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Equations and Tables for the Thermodynamic Properties of Ordinary Water Substance at Saturation from the Critical Point down to $-60\text{ }^{\circ}\text{C}$

ABSTRACT

This report summarizes and extends the range of the equations proposed by Saul and Wagner (1987) down to $-60\text{ }^{\circ}\text{C}$. The uniformity of the equations used is extremely practical for use in computer programs. For temperatures above the triple point, the coefficients determined by Saul and Wagner are maintained, except for density, for which the new coefficients proposed by the IAPWS (1997) were adopted. For temperatures below that, new coefficients were determined, while retaining the same form of the equations. A listing of a calculation routine for the whole temperature range, written in the Borland Pascal™ programming language is included in Appendix A. SI Units are used throughout for all quantities. A table of properties at saturation, for the whole temperature range considered, is included as Appendix B.

Nomenclature

Thermodynamic quantities:

h	specific enthalpy
l	enthalpy of phase transition
P	vapour pressure
s	specific entropy
T	temperature
ρ	density
α	auxiliary quantity for specific enthalpy
φ	auxiliary quantity for specific entropy
$\theta = T/T_c$	
$\tau = 1 - \theta$	

Subscripts:

c	value at the critical point
s	value for solid phase
L	value for liquid phase
V	value for vapour phase
sg	solid to vapour phase transition
fg	liquid to vapour phase transition
sat	at saturation

Reference constants

$T_c = 647.14$	K
$P_c = 22.064 \times 10^6$	Pa
$\rho_c = 322$	kg m^{-3}
$R = 461.518\ 350\ 5$	$\text{J kg}^{-1}\ \text{K}^{-1}$
$M = 18.015\ 34$	

Vapour pressure

$$LN\left(\frac{P_{SAT}}{P_c}\right) = \frac{a_1\tau + a_2\tau^{1.5} + a_3\tau^3 + a_4\tau^{3.5} + a_5\tau^4 + a_6\tau^{7.5}}{1-\tau}$$

	213.15 K ≤ T ≤ 273.16 K	273.16 K ≤ T ≤ 647.14 K
a ₁	2.442 663	-7.858 230
a ₂	-11.413 077	1.839 910
a ₃	-15.109 346	-11.781 100
a ₄	1.119 193	22.670 500
a ₅	18.159 568	-15.939 300
a ₆	-6.138 264	1.775 160

Density of the condensed phase

$$\frac{\rho_L}{\rho_c} = 1 + b_1\tau^{1/3} + b_2\tau^{2/3} + b_3\tau^{5/3} + b_4\tau^{16/3} + b_5\tau^{43/3} + b_6\tau^{110/3}$$

	213.15 K ≤ T ≤ 273.16 K	273.16 K ≤ T ≤ 647.14 K
b ₁	-2.379 140	1.993 771 843
b ₂	7.999 465	1.098 521 160
b ₃	-4.270 316	-0.509 449 300
b ₄	-0.344 761	-1.761 912 427
b ₅	22.552 663	-45.900 548 027
b ₆	-32 596.064 921	-723 692.261 863 189

Density of the gaseous phase

$$LN\left(\frac{\rho_V}{\rho_c}\right) = c_1\tau^{1/3} + c_2\tau^{2/3} + c_3\tau^{4/3} + c_4\tau^3 + c_5\tau^{37/6} + c_6\tau^{71/6}$$

	213.15 K ≤ T ≤ 273.16 K	273.16 K ≤ T ≤ 647.14 K
c ₁	-0.864 991	-2.025 450 113
c ₂	-1.629 574	-2.701 314 216
c ₃	-4.019 472	-5.359 161 836
c ₄	-32.838 573	-17.343 964 539
c ₅	-24.601 436	-44.618 326 953
c ₆	-93.753 172	-64.869 052 901

Specific enthalpy and entropy

Auxiliary equations

$$\frac{\alpha}{\alpha_0} = d_\alpha + d_1\theta^{-19} + d_2\theta + d_3\theta^{4.5} + d_4\theta^5 + d_5\theta^{54.5}$$

$$\frac{\varphi}{\varphi_0} = d_\varphi + d_1\theta^{-20} + d_2 LN\theta + \frac{9}{7}d_3\theta^{3.5} + \frac{5}{4}d_4\theta^4 + \frac{109}{107}d_5\theta^{53.5}$$

	213.15 K ≤ T ≤ 273.16 K	273.16 K ≤ T ≤ 647.14 K
d ₁	0.0	-5.717 56x10 ⁻⁸
d ₂	667.663 152	2 689.810
d ₃	14 202.078 027	129.889
d ₄	-15 324.511 005	-137.181
d ₅	0.0	0.968 874
d _α	-702.840 803	-1135.481 615 639
d _φ	-498.196 684	2 318.914 2

with

$$\alpha_0 = 1000.0 \text{ J kg}^{-1}$$

$$\varphi_0 = \alpha_0/T_c \text{ J kg}^{-1} \text{ K}^{-1}$$

Specific enthalpy of the condensed phase

$$h_L = \alpha + \frac{T}{\rho_L} \frac{dP_{sat}}{dT}$$

Specific enthalpy of the gaseous phase

$$h_G = \alpha + \frac{T}{\rho_G} \frac{dP_{sat}}{dT}$$

Specific entropy of the condensed phase

$$s_L = \varphi + \frac{1}{\rho_L} \frac{dP_{sat}}{dT}$$

Specific entropy of the gaseous phase

$$s_G = \varphi + \frac{1}{\rho_G} \frac{dP_{sat}}{dT}$$

Range of validity of the equations

The equations presented here are valid for

$$213.15 \text{ K} \leq T \leq 647.14 \text{ K}$$

References

- Saul, A., W. Wagner 1987.** International Equations for the Saturation Properties of Ordinary Water Substance, J. Phys. Chem. Ref. Data, 16(4), 893-901.
- IAPWS (The International Association for the Properties of Water and Steam) 1997.** Release on the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam, London, UK.

APPENDIX A

```
{ $N+, F+, D+ }
UNIT SatWater;
{ For the calculation of the properties of saturated water between 213.0 .. and
the critical point. Equations used have the form proposed by Saul & Wagner
(1987) in J. Phys. Chem. Ref. Data, Vol.16, No. 4, 893-901.
The coefficients for solid state were adjusted using data from
ASHRAE - Psychrometrics Theory and Practice, 1996
M. Conde Engineering, Created, June 16, 1997
Last Update, June 17, 2002 }
```

Interface

Uses DOS,Crt;

TYPE

```
TH2oParamArray = ARRAY[0..6] OF DOUBLE;
TH2oPropRec = RECORD
    RH2o      : DOUBLE;
    MH2o      : DOUBLE;
    H2oTc     : DOUBLE;
    H2oPc     : DOUBLE;
    H2oRhoc   : DOUBLE;
    H2oAlpha0 : DOUBLE;
    IceVp     : TH2oParamArray;
    H2oVp     : TH2oParamArray;
    IceRho    : TH2oParamArray;
    H2oRho    : TH2oParamArray;
    VapIceRho : TH2oParamArray;
    VapH2oRho : TH2oParamArray;
    IceAux    : TH2oParamArray;
    H2oAux    : TH2oParamArray;
```

END;

```
H2oFil = FILE OF TH2oPropRec;
```

CONST

```
DH2o : TH2oPropRec = (RH2o      : 461.5183505; { J/kg K }
    MH2o      : 18.01534;
    H2oTc     : 647.14; { K }
    H2oPc     : 22.064E+6; { Pa }
    H2oRhoc   : 322.0; { kg/m3 }
    H2oAlpha0 : 1000.0; { J/kg }
    IceVp : ( 0.0,          { Vapour pressure over ice }
        2.442663,
        -11.413077,
        -15.109346,
        1.119193,
        18.159568,
        -6.138264);
    H2oVp : ( 0.0,          { Vapour pressure over liquid }
        -7.858230,
```



```
        1.839910,  
        -11.781100,  
        22.670500,  
        -15.939300,  
        1.775160);  
IceRho : ( 0.0,      { Solid density }  
        -2.379140,  
        7.999465,  
        -4.270316,  
        -0.344761,  
        22.552663,  
        -32956.064921);  
H2oRho : ( 0.0,      { Liquid density }  
        1.993771842992,  
        1.098521160394,  
        -0.509449299608,  
        -1.761912427015,  
        -44.900548026659,  
        -723692.261863189517);  
VapIceRho : ( 0.0,      { Density of steam over ice }  
        -0.864991,  
        -1.629574,  
        -4.019472,  
        -32.838573,  
        -24.601436,  
        -93.753172);  
VapH2oRho : ( 0.0,      { Density of steam over liquid }  
        -2.025450113018,  
        -2.701314216303,  
        -5.359161836041,  
        -17.343964538812,  
        -44.618326953465,  
        -64.869052901136);  
IceAux : ( -702.840803, { Saul & Wagner's d_alpha }  
        0.0,  
        667.663152,  
        14202.078027,  
        -15324.511005,  
        0.0,  
        -498.196684); { Saul & Wagner's d_phi }  
H2oAux : ( -1135.481615639, { Saul & Wagner's d_alpha }  
        -5.717560E-8,  
        2689.81,  
        129.889,  
        -137.181,  
        0.968874,  
        2318.9142)); { Saul & Wagner's d_phi }
```

Error : BOOLEAN = FALSE;

```

FUNCTION VapPressure      (T : REAL) : REAL;
FUNCTION SatTemp         (P : REAL) : REAL;
FUNCTION CondensPhaseRho (T : REAL) : REAL;
FUNCTION VapourPhaseRho (T : REAL) : REAL;
FUNCTION LiqEnthalpy     (T : REAL) : REAL;
FUNCTION VapEnthalpy     (T : REAL) : REAL;
FUNCTION LiqEntropy      (T : REAL) : REAL;
FUNCTION VapEntropy      (T : REAL) : REAL;
FUNCTION LatentEnthalpy  (T : REAL) : REAL;
FUNCTION LatentEntropy   (T : REAL) : REAL;

```

Implementation

```

CONST
    PTol = 0.01; { Pascal }
    MaxIter = 30;

FUNCTION TRangeOK (T : REAL) : BOOLEAN;
Begin
    TRangeOK:=((T >= 213.0) AND (T <= DH2o.H2oTc));
END;

FUNCTION PRangeOK (P : REAL) : BOOLEAN;
Begin
    PRangeOK:=((P >= 1.08) AND (P <= DH2o.H2oPc));
END;

FUNCTION dPSatdT (T : REAL) : DOUBLE;
{ Calculates the derivative of the vapour pressure in relation to the
  saturation temperature }
VAR PParm : TH2oParamArray;

FUNCTION dPdTCalc (T : REAL) : REAL;
VAR Ps, Tau, X, LnTau : DOUBLE;
Begin
    Ps:=VapPressure(T);
    Tau:=1.0-T/DH2o.H2oTc;
    LnTau:=LN(Tau);
    X:=7.5*PParm[6]*EXP(6.5*LnTau);
    X:=X+4.0*PParm[5]*Tau*Tau*Tau;
    X:=X+3.5*PParm[4]*EXP(2.5*LnTau);
    X:=X+3.0*PParm[3]*Tau*Tau;
    X:=X+1.5*PParm[2]*EXP(0.5*LnTau);
    X:=X+PParm[1]+LN(Ps/DH2o.H2oPc);
    dPdTCalc:=-Ps/T*X;
END;

Begin { dPSatdT }
    IF ((T >= 213.0) AND (T <= 273.15)) THEN Begin { Condensed phase is solid }

```

```

    PParm:=DH2o.IceVp;
    dPSatdT:=dPdTCalc(T);
END ELSE
    IF ((T > 273.15) AND (T < DH2o.H2oTc)) THEN Begin { Condensed phase is liquid
}
        PParm:=DH2o.H2oVp;
        dPSatdT:=dPdTCalc(T);
    END ELSE
        IF T = DH2o.H2oTc THEN dPSatdT:=0.0;
END; { dPSatdT }

FUNCTION VapPressure (T : REAL) : REAL;
VAR PParm : TH2oParamArray;

FUNCTION PsatCalc (T : REAL) : REAL;
VAR Tau, LnTau, X : REAL;
Begin
    Tau:=1.0-T/DH2o.H2oTc;
    LnTau:=LN(Tau);
    X:=PParm[6]*EXP(7.5*LnTau);
    X:=X+PParm[5]*EXP(4.0*LnTau);
    X:=X+PParm[4]*EXP(3.5*LnTau);
    X:=X+PParm[3]*Tau*Tau*Tau;
    X:=X+PParm[2]*EXP(1.5*LnTau);
    X:=X+PParm[1]*Tau;
    PSatCalc:=DH2o.H2oPc*EXP(DH2o.H2oTc*X/T);
END;

Begin { VapPressure }
    IF TRangeOk(T) THEN Begin
        IF ((T >= 213.0) AND (T <= 273.15)) THEN Begin { Condensed phase is solid }
            PParm:=DH2o.IceVp;
            VapPressure:=PSatCalc(T);
        END ELSE
            IF ((T > 273.15) AND (T < DH2o.H2oTc)) THEN Begin { Condensed phase is liquid
}
                PParm:=DH2o.H2oVp;
                VapPressure:=PSatCalc(T);
            END ELSE
                IF T = DH2o.H2oTc THEN VapPressure:=DH2o.H2oPc;
            END ELSE Begin
                { Error: T Out of Range }
                Error:=TRUE;
            END;
        END;
    END;

FUNCTION SatTemp (P : REAL) : REAL;
VAR PCalc, dPdT, T : REAL;
    Itc : INTEGER;

```

```

Begin { SatTemp }
  IF PRangeOk(P) THEN Begin
    T:=293.15;
    Itc:=0;
    REPEAT
      INC(Itc);
      PCalc:=VapPressure(T);
      dPdT:=dPSatdT(T);
      T:=T-(PCalc-P)/dPdT;
    UNTIL ((ABS(PCalc-P) < PTol) OR (Itc > MaxIter));
    IF (Itc > MaxIter) THEN Begin
      { Error: Convergence not found on P }
      Error:=TRUE;
    END;
  END ELSE Begin
    { Error: P Out of Range }
    Error:=TRUE;
  END;
END;

FUNCTION CondensPhaseRho (T : REAL) : REAL;
VAR RParm : TH2oParamArray;

FUNCTION RhoCalc (T : REAL) : REAL;
VAR Tau, LnTau, X : REAL;
Begin
  Tau:=1.0-T/DH2o.H2oTc;
  LnTau:=LN(Tau);
  X:=RParm[6]*EXP(110.0*LnTau/3.0);
  X:=X+RParm[5]*EXP(43.0*LnTau/3.0);
  X:=X+RParm[4]*EXP(16.0*LnTau/3.0);
  X:=X+RParm[3]*EXP(5.0*LnTau/3.0);
  X:=X+RParm[2]*EXP(2.0*LnTau/3.0);
  X:=X+RParm[1]*Exp(LnTau/3.0);
  RhoCalc:=DH2o.H2oRhoc*(1.0+X);
END;

Begin { CondensPhaseRho }
  IF TRangeOK(T) THEN Begin
    IF ((T >= 213.0) AND (T <= 273.15)) THEN Begin { Condensed phase is solid }
      RParm:=DH2o.IceRho;
      CondensPhaseRho:=RhoCalc(T);
    END ELSE
      IF ((T > 273.15) AND (T < DH2o.H2oTc)) THEN Begin { Condensed phase is liquid }
        RParm:=DH2o.H2oRho;
        CondensPhaseRho:=RhoCalc(T);
      END ELSE
        IF T = DH2o.H2oTc THEN CondensPhaseRho:=DH2o.H2oRhoc;

```

```

END ELSE Begin
    { Error: T Out of Range }
    Error:=TRUE;
END;
END;    { CondensPhaseRho }

FUNCTION VapourPhaseRho (T : REAL) : REAL;
VAR RParm : TH2oParamArray;

FUNCTION RhoCalc (T : REAL) : REAL;
VAR Tau, LnTau, X : REAL;
Begin
    Tau:=1.0-T/DH2o.H2oTc;
    LnTau:=LN(Tau);
    X:=RParm[6]*EXP(71.0*LnTau/6.0);
    X:=X+RParm[5]*EXP(37.0*LnTau/6.0);
    X:=X+RParm[4]*EXP(3.0*LnTau);
    X:=X+RParm[3]*EXP(4.0*LnTau/3.0);
    X:=X+RParm[2]*EXP(2.0*LnTau/3.0);
    X:=X+RParm[1]*Exp(LnTau/3.0);
    RhoCalc:=DH2o.H2oRhoc*EXP(X);
END;

Begin { VapourPhaseRho }
    IF TRangeOK(T) THEN Begin
        IF ((T >= 213.0) AND (T <= 273.15)) THEN Begin { Condensed phase is solid }
            RParm:=DH2o.VapIceRho;
            VapourPhaseRho:=RhoCalc(T);
        END ELSE
            IF ((T > 273.15) AND (T < DH2o.H2oTc)) THEN Begin { Condensed phase is liquid }
                RParm:=DH2o.VapH2oRho;
                VapourPhaseRho:=RhoCalc(T);
            END ELSE
                IF T = DH2o.H2oTc THEN VapourPhaseRho:=DH2o.H2oRhoc;
            END ELSE Begin
                { Error: T Out of Range }
                Error:=TRUE;
            END;
    END;
END;    { VapourPhaseRho }

FUNCTION FAlpha (T: REAL) : DOUBLE;
VAR AParm : TH2oParamArray;

FUNCTION CalcAlpha (T : REAL) : REAL;
VAR Theta, LnTheta, X : REAL;
Begin
    Theta:=T/DH2o.H2oTc;
    LnTheta:=LN(Theta);

```

```

X:=AParm[5]*EXP(54.5*LnTheta);
X:=X+AParm[4]*EXP(5.0*LnTheta);
X:=X+AParm[3]*EXP(4.5*LnTheta);
X:=X+AParm[2]*Theta;
X:=X+AParm[1]*EXP(-19.0*LnTheta);
CalcAlpha:=1000.0*(X+AParm[0]);
END;

Begin
  IF TRangeOK(T) THEN Begin
    IF ((T >= 213.0) AND (T <= 273.15)) THEN { Condensed phase is solid }
      AParm:=DH2o.IceAux
    ELSE
      IF ((T > 273.15) AND (T <= DH2o.H2oTc)) THEN { Condensed phase is liquid }
        AParm:=DH2o.H2oAux;
        FAlpha:=CalcAlpha(T);
      END ELSE Begin
        { Error: T Out of Range }
        Error:=TRUE;
      END;
    END; { FAlpha }

FUNCTION LiqEnthalpy (T : REAL) : REAL;
VAR Rho, dPdT : REAL;
Begin
  IF TRangeOK(T) THEN Begin
    Rho:=CondensPhaseRho(T);
    dPdT:=dPSatdT(T);
    IF NOT Error THEN LiqEnthalpy:=FAlpha(T)+T/Rho*dPdT;
  END ELSE Begin
    { Error: T Out of Range }
    Error:=TRUE;
  END;
END;

FUNCTION VapEnthalpy (T : REAL) : REAL;
VAR Rho, dPdT : REAL;
Begin
  IF TRangeOK(T) THEN Begin
    Rho:=VapourPhaseRho(T);
    dPdT:=dPSatdT(T);
    IF NOT Error THEN VapEnthalpy:=FAlpha(T)+T/Rho*dPdT;
  END ELSE Begin
    { Error: T Out of Range }
    Error:=TRUE;
  END;
END;

FUNCTION FPhi (T : REAL) : DOUBLE;

```

```

VAR AParm : TH2oParamArray;

FUNCTION CalcPhi (T : REAL) : REAL;
VAR Theta, LnTheta, X : REAL;

Begin
  Theta:=T/DH2o.H2oTc;
  LnTheta:=LN(Theta);
  X:=109.0/107.0*AParm[5]*EXP(53.5*LnTheta);
  X:=X+5.0/4.0*AParm[4]*EXP(4.0*LnTheta);
  X:=X+9.0/7.0*AParm[3]*EXP(3.5*LnTheta);
  X:=X+AParm[2]*LnTheta;
  X:=X+19.0/20.0*AParm[1]*EXP(-20.0*LnTheta);
  CalcPhi:=1000.0/DH2o.H2oTc*(AParm[6]+X);
END; { CalcPhi }

Begin
  IF TRangeOK(T) THEN Begin
    IF ((T >= 213.0) AND (T <= 273.15)) THEN { Condensed phase is solid }
      AParm:=DH2o.IceAux
    ELSE
      IF ((T > 273.15) AND (T <= DH2o.H2oTc)) THEN { Condensed phase is liquid }
        AParm:=DH2o.H2oAux;
      FPhi:=CalcPhi(T);
    END ELSE Begin
      { Error: T Out of Range }
      Error:=TRUE;
    END;
  END; { FPhi}

FUNCTION LiqEntropy (T : REAL) : REAL;
VAR Rho, dPdT : REAL;
Begin
  IF TRangeOK(T) THEN Begin
    Rho:=CondensPhaseRho(T);
    dPdT:=dPSatdT(T);
    IF NOT Error THEN LiqEntropy:=FPhi(T)+1.0/Rho*dPdT;
  END ELSE Begin
    { Error: T Out of Range }
    Error:=TRUE;
  END;
END;

FUNCTION VapEntropy (T : REAL) : REAL;
VAR Rho, dPdT : REAL;
Begin
  IF TRangeOK(T) THEN Begin
    Rho:=VapourPhaseRho(T);
    dPdT:=dPSatdT(T);

```

```
        IF NOT Error THEN VapEntropy:=FPhi(T)+1.0/Rho*dPdT;
    END ELSE Begin
        { Error: T Out of Range }
        Error:=TRUE;
    END;
END;

FUNCTION LatentEnthalpy (T: REAL) : REAL;
VAR RhoL, RhoG, dPdT : REAL;
Begin
    IF TRangeOK(T) THEN Begin
        RhoG:=VapourPhaseRho(T);
        RhoL:=CondensPhaseRho(T);
        dPdT:=dPSatdT(T);
        IF NOT Error THEN LatentEnthalpy:=T*(1.0/RhoG-1.0/RhoL)*dPdT;
    END ELSE Begin
        { Error: T Out of Range }
        Error:=TRUE;
    END;
END;

FUNCTION LatentEntropy (T : REAL) : REAL;
VAR RhoL, RhoG, dPdT : REAL;
Begin
    IF TRangeOK(T) THEN Begin
        RhoG:=VapourPhaseRho(T);
        RhoL:=CondensPhaseRho(T);
        dPdT:=dPSatdT(T);
        IF NOT Error THEN LatentEntropy:=(1.0/RhoG-1.0/RhoL)*dPdT;
    END ELSE Begin
        { Error: T Out of Range }
        Error:=TRUE;
    END;
END;

END. { Implementation Part }
```


APPENDIX B

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
-60.0	0.00108	924.304	1.100e-05	-446.408	2836.587	2390.179	-1.6854	13.3079	11.6226
-59.0	0.00124	924.263	1.300e-05	-444.741	2836.950	2392.208	-1.6776	13.2475	11.5699
-58.0	0.00141	924.209	1.400e-05	-443.067	2837.271	2394.204	-1.6698	13.1874	11.5176
-57.0	0.00161	924.142	1.600e-05	-441.386	2837.554	2396.168	-1.6620	13.1277	11.4657
-56.0	0.00184	924.066	1.800e-05	-439.697	2837.803	2398.105	-1.6542	13.0684	11.4142
-55.0	0.00209	923.980	2.100e-05	-438.002	2838.020	2400.018	-1.6464	13.0095	11.3631
-54.0	0.00238	923.887	2.400e-05	-436.299	2838.208	2401.909	-1.6386	12.9510	11.3124
-53.0	0.00271	923.786	2.700e-05	-434.589	2838.370	2403.781	-1.6308	12.8929	11.2621
-52.0	0.00307	923.680	3.000e-05	-432.872	2838.507	2405.636	-1.6230	12.8352	11.2122
-51.0	0.00348	923.569	3.400e-05	-431.147	2838.623	2407.476	-1.6153	12.7780	11.1627
-50.0	0.00394	923.453	3.800e-05	-429.415	2838.719	2409.304	-1.6075	12.7211	11.1137
-49.0	0.00445	923.334	4.300e-05	-427.676	2838.798	2411.122	-1.5997	12.6647	11.0650
-48.0	0.00503	923.212	4.800e-05	-425.930	2838.860	2412.930	-1.5919	12.6087	11.0168
-47.0	0.00568	923.088	5.400e-05	-424.176	2838.907	2414.731	-1.5842	12.5532	10.9691
-46.0	0.00640	922.961	6.100e-05	-422.415	2838.942	2416.527	-1.5764	12.4981	10.9217
-45.0	0.00721	922.834	6.800e-05	-420.647	2838.965	2418.318	-1.5686	12.4434	10.8748
-44.0	0.00811	922.705	7.700e-05	-418.871	2838.977	2420.106	-1.5608	12.3892	10.8283
-43.0	0.00911	922.575	8.600e-05	-417.088	2838.980	2421.892	-1.5531	12.3353	10.7823
-42.0	0.01023	922.444	9.600e-05	-415.297	2838.974	2423.677	-1.5453	12.2820	10.7366
-41.0	0.01147	922.314	1.070e-04	-413.499	2838.961	2425.462	-1.5376	12.2290	10.6914
-40.0	0.01285	922.183	1.190e-04	-411.694	2838.942	2427.248	-1.5298	12.1765	10.6467
-39.0	0.01438	922.052	1.330e-04	-409.882	2838.916	2429.035	-1.5220	12.1243	10.6023
-38.0	0.01608	921.921	1.480e-04	-408.062	2838.885	2430.824	-1.5143	12.0727	10.5584
-37.0	0.01796	921.790	1.650e-04	-406.234	2838.850	2432.615	-1.5065	12.0214	10.5148
-36.0	0.02005	921.659	1.830e-04	-404.399	2838.810	2434.410	-1.4988	11.9705	10.4717
-35.0	0.02235	921.529	2.030e-04	-402.557	2838.766	2436.209	-1.4910	11.9201	10.4290
-34.0	0.02490	921.398	2.260e-04	-400.707	2838.718	2438.011	-1.4833	11.8700	10.3868
-33.0	0.02772	921.268	2.500e-04	-398.850	2838.667	2439.817	-1.4755	11.8204	10.3449
-32.0	0.03082	921.139	2.770e-04	-396.986	2838.613	2441.628	-1.4678	11.7712	10.3034
-31.0	0.03425	921.009	3.060e-04	-395.114	2838.556	2443.442	-1.4600	11.7223	10.2623
-30.0	0.03802	920.879	3.390e-04	-393.234	2838.496	2445.262	-1.4523	11.6738	10.2216
-29.0	0.04217	920.750	3.740e-04	-391.348	2838.434	2447.086	-1.4445	11.6258	10.1812
-28.0	0.04673	920.620	4.130e-04	-389.454	2838.368	2448.915	-1.4368	11.5781	10.1413

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
-27.0	0.05175	920.491	4.560e-04	-387.552	2838.300	2450.748	-1.4291	11.5308	10.1017
-26.0	0.05725	920.361	5.020e-04	-385.643	2838.228	2452.585	-1.4213	11.4838	10.0625
-25.0	0.06329	920.231	5.530e-04	-383.727	2838.154	2454.427	-1.4136	11.4373	10.0237
-24.0	0.06991	920.100	6.080e-04	-381.803	2838.076	2456.273	-1.4058	11.3910	9.9852
-23.0	0.07716	919.969	6.680e-04	-379.872	2837.995	2458.122	-1.3981	11.3452	9.9471
-22.0	0.08510	919.837	7.340e-04	-377.934	2837.909	2459.976	-1.3904	11.2997	9.9093
-21.0	0.09377	919.704	8.060e-04	-375.988	2837.820	2461.832	-1.3826	11.2545	9.8718
-20.0	0.10326	919.571	8.840e-04	-374.035	2837.727	2463.692	-1.3749	11.2097	9.8347
-19.0	0.11362	919.436	9.690e-04	-372.074	2837.628	2465.554	-1.3672	11.1652	9.7980
-18.0	0.12492	919.301	1.061e-03	-370.106	2837.525	2467.419	-1.3595	11.1210	9.7615
-17.0	0.13724	919.164	1.161e-03	-368.131	2837.417	2469.286	-1.3517	11.0772	9.7254
-16.0	0.15067	919.025	1.270e-03	-366.149	2837.303	2471.154	-1.3440	11.0336	9.6896
-15.0	0.16530	918.885	1.388e-03	-364.159	2837.182	2473.023	-1.3363	10.9904	9.6542
-14.0	0.18121	918.743	1.516e-03	-362.162	2837.055	2474.893	-1.3286	10.9475	9.6190
-13.0	0.19851	918.600	1.654e-03	-360.158	2836.921	2476.763	-1.3208	10.9049	9.5841
-12.0	0.21732	918.454	1.804e-03	-358.147	2836.779	2478.633	-1.3131	10.8626	9.5495
-11.0	0.23774	918.307	1.966e-03	-356.128	2836.630	2480.502	-1.3054	10.8206	9.5152
-10.0	0.25990	918.157	2.141e-03	-354.102	2836.472	2482.369	-1.2977	10.7789	9.4812
-9.0	0.28393	918.005	2.330e-03	-352.069	2836.305	2484.235	-1.2900	10.7375	9.4475
-8.0	0.30998	917.851	2.534e-03	-350.029	2836.128	2486.099	-1.2823	10.6963	9.4140
-7.0	0.33819	917.693	2.754e-03	-347.982	2835.942	2487.959	-1.2746	10.6554	9.3808
-6.0	0.36873	917.534	2.992e-03	-345.928	2835.745	2489.817	-1.2669	10.6148	9.3479
-5.0	0.40177	917.371	3.248e-03	-343.867	2835.537	2491.670	-1.2592	10.5744	9.3153
-4.0	0.43748	917.205	3.523e-03	-341.799	2835.317	2493.518	-1.2515	10.5343	9.2829
-3.0	0.47607	917.036	3.820e-03	-339.723	2835.085	2495.362	-1.2438	10.4945	9.2507
-2.0	0.51773	916.864	4.139e-03	-337.641	2834.841	2497.200	-1.2361	10.4549	9.2188
-1.0	0.56269	916.689	4.482e-03	-335.552	2834.583	2499.031	-1.2284	10.4155	9.1871
0.0	0.61117	916.510	4.850e-03	-333.456	2834.311	2500.855	-1.2207	10.3764	9.1557
1.0	0.657	999.849	5.195e-03	4.176	2498.021	2502.198	0.0153	9.1119	9.1271
2.0	0.706	999.890	5.562e-03	8.391	2495.723	2504.114	0.0306	9.0704	9.1010
3.0	0.758	999.915	5.950e-03	12.603	2493.420	2506.022	0.0459	9.0292	9.0751
4.0	0.813	999.923	6.363e-03	16.811	2491.111	2507.922	0.0611	8.9883	9.0494
5.0	0.872	999.915	6.800e-03	21.017	2488.798	2509.815	0.0762	8.9477	9.0239

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
6.0	0.935	999.892	7.263e-03	25.221	2486.481	2511.702	0.0913	8.9073	8.9987
7.0	1.002	999.854	7.753e-03	29.422	2484.160	2513.581	0.1064	8.8672	8.9736
8.0	1.073	999.801	8.273e-03	33.621	2481.834	2515.455	0.1213	8.8274	8.9488
9.0	1.148	999.734	8.822e-03	37.818	2479.505	2517.323	0.1362	8.7879	8.9241
10.0	1.228	999.653	9.403e-03	42.013	2477.173	2519.187	0.1511	8.7486	8.8997
11.0	1.313	999.558	1.002e-02	46.207	2474.838	2521.045	0.1658	8.7096	8.8755
12.0	1.402	999.451	1.067e-02	50.399	2472.499	2522.898	0.1806	8.6709	8.8514
13.0	1.498	999.331	1.135e-02	54.590	2470.157	2524.748	0.1952	8.6324	8.8276
14.0	1.599	999.198	1.207e-02	58.780	2467.813	2526.593	0.2099	8.5942	8.8040
15.0	1.705	999.054	1.283e-02	62.968	2465.466	2528.434	0.2244	8.5562	8.7806
16.0	1.818	998.898	1.364e-02	67.155	2463.117	2530.272	0.2389	8.5185	8.7574
17.0	1.938	998.730	1.448e-02	71.342	2460.765	2532.107	0.2534	8.4810	8.7344
18.0	2.064	998.551	1.538e-02	75.527	2458.412	2533.938	0.2678	8.4438	8.7116
19.0	2.198	998.361	1.632e-02	79.711	2456.055	2535.767	0.2821	8.4068	8.6890
20.0	2.338	998.160	1.730e-02	83.895	2453.697	2537.593	0.2964	8.3701	8.6665
21.0	2.487	997.948	1.834e-02	88.078	2451.337	2539.416	0.3107	8.3336	8.6443
22.0	2.644	997.726	1.944e-02	92.261	2448.975	2541.236	0.3249	8.2974	8.6222
23.0	2.810	997.495	2.059e-02	96.443	2446.611	2543.054	0.3390	8.2614	8.6004
24.0	2.985	997.253	2.179e-02	100.624	2444.246	2544.870	0.3531	8.2256	8.5787
25.0	3.169	997.001	2.306e-02	104.806	2441.878	2546.684	0.3671	8.1901	8.5572
26.0	3.363	996.740	2.439e-02	108.986	2439.509	2548.495	0.3811	8.1548	8.5359
27.0	3.567	996.470	2.579e-02	113.166	2437.138	2550.305	0.3951	8.1197	8.5148
28.0	3.781	996.191	2.725e-02	117.346	2434.766	2552.112	0.4090	8.0849	8.4939
29.0	4.007	995.902	2.879e-02	121.526	2432.391	2553.918	0.4228	8.0503	8.4731
30.0	4.245	995.605	3.040e-02	125.706	2430.016	2555.721	0.4367	8.0159	8.4525
31.0	4.495	995.299	3.208e-02	129.885	2427.638	2557.523	0.4504	7.9817	8.4321
32.0	4.757	994.984	3.385e-02	134.064	2425.259	2559.323	0.4641	7.9478	8.4119
33.0	5.033	994.661	3.569e-02	138.243	2422.878	2561.122	0.4778	7.9140	8.3918
34.0	5.323	994.330	3.763e-02	142.422	2420.496	2562.918	0.4914	7.8805	8.3719
35.0	5.626	993.990	3.965e-02	146.601	2418.112	2564.713	0.5050	7.8472	8.3522
36.0	5.945	993.643	4.176e-02	150.780	2415.726	2566.506	0.5186	7.8141	8.3326
37.0	6.279	993.287	4.397e-02	154.959	2413.339	2568.298	0.5321	7.7812	8.3132
38.0	6.630	992.924	4.628e-02	159.138	2410.950	2570.088	0.5455	7.7485	8.2940

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
39.0	6.997	992.553	4.869e-02	163.317	2408.559	2571.876	0.5589	7.7160	8.2749
40.0	7.381	992.175	5.120e-02	167.496	2406.166	2573.662	0.5723	7.6837	8.2560
41.0	7.784	991.789	5.383e-02	171.675	2403.772	2575.447	0.5856	7.6517	8.2373
42.0	8.205	991.396	5.657e-02	175.854	2401.375	2577.230	0.5989	7.6198	8.2187
43.0	8.646	990.995	5.943e-02	180.034	2398.977	2579.011	0.6121	7.5881	8.2002
44.0	9.107	990.588	6.241e-02	184.213	2396.577	2580.790	0.6253	7.5566	8.1819
45.0	9.590	990.173	6.551e-02	188.393	2394.175	2582.568	0.6385	7.5253	8.1638
46.0	10.094	989.751	6.875e-02	192.573	2391.770	2584.343	0.6516	7.4942	8.1458
47.0	10.620	989.323	7.212e-02	196.753	2389.364	2586.117	0.6647	7.4633	8.1279
48.0	11.171	988.888	7.563e-02	200.933	2386.955	2587.889	0.6777	7.4325	8.1102
49.0	11.745	988.446	7.928e-02	205.114	2384.545	2589.659	0.6907	7.4020	8.0927
50.0	12.345	987.997	8.308e-02	209.295	2382.132	2591.427	0.7037	7.3716	8.0752
51.0	12.970	987.542	8.703e-02	213.476	2379.716	2593.192	0.7166	7.3414	8.0580
52.0	13.623	987.080	9.114e-02	217.658	2377.298	2594.956	0.7294	7.3114	8.0408
53.0	14.303	986.612	9.541e-02	221.840	2374.878	2596.717	0.7423	7.2816	8.0238
54.0	15.013	986.138	9.985e-02	226.022	2372.455	2598.477	0.7551	7.2519	8.0070
55.0	15.752	985.657	1.045e-01	230.204	2370.029	2600.234	0.7679	7.2224	7.9902
56.0	16.522	985.171	1.093e-01	234.387	2367.601	2601.988	0.7806	7.1931	7.9737
57.0	17.324	984.678	1.142e-01	238.571	2365.170	2603.741	0.7933	7.1639	7.9572
58.0	18.160	984.179	1.194e-01	242.754	2362.736	2605.491	0.8059	7.1349	7.9409
59.0	19.029	983.674	1.247e-01	246.938	2360.299	2607.238	0.8185	7.1061	7.9247
60.0	19.933	983.163	1.303e-01	251.123	2357.860	2608.983	0.8311	7.0775	7.9086
61.0	20.874	982.646	1.361e-01	255.308	2355.417	2610.725	0.8436	7.0490	7.8926
62.0	21.852	982.123	1.420e-01	259.494	2352.971	2612.464	0.8561	7.0206	7.8768
63.0	22.869	981.595	1.482e-01	263.680	2350.521	2614.201	0.8686	6.9925	7.8611
64.0	23.926	981.061	1.547e-01	267.866	2348.069	2615.935	0.8810	6.9645	7.8455
65.0	25.024	980.521	1.613e-01	272.053	2345.612	2617.666	0.8934	6.9366	7.8301
66.0	26.164	979.976	1.682e-01	276.241	2343.153	2619.394	0.9058	6.9089	7.8147
67.0	27.349	979.425	1.753e-01	280.429	2340.690	2621.119	0.9181	6.8813	7.7995
68.0	28.578	978.868	1.827e-01	284.618	2338.223	2622.840	0.9304	6.8539	7.7844
69.0	29.854	978.306	1.903e-01	288.807	2335.752	2624.559	0.9427	6.8267	7.7694
70.0	31.178	977.739	1.982e-01	292.997	2333.278	2626.274	0.9549	6.7996	7.7545
71.0	32.551	977.166	2.064e-01	297.187	2330.799	2627.987	0.9671	6.7726	7.7397

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
72.0	33.974	976.588	2.148e-01	301.379	2328.317	2629.695	0.9793	6.7458	7.7251
73.0	35.450	976.004	2.236e-01	305.571	2325.830	2631.400	0.9914	6.7191	7.7105
74.0	36.980	975.415	2.326e-01	309.763	2323.339	2633.102	1.0035	6.6926	7.6961
75.0	38.565	974.821	2.419e-01	313.956	2320.844	2634.800	1.0155	6.6662	7.6817
76.0	40.207	974.222	2.516e-01	318.150	2318.344	2636.494	1.0276	6.6400	7.6675
77.0	41.908	973.618	2.615e-01	322.345	2315.840	2638.185	1.0395	6.6139	7.6534
78.0	43.668	973.009	2.718e-01	326.540	2313.331	2639.872	1.0515	6.5879	7.6394
79.0	45.490	972.394	2.824e-01	330.736	2310.818	2641.554	1.0634	6.5620	7.6255
80.0	47.376	971.775	2.934e-01	334.933	2308.300	2643.233	1.0753	6.5363	7.6116
81.0	49.327	971.150	3.046e-01	339.131	2305.777	2644.908	1.0872	6.5107	7.5979
82.0	51.345	970.520	3.163e-01	343.329	2303.249	2646.578	1.0990	6.4853	7.5843
83.0	53.431	969.886	3.283e-01	347.529	2300.716	2648.244	1.1108	6.4600	7.5708
84.0	55.589	969.246	3.407e-01	351.729	2298.177	2649.906	1.1226	6.4348	7.5574
85.0	57.818	968.602	3.535e-01	355.930	2295.634	2651.564	1.1343	6.4097	7.5440
86.0	60.122	967.953	3.666e-01	360.132	2293.085	2653.217	1.1460	6.3848	7.5308
87.0	62.503	967.299	3.802e-01	364.335	2290.530	2654.865	1.1577	6.3599	7.5177
88.0	64.961	966.640	3.942e-01	368.539	2287.970	2656.509	1.1694	6.3352	7.5046
89.0	67.500	965.976	4.086e-01	372.744	2285.404	2658.148	1.1810	6.3107	7.4916
90.0	70.121	965.308	4.234e-01	376.949	2282.833	2659.782	1.1926	6.2862	7.4788
91.0	72.826	964.635	4.387e-01	381.156	2280.256	2661.412	1.2041	6.2619	7.4660
92.0	75.618	963.957	4.544e-01	385.364	2277.672	2663.036	1.2157	6.2376	7.4533
93.0	78.498	963.274	4.706e-01	389.573	2275.083	2664.656	1.2272	6.2135	7.4407
94.0	81.469	962.587	4.872e-01	393.783	2272.487	2666.270	1.2386	6.1895	7.4282
95.0	84.533	961.895	5.043e-01	397.994	2269.886	2667.879	1.2501	6.1657	7.4157
96.0	87.692	961.198	5.219e-01	402.206	2267.277	2669.483	1.2615	6.1419	7.4034
97.0	90.948	960.497	5.400e-01	406.419	2264.663	2671.081	1.2729	6.1182	7.3911
98.0	94.305	959.791	5.587e-01	410.633	2262.041	2672.675	1.2843	6.0947	7.3789
99.0	97.763	959.081	5.778e-01	414.849	2259.413	2674.262	1.2956	6.0712	7.3668
100.0	101.325	958.366	5.975e-01	419.065	2256.779	2675.844	1.3069	6.0479	7.3548
101.0	104.995	957.647	6.177e-01	423.283	2254.137	2677.420	1.3182	6.0247	7.3429
102.0	108.774	956.923	6.384e-01	427.502	2251.488	2678.991	1.3294	6.0016	7.3310
103.0	112.664	956.194	6.598e-01	431.723	2248.833	2680.555	1.3407	5.9786	7.3192
104.0	116.669	955.461	6.817e-01	435.945	2246.170	2682.114	1.3519	5.9556	7.3075

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
105.0	120.791	954.724	7.042e-01	440.168	2243.499	2683.667	1.3630	5.9328	7.2958
106.0	125.032	953.982	7.273e-01	444.392	2240.822	2685.214	1.3742	5.9101	7.2843
107.0	129.395	953.236	7.510e-01	448.618	2238.136	2686.754	1.3853	5.8875	7.2728
108.0	133.883	952.485	7.753e-01	452.845	2235.444	2688.288	1.3964	5.8650	7.2614
109.0	138.498	951.730	8.003e-01	457.073	2232.743	2689.816	1.4074	5.8426	7.2500
110.0	143.243	950.970	8.259e-01	461.303	2230.035	2691.338	1.4185	5.8203	7.2388
111.0	148.122	950.206	8.522e-01	465.535	2227.318	2692.853	1.4295	5.7980	7.2275
112.0	153.136	949.437	8.792e-01	469.768	2224.594	2694.361	1.4405	5.7759	7.2164
113.0	158.288	948.665	9.068e-01	474.002	2221.861	2695.863	1.4515	5.7539	7.2053
114.0	163.582	947.887	9.352e-01	478.238	2219.121	2697.359	1.4624	5.7319	7.1943
115.0	169.021	947.106	9.643e-01	482.476	2216.371	2698.847	1.4733	5.7101	7.1834
116.0	174.607	946.320	9.941e-01	486.715	2213.614	2700.328	1.4842	5.6883	7.1725
117.0	180.343	945.530	1.025e+00	490.955	2210.848	2701.803	1.4951	5.6667	7.1617
118.0	186.232	944.735	1.056e+00	495.198	2208.073	2703.271	1.5059	5.6451	7.1510
119.0	192.278	943.936	1.088e+00	499.442	2205.289	2704.731	1.5167	5.6236	7.1403
120.0	198.483	943.133	1.121e+00	503.688	2202.497	2706.184	1.5275	5.6022	7.1297
121.0	204.851	942.325	1.154e+00	507.935	2199.695	2707.630	1.5383	5.5809	7.1192
122.0	211.385	941.514	1.189e+00	512.185	2196.884	2709.069	1.5491	5.5596	7.1087
123.0	218.088	940.697	1.224e+00	516.436	2194.064	2710.500	1.5598	5.5385	7.0983
124.0	224.963	939.877	1.260e+00	520.689	2191.235	2711.924	1.5705	5.5174	7.0879
125.0	232.014	939.052	1.297e+00	524.943	2188.396	2713.340	1.5812	5.4964	7.0776
126.0	239.244	938.223	1.335e+00	529.200	2185.548	2714.748	1.5918	5.4755	7.0673
127.0	246.655	937.390	1.374e+00	533.459	2182.690	2716.149	1.6025	5.4547	7.0571
128.0	254.253	936.552	1.413e+00	537.719	2179.823	2717.542	1.6131	5.4339	7.0470
129.0	262.040	935.710	1.454e+00	541.982	2176.945	2718.927	1.6237	5.4133	7.0369
130.0	270.019	934.864	1.495e+00	546.246	2174.057	2720.304	1.6342	5.3927	7.0269
131.0	278.194	934.014	1.538e+00	550.513	2171.160	2721.673	1.6448	5.3722	7.0170
132.0	286.569	933.159	1.581e+00	554.781	2168.252	2723.033	1.6553	5.3517	7.0070
133.0	295.147	932.300	1.625e+00	559.052	2165.334	2724.386	1.6658	5.3314	6.9972
134.0	303.932	931.437	1.671e+00	563.325	2162.405	2725.730	1.6763	5.3111	6.9874
135.0	312.927	930.569	1.717e+00	567.600	2159.466	2727.066	1.6868	5.2909	6.9776
136.0	322.136	929.698	1.764e+00	571.877	2156.516	2728.393	1.6972	5.2707	6.9679
137.0	331.564	928.821	1.813e+00	576.157	2153.555	2729.712	1.7076	5.2507	6.9583

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
138.0	341.213	927.941	1.862e+00	580.439	2150.584	2731.023	1.7180	5.2307	6.9487
139.0	351.087	927.057	1.913e+00	584.723	2147.601	2732.324	1.7284	5.2107	6.9391
140.0	361.191	926.168	1.965e+00	589.009	2144.608	2733.617	1.7388	5.1909	6.9296
141.0	371.528	925.275	2.017e+00	593.298	2141.603	2734.901	1.7491	5.1711	6.9202
142.0	382.102	924.377	2.071e+00	597.589	2138.586	2736.176	1.7594	5.1514	6.9108
143.0	392.918	923.476	2.126e+00	601.883	2135.559	2737.442	1.7697	5.1317	6.9014
144.0	403.978	922.570	2.183e+00	606.179	2132.519	2738.699	1.7800	5.1121	6.8921
145.0	415.287	921.659	2.240e+00	610.478	2129.468	2739.946	1.7903	5.0926	6.8829
146.0	426.849	920.745	2.299e+00	614.779	2126.406	2741.185	1.8005	5.0731	6.8737
147.0	438.669	919.826	2.358e+00	619.083	2123.331	2742.414	1.8108	5.0537	6.8645
148.0	450.750	918.903	2.420e+00	623.389	2120.244	2743.634	1.8210	5.0344	6.8554
149.0	463.096	917.976	2.482e+00	627.699	2117.145	2744.844	1.8312	5.0151	6.8463
150.0	475.712	917.044	2.545e+00	632.010	2114.034	2746.044	1.8413	4.9959	6.8373
151.0	488.603	916.108	2.610e+00	636.325	2110.910	2747.235	1.8515	4.9768	6.8283
152.0	501.771	915.167	2.677e+00	640.642	2107.774	2748.417	1.8616	4.9577	6.8193
153.0	515.222	914.223	2.744e+00	644.963	2104.625	2749.588	1.8717	4.9387	6.8104
154.0	528.960	913.274	2.813e+00	649.286	2101.464	2750.749	1.8818	4.9197	6.8015
155.0	542.989	912.320	2.883e+00	653.612	2098.289	2751.901	1.8919	4.9008	6.7927
156.0	557.314	911.363	2.955e+00	657.940	2095.102	2753.042	1.9020	4.8820	6.7839
157.0	571.938	910.401	3.028e+00	662.272	2091.901	2754.173	1.9120	4.8632	6.7752
158.0	586.868	909.434	3.103e+00	666.607	2088.687	2755.294	1.9220	4.8445	6.7665
159.0	602.107	908.463	3.179e+00	670.945	2085.460	2756.405	1.9320	4.8258	6.7578
160.0	617.659	907.488	3.257e+00	675.286	2082.219	2757.505	1.9420	4.8072	6.7492
161.0	633.530	906.509	3.336e+00	679.630	2078.965	2758.595	1.9520	4.7886	6.7406
162.0	649.724	905.525	3.416e+00	683.978	2075.696	2759.674	1.9620	4.7701	6.7320
163.0	666.245	904.536	3.498e+00	688.329	2072.414	2760.743	1.9719	4.7516	6.7235
164.0	683.099	903.543	3.582e+00	692.682	2069.118	2761.800	1.9818	4.7332	6.7150
165.0	700.290	902.546	3.667e+00	697.040	2065.808	2762.847	1.9918	4.7148	6.7066
166.0	717.823	901.544	3.754e+00	701.400	2062.483	2763.883	2.0017	4.6965	6.6982
167.0	735.702	900.538	3.843e+00	705.764	2059.144	2764.908	2.0115	4.6783	6.6898
168.0	753.933	899.527	3.933e+00	710.132	2055.790	2765.922	2.0214	4.6601	6.6815
169.0	772.520	898.512	4.025e+00	714.503	2052.422	2766.925	2.0313	4.6419	6.6732
170.0	791.468	897.493	4.118e+00	718.877	2049.039	2767.916	2.0411	4.6238	6.6649

t [°C]	Psat [kPa]	ρ_L [kg m ⁻³]	ρ_V [kg m ⁻³]	h_L [kJ kg ⁻¹]	h_{fg} [kJ kg ⁻¹]	h_V [kJ kg ⁻¹]	s_L [kJ kg ⁻¹ K ⁻¹]	s_{fg} [kJ kg ⁻¹ K ⁻¹]	s_V [kJ kg ⁻¹ K ⁻¹]
171.0	810.783	896.468	4.214e+00	723.255	2045.641	2768.896	2.0509	4.6057	6.6567
172.0	830.469	895.440	4.311e+00	727.637	2042.228	2769.865	2.0607	4.5877	6.6484
173.0	850.531	894.406	4.410e+00	732.023	2038.799	2770.822	2.0705	4.5698	6.6403
174.0	870.974	893.369	4.511e+00	736.412	2035.356	2771.767	2.0803	4.5518	6.6321
175.0	891.804	892.326	4.613e+00	740.805	2031.896	2772.701	2.0900	4.5340	6.6240
176.0	913.025	891.279	4.718e+00	745.201	2028.421	2773.623	2.0998	4.5161	6.6159
177.0	934.643	890.228	4.824e+00	749.602	2024.930	2774.532	2.1095	4.4983	6.6079
178.0	956.662	889.171	4.932e+00	754.007	2021.424	2775.430	2.1192	4.4806	6.5998
179.0	979.089	888.110	5.042e+00	758.415	2017.901	2776.316	2.1289	4.4629	6.5918
180.0	1001.928	887.045	5.154e+00	762.828	2014.362	2777.190	2.1386	4.4452	6.5839
181.0	1025.184	885.975	5.269e+00	767.244	2010.806	2778.051	2.1483	4.4276	6.5759
182.0	1048.863	884.900	5.385e+00	771.665	2007.235	2778.900	2.1580	4.4101	6.5680
183.0	1072.970	883.820	5.503e+00	776.090	2003.646	2779.736	2.1676	4.3925	6.5601
184.0	1097.511	882.735	5.623e+00	780.519	2000.040	2780.560	2.1773	4.3750	6.5523
185.0	1122.491	881.646	5.746e+00	784.953	1996.418	2781.371	2.1869	4.3576	6.5445
186.0	1147.915	880.552	5.870e+00	789.390	1992.778	2782.169	2.1965	4.3401	6.5367
187.0	1173.790	879.453	5.997e+00	793.833	1989.121	2782.954	2.2061	4.3228	6.5289
188.0	1200.119	878.349	6.126e+00	798.279	1985.447	2783.726	2.2157	4.3054	6.5211
189.0	1226.910	877.241	6.257e+00	802.730	1981.755	2784.485	2.2253	4.2881	6.5134
190.0	1254.167	876.127	6.390e+00	807.186	1978.045	2785.231	2.2348	4.2709	6.5057
191.0	1281.897	875.009	6.526e+00	811.646	1974.317	2785.964	2.2444	4.2536	6.4980
192.0	1310.104	873.886	6.664e+00	816.111	1970.572	2786.683	2.2539	4.2364	6.4903
193.0	1338.794	872.757	6.804e+00	820.581	1966.808	2787.389	2.2635	4.2193	6.4827
194.0	1367.974	871.624	6.947e+00	825.055	1963.025	2788.080	2.2730	4.2021	6.4751
195.0	1397.649	870.486	7.092e+00	829.535	1959.224	2788.759	2.2825	4.1850	6.4675
196.0	1427.825	869.343	7.240e+00	834.019	1955.404	2789.423	2.2920	4.1680	6.4599
197.0	1458.507	868.194	7.390e+00	838.508	1951.565	2790.073	2.3015	4.1509	6.4524
198.0	1489.701	867.041	7.542e+00	843.002	1947.707	2790.709	2.3109	4.1339	6.4449
199.0	1521.414	865.882	7.697e+00	847.502	1943.830	2791.331	2.3204	4.1170	6.4374
200.0	1553.650	864.718	7.855e+00	852.006	1939.933	2791.939	2.3298	4.1000	6.4299