2.19 Heavy Water

Equations for thermodynamic properties have been cited from Hill et al.[1] and those for transport properties from Matsunaga and Nagashima[2] and one for surface tension from IAPS[3].

2.19.1 Temperature Scale

International practical temperature scale 1968 (IPTS-1968)

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

Name of Substance:	Heavy Water
Library File for UNIX:	libjd2o.a
Library File for DOS,Windows95/NT:	JD2O.LIB
Single Shot Program for UNIX:	d2o-ss
Single Shot Program for DOS,Windows95/NT:	D2O–SS.EXE

2.19.3 Important Constants and Others

Molecular Formula:	D_2O
Relative Molecular Mass:	20.027
Gas Constant:	415.15 J/(kg·K)

Critical Constants:

Critical Pressure:	21.66×10^{6}Pa (216.6 bar)
Critical Temperature:	643.89 K (370.74 °C)
Critical Specific Volume:	2.7933×10^{-3}m^3/kg

Triple Point:

Pressure:	660.1 Pa (6.601×10^{-3}bar)
Temperature:	276.95 K (3.8 °C)

Reference State:

For the liquid state at the triple point, 0 J/(kg·K) and 0 J/kg are assigned to the specific entropy and the specific internal energy of saturated liquid, respectively.

2.19.4 Formula

Equation of State:

Equation (1) in a function form of $\psi = \psi(\rho, T)$ in reference [1]. Here ψ= specific helmholtz free energy, ρ= density and T= temperature.

Vapor Pressure:

Equation (1) in reference [1] for specific helmholtz free energy and the Gibbs condition for phase equilibrium.

Properties at Vapor-Liquid Equilibrium:

Equation (1) in reference [1] for specific volume. Equations (6) and (7) in reference [1] for specific entropy and specific enthalpy, respectively. Equation as a function of density and temperature, which has been derived directly by partial differentiation of the specific Helmholtz free energy, equation (1) in reference [1], for isobaric specific heat.

Transport Properties:

Viscosity and thermal conductivity from equations (6) and (7) in reference [2], respectively.

The Other Properties:
Surface tension from equation (10) in reference [3].

References

[1] P.G.Hill,R.D.MacMillan and V.Lee, Tables of Thermodynamic Properties of Heavy Water in S.I. Units, Atomic Energy of Canada Limited, Mississauga, Ontario, (1981).
[2] N.Matsunaga and A.Nagashima, J. Phys. Chem. Ref. Data, 12-4, (1983), pp.933–966.
[3] M.Uematsu, Netsu Bussei (Japan J. Thermophys. Prop.), 2-2, (1988), pp.84-88.

Table II–2.19–1 Heavy Water 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]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
8A	AKPD(P)		
8B	AKPDD(P)		
82	AKPT(P,T)	AKPT: Isentropic Exponent [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
8C	AKTD(T)		
8D	AKTDD(T)		
2	ALAPP(P)	ALAPP: Laplace Coefficient [m] P∗: Pressure [Pa], [bar]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]
3	ALAPT(T)	ALAPT: Laplace Coefficient [m] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
4	ALHP(P)	ALHP: Latent Heat of Vaporization [J/kg] P∗: Pressure [Pa], [bar]	$660.1 \leq P \leq 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P \leq 216.6$ [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	$276.95 \leq T \leq 643.89$ [K] $3.8 \leq T \leq 370.74$ [°C]
6	ALMPD(P)	ALMPD: Thermal Conductivity of Saturated Liquid [W/(m·K)] P∗: Pressure [Pa], [bar]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]
7	ALMPDD(P)	ALMPDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]
8	ALMPT(P,T)	ALMPT: Thermal Conductivity [W/(m·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 823.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 550$ [°C]
9	ALMTD(T)	ALMTD: Thermal Conductivity of Saturated Liquid [W/(m·K)] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
10	ALMTDD(T)	ALMTDD: Thermal Conductivity of Saturated Vapor [W/(m·K)] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
11	AMUPD(P)	AMUPD: Coefficient of Viscosity of Saturated Liquid [Pa·s] P∗: Pressure [Pa], [bar]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]
12	AMUPDD(P)	AMUPDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] P∗: Pressure [Pa], [bar]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]

Table II–2.19–1 Heavy Water Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
13	AMUPT(P,T)	AMUPT: Coefficient of Viscosity [Pa·s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 773.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 500$ [°C]
14	AMUTD(T)	AMUTD: Coefficient of Viscosity of Saturated Liquid [Pa·s] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
15	AMUTDD(T)	AMUTDD: Coefficient of Viscosity of Saturated Vapor [Pa·s] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
92	BPPT(P,T)	BPPT: Volumetric Coefficient of Expansion [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
90	BSPT(P,T)	BSPT: Isentropic Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
91	BTPT(P,T)	BTPT: Isothermal Compressibility [1/Pa] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
93	BVPT(P,T)	BVPT: Pressure Coefficient [1/K] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
16	CPPD(P)	CPPD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]
17	CPPDD(P)	CPPDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [bar]
18	CPPT(P,T)	CPPT: Isobaric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
19	CPTD(T)	CPTD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
20	CPTDD(T)	CPTDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C]
21	CRP('A')	CRP: Critical Constants H: 'A'='H': 1.9657×10^6 [J/kg] Specific Enthalpy P∗: 'A'='P': 21.66×10^6 [Pa], 216.6 [bar] Pressure S: 'A'='S': 4.1815×10^3 [J/(kg·K)] Specific Entropy T∗: 'A'='T': 643.89 [K], 370.74 [°C] Temperature V: 'A'='V': 2.7933×10^{-3} [m^3/kg] Specific Volume	one of 'H', 'P', 'S', 'T' and 'V'

Table II–2.19–1 Heavy Water Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
7A	CVPD(P)		
76	CVPDD(P)	CVPDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$660.1 \leq P \leq 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P \leq 216.6$ [bar]
77	CVPT(P,T)	CVPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
7B	CVTD(T)		
78	CVTDD(T)	CVTDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$276.95 \leq T \leq 643.89$ [K] $3.8 \leq T \leq 370.74$ [°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': 20.027 Relative Molecular Mass R: 'A'='R': 415.15 [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]	$660.1 \leq P \leq 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P \leq 216.6$ [bar]
95	GAMPT(P,T)	GAMPT: Ratio of Specific Heats [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
9B	GAMTD(T)		
97	GAMTDD(T)	GAMTDD: Ratio of Specific Heats of Saturated Vapor [–] T∗: Temperature [K], [°C]	$276.95 \leq T \leq 643.89$ [K] $3.8 \leq T \leq 370.74$ [°C]
23	HPD(P)	HPD: Specific Enthalpy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$660.1 \leq P \leq 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P \leq 216.6$ [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$660.1 \leq P \leq 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P \leq 216.6$ [bar]
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] SPT(P,276.95K)≤S≤ SPT(P,1073.15K) [J/(kg·K)] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] SPT(P,3.8°C)≤S≤ SPT(P,800°C) [J/(kg·K)]
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \leq P \leq 100 \times 10^6$ [Pa] $276.95 \leq T \leq 1073.15$ [K] $6.601 \times 10^{-3} \leq P \leq 1000$ [bar] $3.8 \leq T \leq 800$ [°C]
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$660.1 \leq P \leq 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P \leq 216.6$ [bar] $0 \leq X \leq 1.0$ [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	$276.95 \leq T \leq 643.89$ [K] $3.8 \leq T \leq 370.74$ [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	$276.95 \leq T \leq 643.89$ [K] $3.8 \leq T \leq 370.74$ [°C]

Table II–2.19–1 Heavy Water Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C] 0≤X≤1.0 [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'D2O' Molecular Formula S: 'A'='S': 'HEAVY WATER' 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)	PRPD: Prandtl Number of Saturated Liquid [–] P∗: Pressure [Pa], [bar]	660.1≤P<21.66×10^6 [Pa] 6.601×10^{-3}≤P<216.6 [bar]
86	PRPDD(P)	PRPDD: Prandtl Number of Saturated Vapor [–] P∗: Pressure [Pa], [bar]	660.1≤P<21.66×10^6 [Pa] 6.601×10^{-3}≤P<216.6 [bar]
81	PRPT(P,T)	PRPT: Prandtl Number [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	660.1≤P≤100×10^6 [Pa] 276.95≤T≤773.15 [K] 6.601×10^{-3}≤P≤1000 [bar] 3.8≤T≤500 [°C]
87	PRTD(T)	PRTD: Prandtl Number of Saturated Liquid [–] T∗: Temperature [K], [°C]	276.95≤T<643.89 [K] 3.8≤T<370.74 [°C]
88	PRTDD(T)	PRTDD: Prandtl Number of Saturated Vapor [–] T∗: Temperature [K], [°C]	276.95≤T<643.89 [K] 3.8≤T<370.74 [°C]
99	PSBT(T)		
30	PST(T)	PST∗: Saturation Pressure [Pa], [bar] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
72	PSTD(T)		
73	PSTDD(T)		
31	SIGP(P)	SIGP: Surface Tension [N/m] P∗: Pressure [Pa], [bar]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar]
32	SIGT(T)	SIGT: Surface Tension [N/m] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar]
35	SPT(P,T)	SPT: Specific Entropy [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	660.1≤P≤100×10^6 [Pa] 276.95≤T≤1073.15 [K] 6.601×10^{-3}≤P≤1000 [bar] 3.8≤T≤800 [°C]
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar] 0≤X≤1.0 [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]

Table II–2.19–1 Heavy Water Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C] 0≤X≤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]	$660.1 \le P \le 100\times10^6$ [Pa] HPT(P,276.95K)≤H≤ HPT(P,1073.15K) [J/kg] $6.601\times10^{-3} \le P \le 1000$ [bar] HPT(P,3.8°C)≤H≤ HPT(P,800°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)]	$660.1 \le P \le 100\times10^6$ [Pa] SPT(P,276.95K)≤S≤ SPT(P,1073.15K) [J/(kg·K)] $6.601\times10^{-3} \le P \le 1000$ [bar] SPT(P,3.8°C)≤S≤ SPT(P,800°C) [J/(kg·K)]
6S	TPS2(P,S)		
98	TPSEUP(P)	TPSEUP: Pseudo Boiling Point [K], [°C] P∗: Pressure [Pa], [bar]	$21.66\times10^6 < P \le 50\times10^6$ [Pa] 216.6<P≤500 [bar]
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$660.1 \le P \le 100\times10^6$ [Pa] VPT(P,276.95K)≤V≤ VPT(P,1073.15K) [m^3/kg] $6.601\times10^{-3} \le P \le 1000$ [bar] VPT(P,3.8°C)≤V≤ VPT(P,800°C) [m^3/kg]
41	TRPL('A')	TRPL∗: Properties at Triple Point P∗:'A'='P': 660.1 [Pa], 6.601×10^{-3} [bar] Pressure T∗:'A'='T': 276.95 [K], 3.8 [°C] Temperature	one of 'P' and 'T'
100	TSBP(P)		
40	TSP(P)	TSP∗: Saturation Temperature [K], [°C] P∗: Pressure [Pa], [bar]	$660.1 \le P \le 21.66\times10^6$ [Pa] $6.601\times10^{-3} \le P \le 216.6$ [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$660.1 \le P \le 21.66\times10^6$ [Pa] $6.601\times10^{-3} \le P \le 216.6$ [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$660.1 \le P \le 21.66\times10^6$ [Pa] $6.601\times10^{-3} \le P \le 216.6$ [bar]
79	UPS(P,S)	UPS: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$660.1 \le P \le 100\times10^6$ [Pa] SPT(P,276.95K)≤S≤ SPT(P,1073.15K) [J/(kg·K)] $6.601\times10^{-3} \le P \le 1000$ [bar] SPT(P,3.8°C)≤S≤ SPT(P,800°C) [J/(kg·K)]
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$660.1 \le P \le 100\times10^6$ [Pa] 276.95≤T≤1073.15 [K] $6.601\times10^{-3} \le P \le 1000$ [bar] 3.8≤T≤800 [°C]
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$660.1 \le P \le 21.66\times10^6$ [Pa] $6.601\times10^{-3} \le P \le 216.6$ [bar] 0≤X≤1.0 [–]

Table II–2.19–1 Heavy Water 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]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C] 0≤X≤1.0 [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar]
80	VPS(P,S)	VPS: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	660.1≤P≤100×10^6 [Pa] SPT(P,276.95K)≤S≤ SPT(P,1073.15K) [J/(kg·K)] 6.601×10^{-3}≤P≤1000 [bar] SPT(P,3.8°C)≤S≤ SPT(P,800°C) [J/(kg·K)]
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	660.1≤P≤100×10^6 [Pa] 276.95≤T≤1073.15 [K] 6.601×10^{-3}≤P≤1000 [bar] 3.8≤T≤800 [°C]
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	660.1≤P≤21.66×10^6 [Pa] 6.601×10^{-3}≤P≤216.6 [bar] 0≤X≤1.0 [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	276.95≤T≤643.89 [K] 3.8≤T≤370.74 [°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]	660.1≤P≤100×10^6 [Pa] 276.95≤T≤1073.15 [K] 6.601×10^{-3}≤P≤1000 [bar] 3.8≤T≤800 [°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]	660.1≤P<21.66×10^6 [Pa] 6.601×10^{-3}≤P<216.6 [bar] HPD(P)≤H≤HPDD(P) [J/kg]

Table II–2.19–1 Heavy Water Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
57	XPS(P,S)	XPS: Dryness Fraction [–] P∗: Pressure [Pa], [bar] S: Specific Entropy of Mixture [J/(kg·K)]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [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]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [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]	$660.1 \leq P < 21.66 \times 10^6$ [Pa] $6.601 \times 10^{-3} \leq P < 216.6$ [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]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°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)]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°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]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°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]	$276.95 \leq T < 643.89$ [K] $3.8 \leq T < 370.74$ [°C] VTD(T)≤V≤VTDD(T) [m^3/kg]