg·K)] 0.7≤P≤0.72979 [bar] SPD(P)≤S≤ SPT(P,206.85°C) [J/(kg·K)] 0.72979<P≤150 [bar] SPT(P,−33.15°C)≤S≤ SPT(P,206.85°C) [J/(kg·K)]
6S	TPS2(P,S)		
98	TPSEUP(P)	TPSEUP: Pseudo Boiling Point [K], [°C] P∗: Pressure [Pa], [bar]	$4.064\times10^6 \le P \le 15\times10^6$ [Pa] 40.64≤P≤150 [bar]
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$0.07\times10^6 \le P \le 0.072979\times10^6$ [Pa] VPD(P)≤V≤VPT(P,480K) [m^3/kg] $0.072979\times10^6 < P \le 15\times10^6$ [Pa] VPT(P,240K)≤V≤ VPT(P,480K) [m^3/kg] 0.7≤P≤0.72979 [bar] VPD(P)≤V≤ VPT(P,206.85°C) [m^3/kg] 0.72979<P≤150 [bar] VPT(P,−33.15°C)≤V≤ VPT(P,206.85°C) [m^3/kg]
41	TRPL('A')		
100	TSBP(P)		
40	TSP(P)	TSP∗: Saturation Temperature [K], [°C] P∗: Pressure [Pa], [bar]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] 0.7≤P≤40.64 [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] 0.7≤P≤40.64 [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] 0.7≤P≤40.64 [bar]
79	UPS(P,S)	UPS: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.07\times10^6 \le P \le 0.072979\times10^6$ [Pa] SPD(P)≤S≤SPT(P,480K) [J/(kg·K)] $0.072979\times10^6 < P \le 15\times10^6$ [Pa] SPT(P,240K)≤S≤ SPT(P,480K) [J/(kg·K)] 0.7≤P≤0.72979 [bar] SPD(P)≤S≤ SPT(P,206.85°C) [J/(kg·K)] 0.72979<P≤150 [bar] SPT(P,−33.15°C)≤S≤ SPT(P,206.85°C) [J/(kg·K)]
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.07\times10^6 \le P \le 15\times10^6$ [Pa] 240≤T≤480 [K] 0.7≤P≤150 [bar] −33.15≤T≤206.85 [°C]

Table II–2.45–1 HFC-134a (R134a) Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar] $0\leq X\leq1.0$ [–]
46	UTD(T)	UTD: Specific Internal Energy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C] $0\leq X\leq1.0$ [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar]
80	VPS(P,S)	VPS: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.07\times10^6\leq P\leq0.072979\times10^6$ [Pa] SPD(P)≤S≤SPT(P,480K) [J/(kg·K)] $0.072979\times10^6<P\leq15\times10^6$ [Pa] SPT(P,240K)≤S≤ SPT(P,480K) [J/(kg·K)] $0.7\leq P\leq0.72979$ [bar] SPD(P)≤S≤ SPT(P,206.85°C) [J/(kg·K)] $0.72979<P\leq150$ [bar] SPT(P,−33.15°C)≤S≤ SPT(P,206.85°C) [J/(kg·K)]
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.07\times10^6\leq P\leq15\times10^6$ [Pa] $240\leq T\leq480$ [K] $0.7\leq P\leq150$ [bar] $-33.15\leq T\leq206.85$ [°C]
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar] $0\leq X\leq1.0$ [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	$240\leq T\leq374.3$ [K] $-33.15\leq T\leq101.15$ [°C] $0\leq X\leq1.0$ [–]
8E	WPD(P)		
8F	WPDD(P)		
83	WPT(P,T)	WPT: Velocity of Sound [m/s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0<P\leq15\times10^6$ [Pa] $240\leq T\leq480$ [K] $0<P\leq150$ [bar] $-33.15\leq T\leq206.85$ [°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]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [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)]	$0.07\times10^6\leq P\leq4.064\times10^6$ [Pa] $0.7\leq P\leq40.64$ [bar] SPD(P)≤S≤SPDD(P) [J/(kg·K)]

Table II–2.45–1 HFC-134a (R134a) 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]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] $0.7 \le P \le 40.64$ [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]	$0.07\times10^6 \le P \le 4.064\times10^6$ [Pa] $0.7 \le P \le 40.64$ [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]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°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)]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°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]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°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]	$240 \le T \le 374.3$ [K] $-33.15 \le T \le 101.15$ [°C] VTD(T)≤V≤VTDD(T) [m^3/kg]