2.11 Oxygen

Equations for thermodynamic properties have been cited from Sychev et al.[1].

2.11.1 Temperature Scale

International practical temperature scale 1968 (IPTS-1968)

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

Name of Substance:	Oxygen
Library File for UNIX:	libjo2.a
Library File for DOS,Windows95/NT:	JO2.LIB
Single Shot Program for UNIX:	o2-ss
Single Shot Program for DOS,Windows95/NT:	O2–SS.EXE

2.11.3 Important Constants and Others

Molecular Formula:	O_2
Relative Molecular Mass:	31.9988
Gas Constant:	259.835 J/(kg·K)

Critical Constants:

Critical Pressure:	5.043×10^{6}Pa (50.43 bar)
Critical Temperature:	154.581 K (-118.569°C)
Critical Specific Volume:	2.2925×10^{-3}m^3/kg

Triple Point:

Pressure:	0.1463×10^{3} Pa (1.463×10^{-3}bar)
Temperature:	54.361 K (-218.789°C)

Reference State:

At 0K(-273.15°C), 275.542×10^{3} J/kg is assigned to the heat of sublimation and 0 J/(kg·K) to the specific entropy.

2.11.4 Formula

Equation of State:

Equation (3.6) in a function form of $P = P(\rho, T)$ in reference [1]. Here P=pressure, ρ=density and T=temperature.

Vapor Pressure:

Equation (3.6) [equation of state] in reference [1] and the Gibbs condition for phase equilibrium.

Properties at Vapor-Liquid Equilibrium:

Equation (3.6) [equation of state] and the Gibbs condition for phase equilibrium for specific volume of both saturated liquid and saturated vapor. Equation (2.5) together with these specific volumes for specific entropy, specific enthalpy, isobaric specific heat and isochoric specific heat. All of these equations have been cited from reference [1].

References

[1] V.V.Sychev, A.A.Vasserman, A.D.Kozlov, G.A.Spiridonov and V.A.Tsymarny, Thermodynamic Properties of Oxygen, National Standard Reference Data of the USSR: A Series of Property Tables, Vol.5, Hemisphere Pub. Corp., (1987).

Table II–2.11–1 Oxygen 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)	AKPT: Isentropic Exponent [–] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] $55\leq T\leq1500$ [K], $5.43\times10^6<P\leq100\times10^6$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ $1.0\leq P\leq54.3$ [bar] $-218.15\leq T\leq1226.85$ [°C], $54.3<P\leq1000$ [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
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]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
5	ALHT(T)	ALHT: Latent Heat of Vaporization [J/kg] T∗: Temperature [K], [°C]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°C]
6	ALMPD(P)		
7	ALMPDD(P)		
8	ALMPT(P,T)		
9	ALMTD(T)		
10	ALMTDD(T)		
11	AMUPD(P)		
12	AMUPDD(P)		
13	AMUPT(P,T)		
14	AMUTD(T)		
15	AMUTDD(T)		
92	BPPT(P,T)		
90	BSPT(P,T)		
91	BTPT(P,T)		
93	BVPT(P,T)		
16	CPPD(P)	CPPD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
17	CPPDD(P)	CPPDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]

Table II–2.11–1 Oxygen Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
18	CPPT(P,T)	CPPT: Isobaric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] $55\leq T\leq1500$ [K], $5.43\times10^6<P\leq100\times10^6$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ $1.0\leq P\leq54.3$ [bar] $-218.15\leq T\leq1226.85$ [°C], $54.3<P\leq1000$ [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
19	CPTD(T)	CPTD: Isobaric Specific Heat of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°C]
20	CPTDD(T)	CPTDD: Isobaric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°C]
21	CRP('A')	CRP: Critical Constants H: 'A'='H': 0.30904×10^6 [J/kg] Specific Enthalpy P∗: 'A'='P': 5.043×10^6 [Pa], 50.43 [bar] Pressure S: 'A'='S': 4.2077×10^3 [J/(kg·K)] Specific Entropy T∗: 'A'='T': 154.581 [K], −118.569 [°C] Temperature V: 'A'='V': 2.2925×10^{-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]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
77	CVPT(P,T)	CVPT: Isochoric Specific Heat [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] $55\leq T\leq1500$ [K], $5.43\times10^6<P\leq100\times10^6$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ $1.0\leq P\leq54.3$ [bar] $-218.15\leq T\leq1226.85$ [°C], $54.3<P\leq1000$ [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
7B	CVTD(T)		
78	CVTDD(T)	CVTDD: Isochoric Specific Heat of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°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': 31.9988 Relative Molecular Mass R: 'A'='R': 259.835 [J/(kg·K)] Gas Constant	one of 'M' and 'R'

Table II–2.11–1 Oxygen Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
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]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
24	HPDD(P)	HPDD: Specific Enthalpy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
71	HPS(P,S)	HPS: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] SPT(P,55K)≤S≤ SPT(P,1500K) [J/(kg·K)] $5.43\times10^6<P\leq100\times10^6$ [Pa] $SPT(P,T_L)\leq S\leq$ SPT(P,1500K) [J/(kg·K)] $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤50.43 [bar] SPT(P,−218.15°C)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] 50.43<P≤1000 [bar] $SPT(P,T_L)\leq S\leq$ SPT(P,1226.85°C) [J/(kg·K)] $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
25	HPT(P,T)	HPT: Specific Enthalpy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] 55≤T≤1500 [K], $5.43\times10^6<P\leq100\times10^6$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤54.3 [bar] −218.15≤T≤1226.85 [°C], 54.3<P≤1000 [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
26	HPX(P,X)	HPX: Specific Enthalpy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar] 0≤X≤1.0 [–]
27	HTD(T)	HTD: Specific Enthalpy of Saturated Liquid [J/kg] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
28	HTDD(T)	HTDD: Specific Enthalpy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
29	HTX(T,X)	HTX: Specific Enthalpy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C] 0≤X≤1.0 [–]
84	IDENTF('A')	IDENTF: CHARACTER TYPE FUNCTION for Package Identification (Length 20) C: 'A'='C': 'O2' Molecular Formula S: 'A'='S': 'OXYGEN' 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)		

Table II–2.11–1 Oxygen Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
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]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
72	PSTD(T)		
73	PSTDD(T)		
31	SIGP(P)		
32	SIGT(T)		
33	SPD(P)	SPD: Specific Entropy of Saturated Liquid [J/(kg·K)] P∗: Pressure [Pa], [bar]	0.2×10^3≤P≤5.043×10^6 [Pa] 2.0×10^{-3}≤P≤50.43 [bar]
34	SPDD(P)	SPDD: Specific Entropy of Saturated Vapor [J/(kg·K)] P∗: Pressure [Pa], [bar]	0.2×10^3≤P≤5.043×10^6 [Pa] 2.0×10^{-3}≤P≤50.43 [bar]
35	SPT(P,T)	SPT: Specific Entropy [J/(kg·K)] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	0.1×10^6≤P≤5.43×10^6 [Pa] 55≤T≤1500 [K], 5.43×10^6<P≤100×10^6 [Pa] T_L≤T≤1500 [K], T_L=54.3+$0.11347\times10^{-6}\times$P $-0.68962\times10^{-16}\times P^2$ 1.0≤P≤54.3 [bar] −218.15≤T≤1226.85 [°C], 54.3<P≤1000 [bar] T_L≤T≤1226.85 [°C], T_L=54.3+$0.011347\times$P $-0.68962\times10^{-6}\times P^2-273.15$
36	SPX(P,X)	SPX: Specific Entropy of Mixture [J/(kg·K)] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	0.2×10^3≤P≤5.043×10^6 [Pa] 2.0×10^{-3}≤P≤50.43 [bar] 0≤X≤1.0 [–]
37	STD(T)	STD: Specific Entropy of Saturated Liquid [J/(kg·K)] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
38	STDD(T)	STDD: Specific Entropy of Saturated Vapor [J/(kg·K)] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
39	STX(T,X)	STX: Specific Entropy of Mixture [J/(kg·K)] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C] 0≤X≤1.0 [–]
67	TLDP(P)		
69	TMLP(P)		

Table II–2.11–1 Oxygen Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
64	TPH(P,H)	TPH∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] H: Specific Enthalpy [J/kg]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] HPT(P, 55K)≤H≤ HPT(P,1500K) [J/kg] $5.43\times10^6<P\leq100\times10^6$ [Pa] HPT(P,T_L)≤H≤ HPT(P,1500K) [J/kg] $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤50.43 [bar] HPT(P,−218.15°C)≤H≤ HPT(P,1226.85°C) [J/kg] 50.43<P≤1000 [bar] HPT(P,T_L)≤H≤ HPT(P,1226.85°C) [J/kg] $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
6H	TPH2(P,H)		
65	TPS(P,S)	TPS∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] SPT(P,55K)≤S≤ SPT(P,1500K) [J/(kg·K)] $5.43\times10^6<P\leq100\times10^6$ [Pa] SPT(P,T_L)≤S≤ SPT(P,1500K) [J/(kg·K)] $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤50.43 [bar] SPT(P,−218.15°C)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] 50.43<P≤1000 [bar] SPT(P,T_L)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
6S	TPS2(P,S)		
98	TPSEUP(P)	TPSEUP: Pseudo Boiling Point [K], [°C] T∗: Temperature [K], [°C]	$5.043\times10^6<P\leq50.0\times10^6$ [Pa] 50.43<P≤500 [bar]
70	TPV(P,V)	TPV∗: Temperature [K], [°C] P∗: Pressure [Pa], [bar] V: Specific Volume [m^3/kg]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] VPT(P,55K)≤V≤ VPT(P,1500K) [m^3/kg] $5.43\times10^6<P\leq100\times10^6$ [Pa] VPT(P,T_L)≤V≤ VPT(P,1500K) [m^3/kg] $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤50.43 [bar] VPT(P,−218.15°C)≤V≤ VPT(P,1226.85°C) [m^3/kg] 50.43<P≤1000 [bar] VPT(P,T_L)≤V≤ VPT(P,1226.85°C) [m^3/kg] $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$

Table II–2.11–1 Oxygen Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
41	TRPL('A')	TRPL∗: Properties at Triple Point P∗: 'A'='P': 146.3 [Pa], 1.463×10^{-3} [bar] Pressure T∗: 'A'='T': 54.361 [K], −218.789 [°C] Temperature	one of 'P' and 'T'
100	TSBP(P)		
40	TSP(P)	TSP∗: Saturation Temperature [K], [°C] P∗: Pressure [Pa], [bar]	$0.2\times10^{3}\leq P\leq5.043\times10^{6}$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
74	TSPD(P)		
75	TSPDD(P)		
42	UPD(P)	UPD: Specific Internal Energy of Saturated Liquid [J/kg] P∗: Pressure [Pa], [bar]	$0.2\times10^{3}\leq P\leq5.043\times10^{6}$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
43	UPDD(P)	UPDD: Specific Internal Energy of Saturated Vapor [J/kg] P∗: Pressure [Pa], [bar]	$0.2\times10^{3}\leq P\leq5.043\times10^{6}$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
79	UPS(P,S)	UPS: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.1\times10^{6}\leq P\leq5.43\times10^{6}$ [Pa] SPT(P,55K)≤S≤ SPT(P,1500K) [J/(kg·K)] $5.43\times10^{6}<P\leq100\times10^{6}$ [Pa] SPT(P,T_L)≤S≤ SPT(P,1500K) [J/(kg·K)] $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ $1.0\leq P\leq50.43$ [bar] SPT(P,−218.15°C)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] $50.43<P\leq1000$ [bar] SPT(P,T_L)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
44	UPT(P,T)	UPT: Specific Internal Energy [J/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^{6}\leq P\leq5.43\times10^{6}$ [Pa] $55\leq T\leq1500$ [K], $5.43\times10^{6}<P\leq100\times10^{6}$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ $1.0\leq P\leq54.3$ [bar] $-218.15\leq T\leq1226.85$ [°C], $54.3<P\leq1000$ [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
45	UPX(P,X)	UPX: Specific Internal Energy of Mixture [J/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.2\times10^{3}\leq P\leq5.043\times10^{6}$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar] $0\leq X\leq1.0$ [–]

Table II–2.11–1 Oxygen 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]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
47	UTDD(T)	UTDD: Specific Internal Energy of Saturated Vapor [J/kg] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
48	UTX(T,X)	UTX: Specific Internal Energy of Mixture [J/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C] 0≤X≤1.0 [–]
49	VPD(P)	VPD: Specific Volume of Saturated Liquid [m^3/kg] P∗: Pressure [Pa], [bar]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
50	VPDD(P)	VPDD: Specific Volume of Saturated Vapor [m^3/kg] P∗: Pressure [Pa], [bar]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar]
80	VPS(P,S)	VPS: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] S: Specific Entropy [J/(kg·K)]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] SPT(P,55K)≤S≤ SPT(P,1500K) [J/(kg·K)] $5.43\times10^6<P\leq100\times10^6$ [Pa] SPT(P,T_L)≤S≤ SPT(P,1500K) [J/(kg·K)] $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤50.43 [bar] SPT(P,−218.15°C)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] 50.43<P≤1000 [bar] SPT(P,T_L)≤S≤ SPT(P,1226.85°C) [J/(kg·K)] $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
51	VPT(P,T)	VPT: Specific Volume [m^3/kg] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] 55≤T≤1500 [K], $5.43\times10^6<P\leq100\times10^6$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ 1.0≤P≤54.3 [bar] −218.15≤T≤1226.85 [°C], 54.3<P≤1000 [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
52	VPX(P,X)	VPX: Specific Volume of Mixture [m^3/kg] P∗: Pressure [Pa], [bar] X: Dryness Fraction [–]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [bar] 0≤X≤1.0 [–]
53	VTD(T)	VTD: Specific Volume of Saturated Liquid [m^3/kg] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
54	VTDD(T)	VTDD: Specific Volume of Saturated Vapor [m^3/kg] T∗: Temperature [K], [°C]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C]
55	VTX(T,X)	VTX: Specific Volume of Mixture [m^3/kg] T∗: Temperature [K], [°C] X: Dryness Fraction [–]	55≤T≤154.581 [K] −218.15≤T≤−118.569 [°C] 0≤X≤1.0 [–]
8E	WPD(P)		
8F	WPDD(P)		

Table II–2.11–1 Oxygen Function (cont'd)

No.	Name of Function	Function and Argument(s)	Range of Argument(s)
83	WPT(P,T)	WPT: Velocity of Sound [m/s] P∗: Pressure [Pa], [bar] T∗: Temperature [K], [°C]	$0.1\times10^6\leq P\leq5.43\times10^6$ [Pa] $55\leq T\leq1500$ [K], $5.43\times10^6<P\leq100\times10^6$ [Pa] $T_L\leq T\leq1500$ [K], $T_L=54.3+0.11347\times10^{-6}\times P-0.68962\times10^{-16}\times P^2$ $1.0\leq P\leq54.3$ [bar] $-218.15\leq T\leq1226.85$ [°C], $54.3<P\leq1000$ [bar] $T_L\leq T\leq1226.85$ [°C], $T_L=54.3+0.011347\times P-0.68962\times10^{-6}\times P^2-273.15$
8G	WTD(T)		
8H	WTDD(T)		
56	XPH(P,H)	XPH: Dryness Fraction [–] P∗: Pressure [Pa], [bar] H: Specific Enthalpy of Mixture [J/kg]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [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)]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [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]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [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]	$0.2\times10^3\leq P\leq5.043\times10^6$ [Pa] $2.0\times10^{-3}\leq P\leq50.43$ [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]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°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)]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°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]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°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]	$55\leq T\leq154.581$ [K] $-218.15\leq T\leq-118.569$ [°C] VTD(T)≤V≤VTDD(T) [m^3/kg]