Humid Air Properties

Psychrometrics

Excel® Add-In Library

USER GUIDE

Windows® Operating System
SI and I-P Units
Version 2.0

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www.fluidika.com
support@fluidika.com

OVERVIEW

Psychrometrics is an Excel Add-In Library that allows the calculation of thermodynamic and psychrometric properties of humid air, dry air, water, water vapor and ice based entirely on the mathematical formulation of the 2009 ASHRAE Handbook of Fundamentals.

The numerical results obtained are suitable for academic, engineering, scientific or industrial use.

1.1 Description

• Performs all the calculations implementing the latest mathematical models used to generate the tables for moist air properties and thermodynamic properties of water in the 2009 ASHRAE Handbook of Fundamentals, namely:

- Thermodynamic and psychrometric property algorithms from the ASHRAE Research Project 1485.
- Properties of steam, water and ice from the Industrial Formulation IAPWS-IF97, the Scientific Formulation IAPWS-95, IAPWS Formulation 2008 and IAPWS Formulation 2006. Properties of dry air are from the NIST Reference equation of Lemmon et al.

• Calculates the following thermodynamic properties of humid air, dry air, water, water vapor and ice:

- Dry-Bulb Temperature
- Wet-Bulb Temperature
- Dew/Frost Point Temperature
- Partial Pressure of Water Vapor in Humid Air
- Partial Pressure of Dry Air in Humid Air
- Partial Saturation Water Vapor Pressure
- Mole Fraction of Dry Air in Humid Air
- Mole Fraction of Water Vapor in Humid Air
- Mass Fraction of Dry Air in Humid Air
- Mass Fraction of Water Vapor in Humid Air
- Humidity Ratio
- Saturation Humidity Ratio
- Relative Humidity
- Absolute Humidity
- Parts per million by weight
- Parts per million by volume
- Enhancement Factor
- Specific Volume of Humid Air
- Specific Volume of Dry Air
- Density of Humid Air
- Density of Dry Air
- Specific Enthalpy of Humid Air
- Specific Enthalpy of Dry Air
- Specific Entropy of Humid Air
- Specific Entropy of Dry Air
- Specific Internal Energy of Humid Air
- Specific Internal Energy of Dry Air

- Specific Isobaric Heat Capacity of Humid Air
- Compressibility of Humid Air
- Specific Enthalpy of Liquid Water
- Specific Enthalpy of Saturated Liquid Water
- Specific Enthalpy of Saturated Water Vapor (for T ⩾ 273.15 K / 32 °F)
- Specific Entropy of Liquid Water
- Specific Entropy of Saturated Liquid Water
- Specific Entropy of Saturated Water Vapor (for T ⩾ 273.15 K / 32 °F)
- Specific Volume of Liquid Water
- Specific Volume of Saturated Liquid Water
- Specific Volume of Saturated Water Vapor (for T ⩾ 273.15 K / 32 °F)
- Saturation Pressure of Water
- Saturation Temperature of Water
- Specific Enthalpy of Saturated Ice
- Specific Enthalpy of Saturated Water Vapor (for T ⩽ 273.15 K / 32 °F)
- Specific Entropy of Saturated Ice
- Specific Entropy of Saturated Water Vapor (for T ⩽ 273.15 K / 32 °F)
- Specific Volume of Saturated Ice
- Specific Volume of Saturated Water Vapor (for T ⩽ 273.15 K / 32 °F)
- Melting Pressure of Ice
- Sublimation Pressure of Ice
- Melting Temperature of Ice
- Sublimation Temperature of Ice

- Allows for 17 different combinations of thermodynamic properties to be entered as input parameters in both the SI (metric) and the I-P (English) system of units.
  - Dry-bulb Temperature / Wet-bulb Temperature
  - Dry-bulb Temperature / Dew Point Temperature
  - Dry-bulb Temperature / Relative Humidity
  - Dry-bulb Temperature / Humidity Ratio
  - Dry-bulb Temperature / Specific Enthalpy
  - Dry-bulb Temperature / Specific Volume
  - Wet-bulb Temperature / Dew Point Temperature
  - Wet-bulb Temperature / Relative Humidity
  - Wet-bulb Temperature / Humidity Ratio
  - Dew Point Temperature / Relative Humidity
  - Dew Point Temperature / Specific Enthalpy
  - Dew Point Temperature / Specific Volume
  - Relative Humidity / Humidity Ratio
  - Relative Humidity / Specific Enthalpy
  - Relative Humidity / Specific Volume
  - Humidity Ratio / Specific Enthalpy
  - Humidity Ratio / Specific Volume

1.2 System Requirements

The following are the requirements in order to install and utilize Psychrometrics. Please note that if your operating system does not include the corresponding C++ Runtime Library it will be installed by the installation file.

	OPERATING SYSTEM
Windows OS	Windows 7 Windows 8 Windows 8.1 Windows 10

	MINIMUM VERSION	REQUIREMENT
Office Excel	Excel 2010	32-bit or 64-bit

	BITNESS	REQUIREMENT
C++ Runtime Library	32-bit	Microsoft Visual C++ 2012 Redistributable (32-bit) - 11.0.6.61030
	64-bit	Microsoft Visual C++ 2012 Redistributable (64-bit) - 11.0.6.61030

- Please note that the minimum supported Windows OS is Windows 7, and the minimum supported Excel version is Office 2010.

Psychrometrics is available as a 32-bit or 64-bit Excel Add-in in accordance with the Excel version. Please select the correct installation file that matches your Office version.

Installation File	Excel Version
Psychrometrics_XLL_x86_Setup	32-bit
Psychrometrics_XLL_x64_Setup	64-bit

1.3 Installation

Once you have downloaded the suitable version of Psychrometrics Add-In Library for your Excel installation, unzip the file in a suitable location. Double click the corresponding file:

Psychrometrics_XLL_x86_Setup.exe (for 32-bit Excel Installation)
Psychrometrics_XLL_x64_Setup.exe (for 64-bit Excel installation)

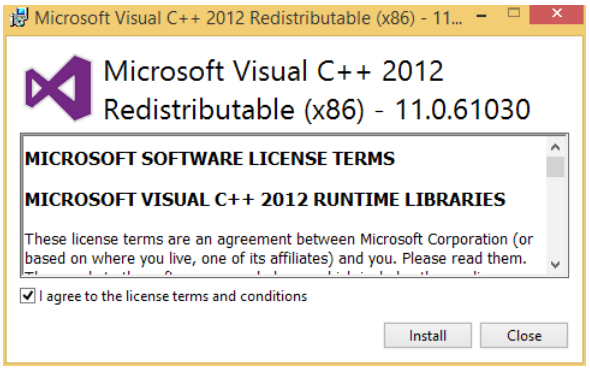
You need to agree to the *License terms and conditions* before installing the software.

You need to have **Administrator** privileges on your computer in order to install the software

1.4 License

Introduce the **SERIAL KEY** that you received in order to install the Add-In.

If your system does not include the Microsoft VC++ 2012 Redistributable runtime library, it will be installed by the application. Once you agreed to the license terms and conditions, click on the install button to proceed with the installation.



1.5 Upgrades

Information about upgrades will be send to the email address that was registered.

1.6 Uninstalling the software

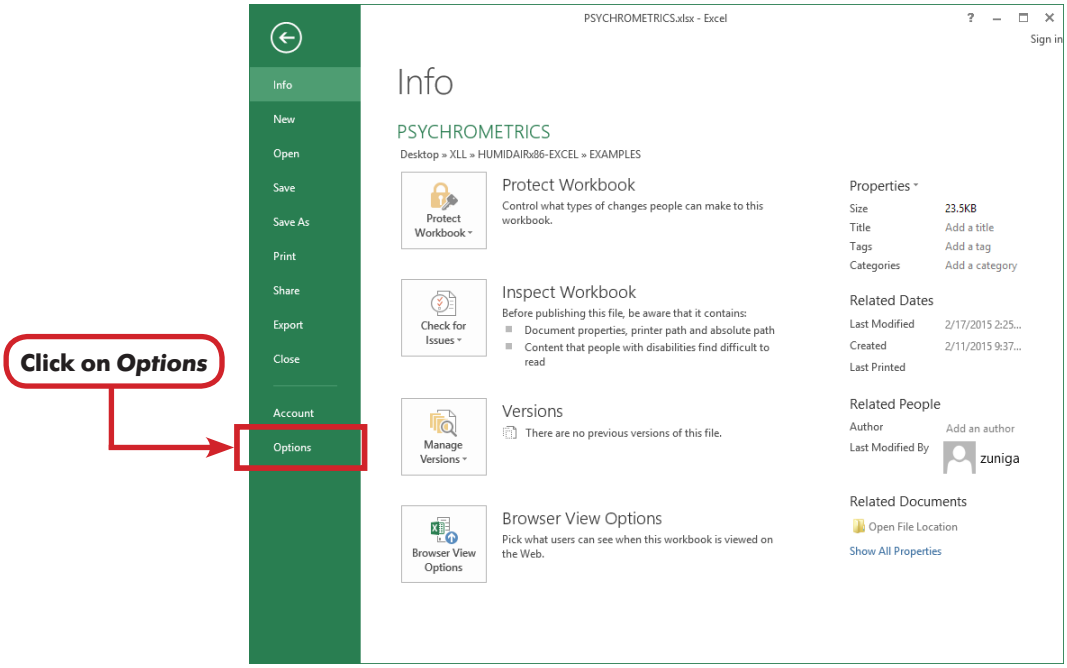
To uninstall the Add-In, double click the installation file and follow the on-screen instructions, or use the standard windows uninstaller, usually located at

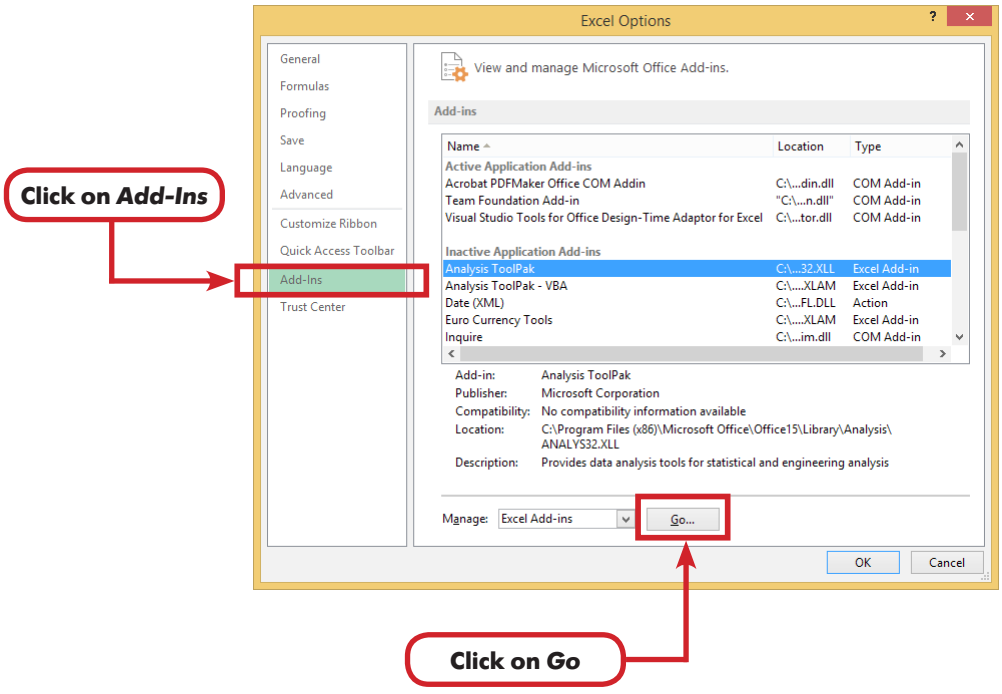
Control Panel → *Programs* → *Programs and Features*

1.7 Registering the Add-In in Excel

Once the installation has been completed, it is necessary to manually register the Add-In with Excel (here shown in Excel 2013). From an opened document, navigate to

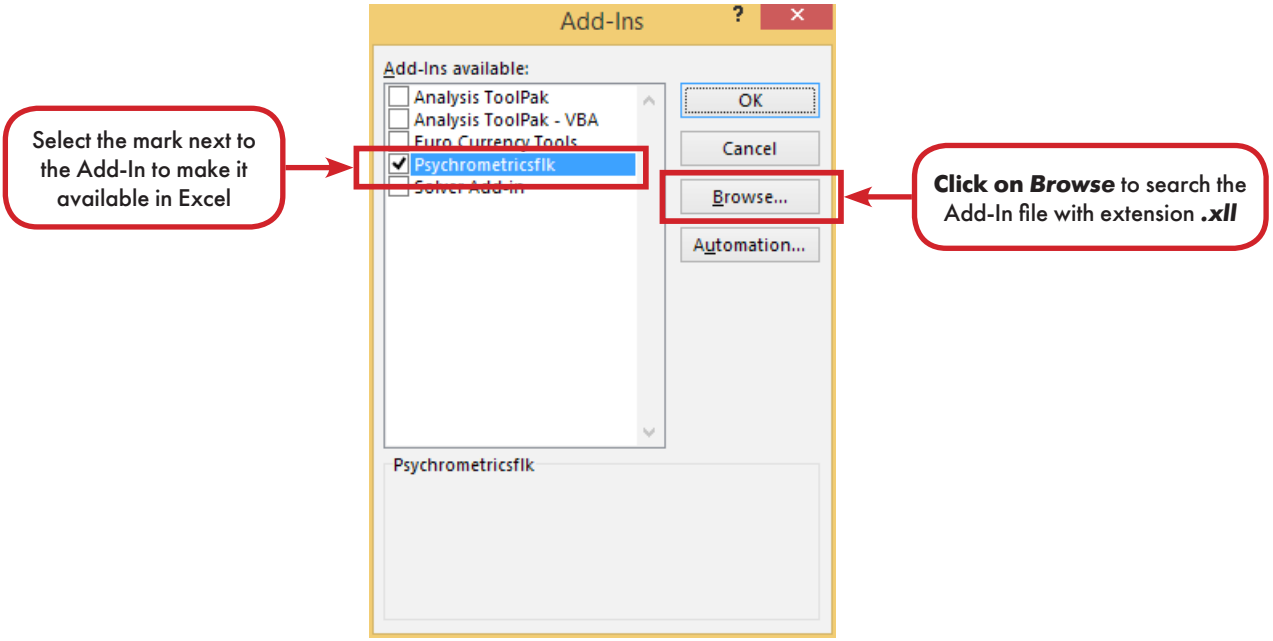
File → *Options* → *Add-Ins* → *Go*





The *Add-Ins* Window appears, showing the current Add-Ins available. Click on the *Browse* button to search on the installation directory for the file

PSYCHROMETRICSFLK.xll



The Add-In is now ready for use.

IMPORTANT: Do not rename or move any of the files with extension ***.dll*** that are located in the same directory as the Add-In (*PSYCHROMETRICSFLK.XLL*).

2.1 Range of validity

In order to calculate thermodynamic properties associated with liquid water, ice and vapor, the formulations from the International Association for the Properties of Water and Steam (IAPWS) are used to delimitate the calculations according to the pressure-temperature diagram in Figure 1.

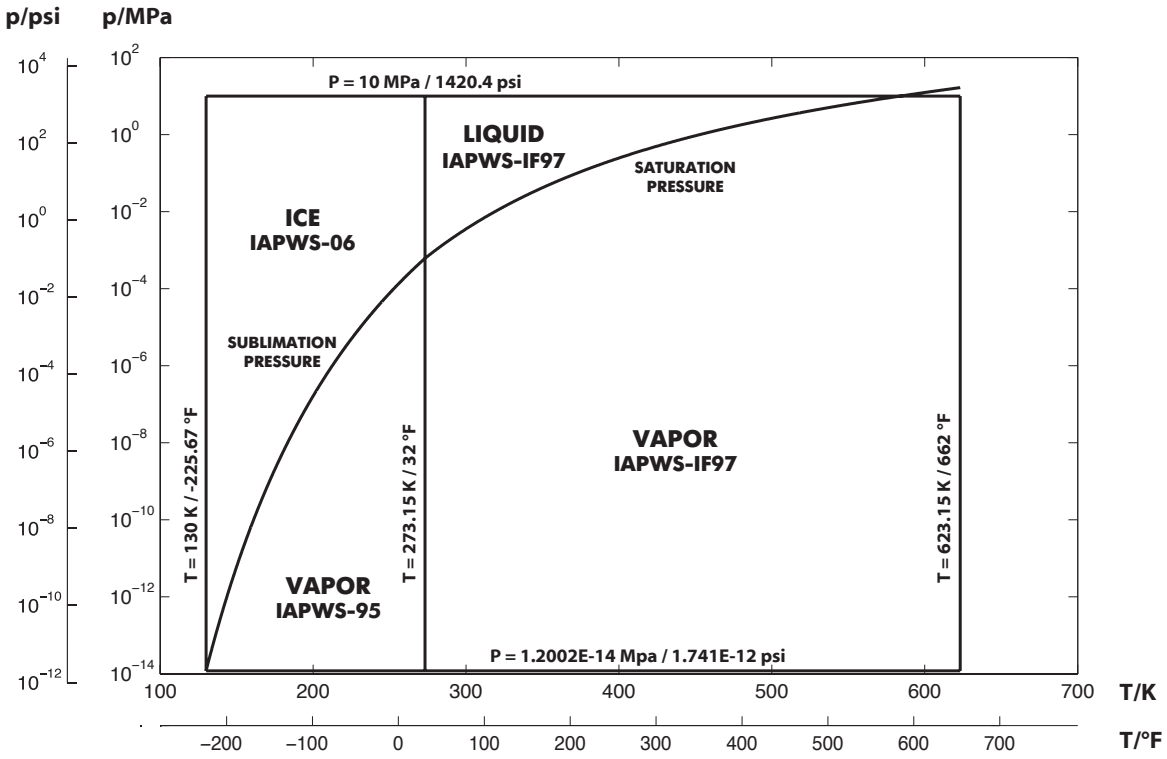


Figure 1. Range of validity of the functions defined in Psychrometrics

The absolute range for input and output variables is shown in Table 1. These values delimitate the numerical calculations. 17 possible combination of input variables plus pressure are shown in Table 2. For each of these possible combinations of input variables, the properties that are calculated are described in Table 7.

Property		Range in SI Units	SI Units
Dry-bulb Temperature	(Tdb)	130 ⩽ Tdb ⩽ 623.15	K
Wet-bulb Temperature	(Twb)	130 ⩽ Twb ⩽ 623.15	K
Dew Point Temperature	(Td)	130 ⩽ Td ⩽ 623.15	K
Relative Humidity	(PHI)	0 ⩽ PHI ⩽ 1.0	(decimal ratio)
Humidity Ratio	(W)	0 ⩽ W ⩽ 10	kg/kg
Specific Enthalpy	(h)	-311357 ⩽ h ⩽ 32135848	J/kg
Specific Volume	(v)	1.469E-3 ⩽ v ⩽ 3.055E5	m^3/kg
Pressure	(p)	10 ⩽ p ⩽ 10.0E6	Pa

Property		Range in I-P Units	I-P Units
Dry-bulb Temperature	(Tdb)	-225.67 ⩽ Tdb ⩽ 662.0	°F
Wet-bulb Temperature	(Twb)	-225.67 ⩽ Twb ⩽ 662.0	°F
Dew Point Temperature	(Td)	-225.67 ⩽ Td ⩽ 662.0	°F
Relative Humidity	(PHI)	0 ⩽ PHI ⩽ 1.0	(decimal ratio)
Humidity Ratio	(W)	0 ⩽ W ⩽ 10	lb/lb
Specific Enthalpy	(h)	-126.174 ⩽ h ⩽ 13823.61	Btu/lbm
Specific Volume	(v)	2.353E-2 ⩽ v ⩽ 4.893E6	ft^3/lbm
Pressure	(p)	0.00145 ⩽ p ⩽ 1450.4	psi

Table 1. Absolute ranges for input variables used in Psychrometrics

Input Variable		Input Variable		Combination
Dry-bulb Temperature	(Tdb)	Wet-bulb Temperature	(Twb)	**TdbTwb**
Dry-bulb Temperature	(Tdb)	Dew point Temperature	(Td)	**TdbTd**
Dry-bulb Temperature	(Tdb)	Relative Humidity	(PHI)	**TdbPHI**
Dry-bulb Temperature	(Tdb)	Humidity Ratio	(W)	**TdbW**
Dry-bulb Temperature	(Tdb)	Specific Enthalpy	(h)	**Tdbh**
Dry-bulb Temperature	(Tdb)	Specific Volume	(v)	**Tdbv**
Wet-bulb Temperature	(Twb)	Dew point Temperature	(Td)	**TwbTd**
Wet-bulb Temperature	(Twb)	Relative Humidity	(PHI)	**TwbPHI**
Wet-bulb Temperature	(Twb)	Humidity Ratio	(W)	**TwbW**
Dew point Temperature	(Td)	Relative Humidity	(PHI)	**TdPHI**
Dew point Temperature	(Td)	Specific Enthalpy	(h)	**Tdh**
Dew point Temperature	(Td)	Specific Volume	(v)	**Tdv**
Humidity Ratio	(W)	Relative Humidity	(PHI)	**WPHI**
Humidity Ratio	(W)	Specific Enthalpy	(h)	**Wh**
Humidity Ratio	(W)	Specific Volume	(v)	**Wv**
Relative Humidity	(PHI)	Specific Enthalpy	(h)	**PHIh**
Relative Humidity	(PHI)	Specific Volume	(v)	**PHIv**

Table 2. Combination of input variables used in Psychrometrics

2.2 User Defined Functions (UDF)

Psychrometrics Excel Add-In Library is composed of User Defined Functions (UDF) that take parameters (string and/or double) and returns a double (number).

If incorrect or out of bounds input parameters are entered, the function will return the value of

-9999

Table 3 shows the functions defined as a combinations of input variables. Functions defined whether the input temperature (T) is

$$T \geqslant 273.15 \text{ [K]} / 32 \text{ [°F]}$$

or

$$T \leqslant 273.15 \text{ [K]} / 32 \text{ [°F]}$$

are described in Tables 4 and 5. Additional functions are shown in Table 6.

SI UNITS	I-P UNITS	OUTPUT RESULT
HAFLK_SI_pTdbTwb_prop	HAFLK_IP_pTdbTwb_prop	**Depending on value of "prop", see Table 7**
HAFLK_SI_pTdbTd_prop	HAFLK_IP_pTdbTd_prop	
HAFLK_SI_pTdbPHI_prop	HAFLK_IP_pTdbPHI_prop	
HAFLK_SI_pTdbW_prop	HAFLK_IP_pTdbW_prop	
HAFLK_SI_pTdbh_prop	HAFLK_IP_pTdbh_prop	
HAFLK_SI_pTdbv_prop	HAFLK_IP_pTdbv_prop	
HAFLK_SI_pTwbTd_prop	HAFLK_IP_pTwbTd_prop	
HAFLK_SI_pTwbPHI_prop	HAFLK_IP_pTwbPHI_prop	
HAFLK_SI_pTwbW_prop	HAFLK_IP_pTwbW_prop	
HAFLK_SI_pTdPHI_prop	HAFLK_IP_pTdPHI_prop	
HAFLK_SI_pTdh_prop	HAFLK_IP_pTdh_prop	
HAFLK_SI_pTdv_prop	HAFLK_IP_pTdv_prop	
HAFLK_SI_pWPHI_prop	HAFLK_IP_pWPHI_prop	
HAFLK_SI_pWh_prop	HAFLK_IP_pWh_prop	
HAFLK_SI_pWv_prop	HAFLK_IP_pWv_prop	
HAFLK_SI_pPHIh_prop	HAFLK_IP_pPHIh_prop	
HAFLK_SI_pPHIv_prop	HAFLK_IP_pPHIv_prop	

Table 3. Functions based on combination of input variables

SI UNITS	I-P UNITS	OUTPUT RESULT
SWFLK_SI_pT_hlw	SWFLK_IP_pT_hlw	Specific enthalpy of liquid water
SWFLK_SI_T_hlws	SWFLK_IP_T_hlws	Specific enthalpy of saturated liquid water
SWFLK_SI_T_hwvs	SWFLK_IP_T_hwvs	Specific enthalpy of saturated water vapor
SWFLK_SI_pT_slw	SWFLK_IP_pT_slw	Specific entropy of liquid water
SWFLK_SI_T_slws	SWFLK_IP_T_slws	Specific entropy of saturated liquid water
SWFLK_SI_T_swvs	SWFLK_IP_T_swvs	Specific entropy of saturated water vapor
SWFLK_SI_pT_vlw	SWFLK_IP_pT_vlw	Specific volume of liquid water
SWFLK_SI_T_vlws	SWFLK_IP_T_vlws	Specific volume of saturated liquid water
SWFLK_SI_T_vwvs	SWFLK_IP_T_vwvs	Specific volume of saturated water vapor
SWFLK_SI_T_Pws	SWFLK_IP_T_Pws	Saturation pressure of water
SWFLK_SI_p_Tws	SWFLK_IP_p_Tws	Saturation temperature of water

Table 4. Functions for T ⩾ 273.15 K / 32 °F

SI UNITS	I-P UNITS	OUTPUT RESULT
SWFLK_SI_T_hiws	SWFLK_IP_T_hiws	Specific enthalpy of saturated ice
SWFLK_SI_T_hwvs_sub	SWFLK_IP_T_hwvs_sub	Specific enthalpy of saturated water vapor
SWFLK_SI_T_siws	SWFLK_IP_T_siws	Specific entropy of saturated ice
SWFLK_SI_T_swvs_sub	SWFLK_IP_T_swvs_sub	Specific entropy of saturated water vapor
SWFLK_SI_T_viws	SWFLK_IP_T_viws	Specific volume of saturated ice
SWFLK_SI_T_vwvs_sub	SWFLK_IP_T_vwvs_sub	Specific volume of saturated water vapor
SWFLK_SI_T_Pmel	SWFLK_IP_T_Pmel	Melting pressure of ice
SWFLK_SI_T_Psub	SWFLK_IP_T_Psub	Sublimation pressure of ice
SWFLK_SI_p_Tmel	SWFLK_IP_p_Tmel	Melting temperature of ice
SWFLK_SI_p_Tsub	SWFLK_IP_p_Tsub	Sublimation temperature of ice

Table 5. Functions for T ⩽ 273.15 K / 32 °F

SI UNITS	I-P UNITS	OUTPUT RESULT
SWFLK_SI_pT_Pwvs	SWFLK_IP_pT_Pwvs	Partial saturation pressure of water vapor
SWFLK_SI_pT_f	SWFLK_IP_pT_f	Enhancement factor
SWFLK_SI_pT_Ws	SWFLK_IP_pT_Ws	Saturation humidity ratio
SWFLK_SI_pW_Td	SWFLK_IP_pW_Td	Dew/frost point temperture
SWFLK_SI_W_PSIda	SWFLK_IP_W_PSIda	Mole fraction of dry air
SWFLK_SI_W_PSIwv	SWFLK_IP_W_PSIwv	Mole fraction of water vapor
SWFLK_SI_W_XIda	SWFLK_IP_W_XIda	Mass fraction of dry air
SWFLK_SI_W_XIwv	SWFLK_IP_W_XIwv	Mass fraction of water vapor
SWFLK_SI_Zele_p	SWFLK_IP_Zele_p	Pressure of humid air

Table 6. Additional functions defined in Psychrometrics

Result Property	SI Units	I-P Units	prop
Dry-Bub Temperature	K	°F	**Tdb**
Wet-Bulb Temperature	K	°F	**Twb**
Dew Point Temperature	K	°F	**Td**
Partial Pressure of Water Vapor in Humid Air	Pa	psi	**Pwv**
Partial Pressure of Dry Air in Humid Air	Pa	psi	**Pda**
Partial Saturation Water Vapor Pressure	Pa	psi	**Pwvs**
Mole Fraction of Dry Air in Humid Air	[-]	[-]	**PSIda**
Mole Fraction of Water Vapor in Humid Air	[-]	[-]	**PSIwv**
Mass Fraction of Dry Air in Humid Air	[-]	[-]	**XIda**
Mass Fraction of Water Vapor in Humid Air	[-]	[-]	**XIwv**
Humidity Ratio	kg(w)/kg(da)	lb(w)/lb(da)	**W**
Saturation Humidity Ratio	kg(w)/kg(da)	lb(w)/lb(da)	**Ws**
Relative Humidity	(decimal ratio)	(decimal ratio)	**PHI**
Absolute Humidity	kg(w)/m^3	lb(w)/ft^3	**AH**
Parts per million by weight	ppmw	ppmw	**ppmw**
Parts per million by volume	ppmv	ppmv	**ppmv**
Enhancement Factor	[-]	[-]	**f**
Specific Volume of Humid Air	m^3/kg(da)	ft^3/lb(da)	**v**
Specific Volume of Dry Air	m^3/kg(da	ft^3/lb(da)	**vda**
Density of Humid Air	kg/m^3	lb/ ft^3	**RHO**
Density of Dry Air	kg/m^3	lb/ ft^3	**RHOda**
Specific Enthalpy of Humid Air	J/kg	Btu/lb	**h**
Specific Enthalpy of Dry Air	J/kg	Btu/lb	**hda**
Specific Entropy of Humid Air	J/(kg·K)	Btu/(lb °R)	**s**
Specific Entropy of Dry Air	J/(kg·K)	Btu/(lb °R)	**sda**
Specific Internal Energy of Humid Air	J/kg	Btu/lb	**u**
Specific Internal Energy of Dry Air	J/kg	Btu/lb	**uda**
Specific Isobaric Heat Capacity of Humid Air	J/(kg·K)	Btu/(lb °R)	**cp**
Compressibility of Humid Air	[-]	[-]	**Z**

Table 7. **Properties calculated for each combination of input thermodynamic variables**

Property	SI Units (output)	I-P Units (output)
Specific Enthalpy of Liquid Water	J/kg	Btu/lb
Specific Enthalpy of Saturated Liquid Water	J/kg	Btu/lb
Specific Enthalpy of Saturated Water Vapor	J/kg	Btu/lb
Specific Entropy of Liquid Water	J/(kg·K)	Btu/(lb·°R)
Specific Entropy of Saturated Liquid Water	J/(kg·K)	Btu/(lb·°R)
Specific Entropy of Saturated Water Vapor	J/(kg·K)	Btu/(lb·°R)
Specific Volume of Liquid Water	m^3/kg	ft^3/lb
Specific Volume of Saturated Liquid Water	m^3/kg	ft^3/lb
Specific Volume of Saturated Water Vapor	m^3/kg	ft^3/lb
Saturation Pressure of Water	Pa	psi
Saturation Temperature of Water	K	°F
Specific Enthalpy of Saturated Ice	J/kg	Btu/lb
Specific Entropy of Saturated Ice	J/(kg·K)	Btu/(lb·°R)
Specific Volume of Saturated Ice	m^3/kg	ft^3/lb
Melting Pressure of Ice	Pa	psi
Sublimation Pressure of Ice	Pa	psi
Melting Temperature of Ice	K	°F
Sublimation Temperature of Ice	K	°F

Table 8. Additional properties calculated

2.3 Property Functions Reference (SI Units)

FUNCTION NAME: HAFLK_SI_pTdbTwb_prop

EXCEL function usage : HAFLK_SI_pTdbTwb_prop(p, Tdb, Twb, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Tdb : Dry-bulb temperature in K.
Range: 130.0 ⩽ Tdb ⩽ 623.15 [K]

Twb : Wet-bulb temperature in K.
Range: 130.0 ⩽ Twb ⩽ 623.15 [K]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and wet-bulb temperature.
Cell E2 is interpreted as: =HAFLK_SI_pTdbTwb_prop(101325, 350, 320, "h").

	A	B	C	D	E
1	p	Tdb	Twb	prop	
2	101325	350	320	h	=HAFLK_SI_pTdbTwb_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdbTd_prop

EXCEL function usage : HAFLK_SI_pTdbTd_prop(p, Tdb, Td, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Tdb : Dry-bulb temperature in K.
Range: 130.0 ⩽ Tdb ⩽ 623.15 [K]

Td : Dew point temperature in K.
Range: 130.0 ⩽ Td ⩽ 623.15 [K]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and dew point temperature.
Cell E2 is interpreted as: =HAFLK_SI_pTdbTd_prop(101325, 350, 316.2147, "h").

	A	B	C	D	E
1	p	Tdb	Td	prop	
2	101325	350	316.2147	h	=HAFLK_SI_pTdbTd_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdbPHI_prop

EXCEL function usage : HAFLK_SI_pTdbPHI_prop(p, Tdb, PHI, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Tdb : Dry-bulb temperature in K.
Range: 130.0 ⩽ Tdb ⩽ 623.15 [K]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and relative humidity.
Cell E2 is interpreted as: =HAFLK_SI_pTdbPHI_prop(101325, 350, 0.208032661, "h").

	A	B	C	D	E
1	p	Tdb	PHI	prop	
2	101325	350	0.208032661	h	=HAFLK_SI_pTdbPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdbW_prop

EXCEL function usage : HAFLK_SI_pTdbW_prop(p, Tdb, W, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Tdb : Dry-bulb temperature in K.
Range: 130.0 ⩽ Tdb ⩽ 623.15 [K]

W : Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and humidity ratio.
Cell E2 is interpreted as: =HAFLK_SI_pTdbW_prop(101325, 350, 0.05858452, "h").

	A	B	C	D	E
1	p	Tdb	W	prop	
2	101325	350	0.05858452	h	=HAFLK_SI_pTdbW_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdbh_prop

EXCEL function usage : HAFLK_SI_pTdbh_prop(p, Tdb, h, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Tdb : Dry-bulb temperature in K.
Range: 130.0 ⩽ Tdb ⩽ 623.15 [K]

h: Specific enthalpy of humid air in J/kg.
Range: -311357 ⩽ h ⩽ 32135848 [J/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of humidity ratio ("W") as function of pressure, dry-bulb temperature and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pTdbh_prop(101325, 350, 2.32223734e+05, "W").

	A	B	C	D	E
1	p	Tdb	h	prop	
2	101325	350	2.32223734e+05	W	=HAFLK_SI_pTdbh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdbv_prop

EXCEL function usage : HAFLK_SI_pTdbv_prop(p, Tdb, v, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Tdb : Dry-bulb temperature in K.
Range: 130.0 ⩽ Tdb ⩽ 623.15 [K]

v : Specific volume of humid air in m^3/kg(dry air).
Range: 1.469E-3 ⩽ v ⩽ 3.055E5 [m^3/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and specific volume of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pTdbv_prop(101325, 350, 1.084645803, "h").

	A	B	C	D	E
1	p	Tdb	v	prop	
2	101325	350	1.084645803	h	=HAFLK_SI_pTdbv_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pWv_prop

EXCEL function usage : HAFLK_SI_pWv_prop(p, W, v, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

W : Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

v : Specific volume of humid air in m^3/kg(dry air).
Range: 1.469E-3 ⩽ v ⩽ 3.055E5 [m^3/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, humidity ratio and specific volume of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pWv_prop(101325, 0.05858452, 1.084645803, "h").

	A	B	C	D	E
1	p	W	v	prop	
2	101325	0.05858452	1.084645803	h	=HAFLK_SI_pWv_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pWh_prop

EXCEL function usage : HAFLK_SI_pWh_prop(p, W, h, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

W : Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

h: Specific enthalpy of humid air in J/kg.
Range: -311357 ⩽ h ⩽ 32135848 [J/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, humidity ratio and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pWh_prop(101325, 0.05858452, 2.32223734e+05, "s").

	A	B	C	D	E
1	p	W	h	prop	
2	101325	0.05858452	2.32223734e+05	s	=HAFLK_SI_pWh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTwbW_prop

EXCEL function usage : HAFLK_SI_pTwbW_prop(p, Twb, W, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Twb : Wet-bulb temperature in K.
Range: 130.0 ⩽ Twb ⩽ 623.15 [K]

W : Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, wet-bulb temperature and humidity ratio.
Cell E2 is interpreted as: =HAFLK_SI_pTwbW_prop(101325, 320, 0.05858452, "h").

	A	B	C	D	E
1	p	Twb	W	prop	
2	101325	320	0.05858452	h	=HAFLK_SI_pTwbW_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTwbPHI_prop

EXCEL function usage : HAFLK_SI_pTwbPHI_prop(p, Twb, PHI, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Twb : Wet-bulb temperature in K.
Range: 130.0 ⩽ Twb ⩽ 623.15 [K]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, wet-bulb temperature and relative humidity.
Cell E2 is interpreted as: =HAFLK_SI_pTwbPHI_prop(101325, 320, 0.208032661, "h").

	A	B	C	D	E
1	p	Twb	PHI	prop	
2	101325	320	0.208032661	s	=HAFLK_SI_pTwbPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTwbTd_prop

EXCEL function usage : HAFLK_SI_pTwbTd_prop(p, Twb, Td, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Twb : Wet-bulb temperature in K.
Range: 130.0 ⩽ Twb ⩽ 623.15 [K]

Td : Dew point temperature in K.
Range: 130.0 ⩽ Td ⩽ 623.15 [K]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, wet-bulb temperature and dew point temperature.
Cell E2 is interpreted as: =HAFLK_SI_pTwbTd_prop(101325, 320, 0.208032661, "h").

	A	B	C	D	E
1	p	Twb	Td	prop	
2	101325	320	316.2147093	h	=HAFLK_SI_pTwbTd_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdh_prop

EXCEL function usage : HAFLK_SI_pTdh_prop(p, Td, h, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Td : Dew point temperature in K.
Range: 130.0 ⩽ Td ⩽ 623.15 [K]

h: Specific enthalpy of humid air in J/kg.
Range: -311357 ⩽ h ⩽ 32135848 [J/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, dew point temperature and specifc enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pTdh_prop(101325, 316.2147093, 2.32223734e+05, "s").

	A	B	C	D	E
1	p	Td	h	prop	
2	101325	316.2147093	2.32223734e+05	s	=HAFLK_SI_pTdh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdv_prop

EXCEL function usage : HAFLK_SI_pTdv_prop(p, Td, v, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Td : Dew point temperature in K.
Range: 130.0 ⩽ Td ⩽ 623.15 [K]

v : Specific volume of humid air in m^3/kg(dry air).
Range: 1.469E-3 ⩽ v ⩽ 3.055E5 [m^3/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dew point temperature and specifc volume of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pTdv_prop(101325, 316.2147093, 1.084645803, "h").

	A	B	C	D	E
1	p	Td	v	prop	
2	101325	316.2147093	1.084645803	h	=HAFLK_SI_pTdv_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pWPHI_prop

EXCEL function usage : HAFLK_SI_pWPHI_prop(p, W, PHI, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

W : Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, humidity ratio and relative humidity.
Cell E2 is interpreted as: =HAFLK_SI_pWPHI_prop(101325, 0.05858452, 0.208032661, "s").

	A	B	C	D	E
1	p	W	PHI	prop	
2	101325	0.05858452	0.208032661	s	=HAFLK_SI_pWPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pTdPHI_prop

EXCEL function usage : HAFLK_SI_pTdPHI_prop(p, Td, PHI, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

Td : Dew point temperature in K.
Range: 130.0 ⩽ Td ⩽ 623.15 [K]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dew point temperature and relative humidity.
Cell E2 is interpreted as: =HAFLK_SI_pTdPHI_prop(101325, 316.2147093, 0.208032661, "h").

	A	B	C	D	E
1	p	Td	PHI	prop	
2	101325	316.2147093	0.208032661	h	=HAFLK_SI_pTdPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pPHIh_prop

EXCEL function usage : HAFLK_SI_pPHIh_prop(p, PHI, h, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

h: Specific enthalpy of humid air in J/kg.
Range: -311357 ⩽ h ⩽ 32135848 [J/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, relative humidity and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pPHIh_prop(101325, 0.208032661, 2.32223734e+05, "s").

	A	B	C	D	E
1	p	PHI	h	prop	
2	101325	0.208032661	2.32223734e+05	s	=HAFLK_SI_pPHIh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_SI_pPHIv_prop

EXCEL function usage : HAFLK_SI_pPHIv_prop(p, PHI, v, prop)

Input values :

p : Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

v : Specific volume of humid air in m^3/kg(dry air).
Range: 1.469E-3 ⩽ v ⩽ 3.055E5 [m^3/kg]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, relative humidity and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pPHIv_prop(101325, 0.208032661, 1.084645803, "s").

	A	B	C	D	E
1	p	PHI	v	prop	
2	101325	0.208032661	1.084645803	s	=HAFLK_SI_pPHIv_prop(A2, B2, C2, D2)

FUNCTION NAME: SWFLK_SI_pT_hlw

Specific enthalpy of liquid water

EXCEL function usage : SWFLK_SI_pT_hlw(p, T)

Input values :

p : Pressure in Pa.
Range: 611.2 ⩽ p ⩽ 10.0E6 [Pa]

T : Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific enthalpy of liquid water in J/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of specific enthalpy of liquid water as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_SI_pT_hlw(101325, 350).

	A	B	C
1	p	T	
2	101325	350	=SWFLK_SI_pT_hlw(A2, B2)

FUNCTION NAME: **SWFLK_SI_T_hlws**

Specific enthalpy of saturated liquid water

EXCEL function usage : SWFLK_SI_T_hlws(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific enthalpy of saturated liquid water in J/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated liquid water as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_hlws(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_hlws(A2)

FUNCTION NAME: **SWFLK_SI_T_hwvs**

Specific enthalpy of saturated water vapor

EXCEL function usage : SWFLK_SI_T_hwvs(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific enthalpy of saturated water vapor in J/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_hwvs(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_hwvs(A2)

FUNCTION NAME: **SWFLK_SI_pT_slw**

Specific entropy of liquid water

EXCEL function usage : SWFLK_SI_pT_slw(p, T)

Input values : **p :** Pressure in Pa.
Range: 611.2 ⩽ p ⩽ 10.0E6 [Pa]

T : Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific entropy of liquid water in J/(kg·K).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of specific entropy of liquid water as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_SI_pT_slw(101325, 350).

	A	B	C
1	p	T	
2	101325	350	=SWFLK_SI_pT_slw(A2, B2)

FUNCTION NAME: **SWFLK_SI_T_slws**

Specific entropy of saturated liquid water

EXCEL function usage : SWFLK_SI_T_slws(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific entropy of saturated liquid water in J/(kg·K).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated liquid water as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_slws(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_slws(A2)

FUNCTION NAME: **SWFLK_SI_T_swvs**

Specific entropy of saturated water vapor

EXCEL function usage : SWFLK_SI_T_swvs(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific entropy of saturated water vapor in J/(kg·K).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_swvs(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_swvs(A2)

FUNCTION NAME: **SWFLK_SI_pT_vlw**

Specific volume of liquid water

EXCEL function usage : SWFLK_SI_pT_vlw(p, T)

Input values : **p :** Pressure in Pa.
Range: 611.2 ⩽ p ⩽ 10.0E6 [Pa]

T : Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific volume of liquid water in m^3/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of specific volume of liquid water as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_SI_pT_vlw(101325, 350).

	A	B	C
1	p	T	
2	101325	350	=SWFLK_SI_pT_vlw(A2, B2)

FUNCTION NAME: **SWFLK_SI_T_vlws**

Specific volume of saturated liquid water

EXCEL function usage : SWFLK_SI_T_vlws(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific volume of saturated liquid water in m^3/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated liquid water as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_vlws(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_vlws(A2)

FUNCTION NAME: **SWFLK_SI_T_vwvs**

Specific volume of saturated water vapor

EXCEL function usage : SWFLK_SI_T_vwvs(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Specific volume of saturated water vapor in m^3/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_vwvs(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_vwvs(A2)

FUNCTION NAME: **SWFLK_SI_T_Pws**

Saturation pressure of water

EXCEL function usage : SWFLK_SI_T_Pws(T)

Input values : **T :** Temperature in K.
Range: 273.15 ⩽ T ⩽ 623.15 [K]

Output Result : **Saturation pressure of water in Pa.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of saturation pressure of water as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_Pws(350).

	A	B
1	T	
2	350	=SWFLK_SI_T_Pws(A2)

FUNCTION NAME: **SWFLK_SI_p_Tws**

Saturation temperature of water

EXCEL function usage : SWFLK_SI_p_Tws(p)

Input values : **p :** Pressure in Pa.
Range: 611.2 ⩽ p ⩽ 10.0E6 [Pa]

Output Result : **Saturation temperature of water in K.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of saturation temperature of water as function of pressure.
Cell B2 is interpreted as: =SWFLK_SI_p_Tws(101325).

	A	B
1	p	
2	101325	=SWFLK_SI_p_Tws(A2)

FUNCTION NAME: **SWFLK_SI_T_hiws**

Specific enthalpy of saturated ice

EXCEL function usage : SWFLK_SI_T_hiws(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Specific enthalpy of saturated ice in J/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_hiws(200).

	A	B
1	T	
2	200	=SWFLK_SI_T_hiws(A2)

FUNCTION NAME: **SWFLK_SI_T_hwvs_sub**

Specific enthalpy of saturated water vapor

EXCEL function usage : SWFLK_SI_T_hwvs_sub(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Specific enthalpy of saturated water vapor in J/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_hwvs_sub(200).

	A	B
1	T	
2	200	=SWFLK_SI_T_hwvs_sub(A2)

FUNCTION NAME: **SWFLK_SI_T_siws**

Specific entropy of saturated ice

EXCEL function usage : SWFLK_SI_T_siws(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Specific entropy of saturated ice in J/(kg·K).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_siws(200).

	A	B
1	T	
2	200	=SWFLK_SI_T_siws(A2)

FUNCTION NAME: **SWFLK_SI_T_swvs_sub**

Specific entropy of saturated water vapor

EXCEL function usage : SWFLK_SI_T_swvs_sub(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Specific entropy of saturated water vapor in J/(kg·K).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_swvs_sub(200).

	A	B
1	T	
2	200	=SWFLK_SI_T_swvs_sub(A2)

FUNCTION NAME: **SWFLK_SI_T_viws**

Specific volume of saturated ice

EXCEL function usage : SWFLK_SI_T_viws(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Specific volume of saturated ice in m^3/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_viws(200).

	A	B
1	T	
2	200	=SWFLK_SI_T_viws(A2)

FUNCTION NAME: **SWFLK_SI_T_vwvs_sub**

Specific volume of saturated water vapor

EXCEL function usage : SWFLK_SI_T_vwvs_sub(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Specific volume of saturated water vapor in m^3/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_vwvs_sub(200).

	A	B
1	T	
2	200	=SWFLK_SI_T_vwvs_sub(A2)

FUNCTION NAME: **SWFLK_SI_T_Pmel**

Melting pressure of ice

EXCEL function usage : SWFLK_SI_T_Pmel(T)

Input values : **T :** Temperature in K.
Range: 251.165 ⩽ T ⩽ 273.15 [K]

Output Result : **Melting pressure of ice in Pa.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of melting pressure of ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_Pmel(260).

	A	B
1	T	
2	260	=SWFLK_SI_T_Pmel(A2)

FUNCTION NAME: **SWFLK_SI_T_Psub**

Sublimation pressure of ice

EXCEL function usage : SWFLK_SI_T_Psub(T)

Input values : **T :** Temperature in K.
Range: 130.0 ⩽ T ⩽ 273.15 [K]

Output Result : **Sublimation pressure of ice in Pa.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of sublimation pressure of ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_SI_T_Psub(260).

	A	B
1	T	
2	260	=SWFLK_SI_T_Psub(A2)

FUNCTION NAME: **SWFLK_SI_p_Tmel**

Melting temperature of ice

EXCEL function usage : SWFLK_SI_p_Tmel(p)

Input values : **p :** Pressure in Pa.
Range: 611.2 ⩽ p ⩽ 10.0E6 [Pa]

Output Result : **Melting temperature of ice in K.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of melting temperature of ice as function of pressure.
Cell B2 is interpreted as: =SWFLK_SI_p_Tmel(1000000).

	A	B
1	p	
2	1000000	=SWFLK_SI_p_Tmel(A2)

FUNCTION NAME: **SWFLK_SI_p_Tsub**

Sublimation temperature of ice

EXCEL function usage : SWFLK_SI_p_Tsub(p)

Input values : **p :** Pressure in Pa.
Range: 1.2002E-8 ⩽ p ⩽ 611.2 [Pa]

Output Result : **Sublimation temperature of ice in K.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of sublimation temperature of ice as function of pressure.
Cell B2 is interpreted as: =SWFLK_SI_p_Tsub(50).

	A	B
1	p	
2	50	=SWFLK_SI_p_Tsub(A2)

FUNCTION NAME: **SWFLK_SI_pT_Pwvs**

Partial saturation pressure of water vapor

EXCEL function usage : SWFLK_SI_pT_f(p, T)

Input values : **p :** Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

T : Temperature in K.
Range: 130.0 ⩽ T ⩽ 623.15 [K]

Output Result : **Partial saturation pressure of water vapor in Pa.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of the partial saturation pressure of water vapor as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_SI_pT_Pwvs(101325, 350).

	A	B	C
1	p	T	
2	101325	350	=SWFLK_SI_pT_Pwvs(A2, B2)

FUNCTION NAME: **SWFLK_SI_pT_f**

Enhancement factor

EXCEL function usage : SWFLK_SI_pT_f(p, T)

Input values : **p :** Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

T : Temperature in K.
Range: 130.0 ⩽ T ⩽ 623.15 [K]

Output Result : **Enhancement factor in [-].**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of the enhancement factor as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_SI_pT_f(101325, 350).

	A	B	C
1	p	T	
2	101325	350	=SWFLK_SI_pT_f(A2, B2)

FUNCTION NAME: **SWFLK_SI_pT_Ws**

Saturation humidity ratio

EXCEL function usage : SWFLK_SI_pT_Ws(p, T)

Input values : **p :** Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

T : Temperature in K.
Range: 130.0 ⩽ T ⩽ 623.15 [K]

Output Result : **Saturation humidity ratio in kg(water)/kg(dry air).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of saturation humidity ratio as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_SI_pT_Ws(101325, 350).

	A	B	C
1	p	T	
2	101325	350	=SWFLK_SI_pT_Ws(A2, B2)

FUNCTION NAME: **SWFLK_SI_pW_Td**

Dew/frost point temperature

EXCEL function usage : SWFLK_SI_pW_Td(p,W)

Input values : **p :** Pressure in Pa.
Range: 10 ⩽ p ⩽ 10.0E6 [Pa]

W : Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

Output Result : **Dew/frost point temperature in K.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of dew /frost point temperature as function of pressure and humidity ratio.
Cell C2 is interpreted as: =SWFLK_SI_pW_Td(101325, 0.5).

	A	B	C
1	p	W	
2	101325	0.5	=SWFLK_SI_pW_Td(A2, B2)

FUNCTION NAME: **SWFLK_SI_W_PSIda**

Mole fraction of dry air

EXCEL function usage : SWFLK_SI_W_PSIda(W)

Input values : **W :** Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

Output Result : **Mole fraction of dry air in mol(dry air)/mol.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mole fraction of dry air in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_SI_W_PSIda(0.5).

	A	B
1	W	
2	0.5	=SWFLK_SI_W_PSIda(A2)

FUNCTION NAME: **SWFLK_SI_W_PSIwv**

Mole fraction of water vapor

EXCEL function usage : SWFLK_SI_W_PSIwv(W)

Input values : **W :** Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

Output Result : **Mole fraction of water vapor in mol(water vapor)/mol.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mole fraction of water vapor in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_SI_W_PSIwv(0.5).

	A	B
1	W	
2	0.5	=SWFLK_SI_W_PSIwv(A2)

FUNCTION NAME: **SWFLK_SI_W_XIda**

Mass fraction of dry air

EXCEL function usage : SWFLK_SI_W_XIda(W)

Input values : **W :** Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

Output Result : **Mass fraction of dry air in kg(dry air)/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mass fraction of dry air in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_SI_W_XIda(0.5).

	A	B
1	W	
2	0.5	=SWFLK_SI_W_XIda(A2)

FUNCTION NAME: **SWFLK_SI_W_XIwv**

Mass fraction of water vapor

EXCEL function usage : SWFLK_SI_W_XIwv(W)

Input values : **W :** Humidity ratio kg(water)/kg(dry air).
Range: 0 ⩽ W ⩽ 10 [kg/kg]

Output Result : **Mass fraction of water vapor in kg(water vapor)/kg.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mass fraction of water vapor in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_SI_W_XIwv(0.5).

	A	B
1	W	
2	0.5	=SWFLK_SI_W_XIwv(A2)

FUNCTION NAME: **SWFLK_SI_Zele_p**

Pressure of humid air as function of elevation

EXCEL function usage : SWFLK_SI_Zele_p(Zele)

Input values : **Zele :** Elevation in m.
Range: -5000 ⩽ Zele ⩽ 11000 [m]

Output Result : **Humid air pressure in Pa.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of pressure of humid air as function elevation.
Cell B2 is interpreted as: =SWFLK_SI_Zele_p(0).

	A	B
1	Zele	
2	0	=SWFLK_SI_Zele_p(A2)

2.3 Property Functions Reference (I-P Units)

FUNCTION NAME: HAFLK_IP_pTdbTwb_prop

EXCEL function usage : HAFLK_IP_pTdbTwb_prop(p, Tdb, Twb, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Tdb : Dry-bulb temperature in °F.
Range: -225.67 ⩽ Tdb ⩽ 662 [°F]

Twb : Wet-bulb temperature in °F.
Range: -225.67 ⩽ Twb ⩽ 662 [°F]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and wet-bulb temperature.
Cell E2 is interpreted as: =HAFLK_IP_pTdbTwb_prop(14.7, 170.33, 116.33878, "h").

	A	B	C	D	E
1	p	Tdb	Twb	prop	
2	14.7	170.33	116.33878	h	=HAFLK_IP_pTdbTwb_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdbTd_prop

EXCEL function usage : HAFLK_IP_pTdbTd_prop(p, Tdb, Td, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Tdb : Dry-bulb temperature in °F.
Range: -225.67 ⩽ Tdb ⩽ 662 [°F]

Td : Dew point temperature in °F.
Range: -225.67 ⩽ Td ⩽ 662 [°F]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and dew point temperature.
Cell E2 is interpreted as: =HAFLK_IP_pTdbTd_prop(14.7, 170.33, 109.525955, "h").

	A	B	C	D	E
1	p	Tdb	Td	prop	
2	14.7	170.33	109.525955	h	=HAFLK_IP_pTdbTd_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdbPHI_prop

EXCEL function usage : HAFLK_IP_pTdbPHI_prop(p, Tdb, PHI, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Tdb : Dry-bulb temperature in °F.
Range: -225.67 ⩽ Tdb ⩽ 662 [°F]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and relative humidity.
Cell E2 is interpreted as: =HAFLK_IP_pTdbPHI_prop(14.7, 170.33, 0.208089695, "h").

	A	B	C	D	E
1	p	Tdb	PHI	prop	
2	14.7	170.33	0.208089695	h	=HAFLK_IP_pTdbPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdbW_prop

EXCEL function usage : HAFLK_IP_pTdbW_prop(p, Tdb, W, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Tdb : Dry-bulb temperature in °F.
Range: -225.67 ⩽ Tdb ⩽ 662 [°F]

W : Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and humidity ratio.
Cell E2 is interpreted as: =HAFLK_IP_pTdbW_prop(14.7, 170.33, 0.05858452, "h").

	A	B	C	D	E
1	p	Tdb	W	prop	
2	14.7	170.33	0.05858452	h	=HAFLK_IP_pTdbW_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdbh_prop

EXCEL function usage : HAFLK_IP_pTdbh_prop(p, Tdb, h, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Tdb : Dry-bulb temperature in °F.
Range: -225.67 ⩽ Tdb ⩽ 662 [°F]

h: Specific enthalpy of humid air in Btu/lb.
Range: -126.174 ⩽ h ⩽ 13823.61 [Btu/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of humidity ratio ("W") as function of pressure, dry-bulb temperature and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_IP_pTdbh_prop(14.7, 170.33, 107.5238512, "W").

	A	B	C	D	E
1	p	Tdb	h	prop	
2	14.7	170.33	107.5238512	W	=HAFLK_IP_pTdbh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdbv_prop

EXCEL function usage : HAFLK_IP_pTdbv_prop(p, Tdb, v, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Tdb : Dry-bulb temperature in °F.
Range: -225.67 ⩽ Tdb ⩽ 662 [°F]

v : Specific volume of humid air in ft^3/lb(dry air).
Range: 2.353E-2 ⩽ v ⩽ 4.893E6 [ft^3/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dry-bulb temperature and specific volume of humid air.
Cell E2 is interpreted as: =HAFLK_IP_pTdbv_prop(14.7, 170.33, 17.36955915, "h").

	A	B	C	D	E
1	p	Tdb	v	prop	
2	14.7	170.33	17.36955915	h	=HAFLK_IP_pTdbv_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pWv_prop

EXCEL function usage : HAFLK_IP_pWv_prop(p, W, v, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

W : Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

v : Specific volume of humid air in ft^3/lb(dry air).
Range: 2.353E-2 ⩽ v ⩽ 4.893E6 [ft^3/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, humidity ratio and specific volume of humid air.
Cell E2 is interpreted as: =HAFLK_IP_pWv_prop(14.7, 0.05858452, 17.36955915, "h").

	A	B	C	D	E
1	p	W	v	prop	
2	14.7	0.05858452	17.36955915	h	=HAFLK_IP_pWv_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pWh_prop

EXCEL function usage : HAFLK_IP_pWh_prop(p, W, h, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

W : Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

h: Specific enthalpy of humid air in Btu/lb.
Range: -126.174 ⩽ h ⩽ 13823.61 [Btu/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, humidity ratio and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pWh_prop(14.7, 0.05858452, 107.5238512, "s").

	A	B	C	D	E
1	p	W	h	prop	
2	14.7	0.05858452	107.5238512	s	=HAFLK_SI_pWh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTwbW_prop

EXCEL function usage : HAFLK_IP_pTwbW_prop(p, Twb, W, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Twb : Wet-bulb temperature in °F.
Range: -225.67 ⩽ Twb ⩽ 662 [°F]

W : Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, wet-bulb temperature and humidity ratio.
Cell E2 is interpreted as: =HAFLK_IP_pTwbW_prop(14.7, 116.33878764, 0.05858452, "h").

	A	B	C	D	E
1	p	Twb	W	prop	
2	14.7	116.33878764	0.05858452	h	=HAFLK_IP_pTwbW_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTwbPHI_prop

EXCEL function usage : HAFLK_IP_pTwbPHI_prop(p, Twb, PHI, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Twb : Wet-bulb temperature in °F.
Range: -225.67 ⩽ Twb ⩽ 662 [°F]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, wet-bulb temperature and relative humidity.
Cell E2 is interpreted as: =HAFLK_IP_pTwbPHI_prop(14.7, 116.33878764, 0.208089695, "h").

	A	B	C	D	E
1	p	Twb	PHI	prop	
2	14.7	116.33878764	0.208089695	h	=HAFLK_IP_pTwbPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTwbTd_prop

EXCEL function usage : HAFLK_IP_pTwbTd_prop(p, Twb, Td, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Twb : Wet-bulb temperature in °F.
Range: -225.67 ⩽ Twb ⩽ 662 [°F]

Td : Dew point temperature in °F.
Range: -225.67 ⩽ Td ⩽ 662 [°F]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, wet-bulb temperature and dew point temperature.
Cell E2 is interpreted as: =HAFLK_IP_pTwbTd_prop(14.7, 116.33878764, 109.5259551, "h").

	A	B	C	D	E
1	p	Twb	Td	prop	
2	14.7	116.33878764	109.5259551	h	=HAFLK_IP_pTwbTd_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdh_prop

EXCEL function usage : HAFLK_IP_pTdh_prop(p, Td, h, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Td : Dew point temperature in °F.
Range: -225.67 ⩽ Td ⩽ 662 [°F]

h: Specific enthalpy of humid air in Btu/lb.
Range: -126.174 ⩽ h ⩽ 13823.61 [Btu/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, dew point temperature and specifc enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_IP_pTdh_prop(14.7, 109.5259551, 107.5238512, "s").

	A	B	C	D	E
1	p	Td	h	prop	
2	14.7	109.5259551	107.5238512	s	=HAFLK_IP_pTdh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdv_prop

EXCEL function usage : HAFLK_IP_pTdv_prop(p, Td, v, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Td : Dew point temperature in °F.
Range: -225.67 ⩽ Td ⩽ 662 [°F]

v : Specific volume of humid air in ft^3/lb(dry air).
Range: 2.353E-2 ⩽ v ⩽ 4.893E6 [ft^3/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dew point temperature and specifc volume of humid air.
Cell E2 is interpreted as: =HAFLK_IP_pTdv_prop(14.7, 109.5259551, 17.36955915 , "h").

	A	B	C	D	E
1	p	Td	v	prop	
2	14.7	109.5259551	17.36955915	h	=HAFLK_IP_pTdv_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pWPHI_prop

EXCEL function usage : HAFLK_IP_pWPHI_prop(p, W, PHI, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

W : Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, humidity ratio and relative humidity.
Cell E2 is interpreted as: =HAFLK_IP_pWPHI_prop(14.7, 0.05858452, 0.208089695, "s").

	A	B	C	D	E
1	p	W	PHI	prop	
2	14.7	0.05858452	0.208089695	s	=HAFLK_IP_pWPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pTdPHI_prop

EXCEL function usage : HAFLK_IP_pTdPHI_prop(p, Td, PHI, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

Td : Dew point temperature in °F.
Range: -225.67 ⩽ Td ⩽ 662 [°F]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific enthalpy of humid air ("h") as function of pressure, dew point temperature and relative humidity.
Cell E2 is interpreted as: =HAFLK_IP_pTdPHI_prop(14.7, 109.5259551, 0.208089695, "h").

	A	B	C	D	E
1	p	Td	PHI	prop	
2	14.7	109.5259551	0.208089695	h	=HAFLK_IP_pTdPHI_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pPHIh_prop

EXCEL function usage : HAFLK_IP_pPHIh_prop(p, PHI, h, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

h: Specific enthalpy of humid air in Btu/lb.
Range: -126.174 ⩽ h ⩽ 13823.61 [Btu/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, relative humidity and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_IP_pPHIh_prop(14.7, 0.208089695, 107.5238512, "s").

	A	B	C	D	E
1	p	PHI	h	prop	
2	14.7	0.208089695	107.5238512	s	=HAFLK_IP_pPHIh_prop(A2, B2, C2, D2)

FUNCTION NAME: HAFLK_IP_pPHIv_prop

EXCEL function usage : HAFLK_IP_pPHIv_prop(p, PHI, v, prop)

Input values :

p : Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

PHI : Relative Humidity in (decimal ratio)
Range: 0 ⩽ PHI ⩽ 1 [-]

v : Specific volume of humid air in ft^3/lb(dry air).
Range: 2.353E-2 ⩽ v ⩽ 4.893E6 [ft^3/lb]

prop: Output Property. String (see Table 7)

Output Result : See Table 7.

Invalid Output Result : **-9999** For input values outside the valid range , an incorrect string **prop**, or invalid calculation result.

Example : Cell E2 returns the value of specific entropy of humid air ("s") as function of pressure, relative humidity and specific enthalpy of humid air.
Cell E2 is interpreted as: =HAFLK_SI_pPHIv_prop(14.7, 0.208089695, 17.36955915, "s").

	A	B	C	D	E
1	p	PHI	v	prop	
2	14.7	0.208089695	17.36955915	s	=HAFLK_SI_pPHIv_prop(A2, B2, C2, D2)

FUNCTION NAME: SWFLK_IP_pT_hlw

Specific enthalpy of liquid water

EXCEL function usage : SWFLK_IP_pT_hlw(p, T)

Input values :

p : Pressure in psi.
Range: 0.08865 ⩽ p ⩽ 1450.4 [psi]

T : Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific enthalpy of liquid water in Btu/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of specific enthalpy of liquid water as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_IP_pT_hlw(14.7, 170.33).

	A	B	C
1	p	T	
2	14.7	170.33	=SWFLK_IP_pT_hlw(A2, B2)

FUNCTION NAME: **SWFLK_IP_T_hlws**

Specific enthalpy of saturated liquid water

EXCEL function usage : SWFLK_IP_T_hlws(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific enthalpy of saturated liquid water in Btu/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated liquid water as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_hlws(170.33).

	A	B
1	T	
2	170.33	=SWFLK_IP_T_hlws(A2)

FUNCTION NAME: **SWFLK_IP_T_hwvs**

Specific enthalpy of saturated water vapor

EXCEL function usage : SWFLK_IP_T_hwvs(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific enthalpy of saturated water vapor in Btu/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_hwvs(170.33).

	A	B
1	T	
2	170.33	=SWFLK_IP_T_hwvs(A2)

FUNCTION NAME: **SWFLK_IP_pT_slw**

Specific entropy of liquid water

EXCEL function usage : SWFLK_IP_pT_slw(p, T)

Input values : **p :** Pressure in psi.
Range: 0.08865 ⩽ p ⩽ 1450.4 [psi]

T : Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific entropy of liquid water in Btu/(lb·°R).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of specific entropy of liquid water as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_IP_pT_slw(14.7, 170.33).

	A	B	C
1	p	T	
2	14.7	170.33	=SWFLK_IP_pT_slw(A2, B2)

FUNCTION NAME: **SWFLK_IP_T_slws**

Specific entropy of saturated liquid water

EXCEL function usage : SWFLK_IP_T_slws(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific entropy of saturated liquid water in Btu/(lb·°R).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated liquid water as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_slws(170.33).

	A	B
1	T	
2	170.33	=SWFLK_IP_T_slws(A2)

FUNCTION NAME: **SWFLK_IP_T_swvs**

Specific entropy of saturated water vapor

EXCEL function usage : SWFLK_IP_T_swvs(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific entropy of saturated water vapor in Btu/(lb·°R).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_swvs(170.33).

	A	B
1	T	
2	170.33	=SWFLK_IP_T_swvs(A2)

FUNCTION NAME: **SWFLK_IP_pT_vlw**

Specific volume of liquid water

EXCEL function usage : SWFLK_IP_pT_vlw(p, T)

Input values : **p :** Pressure in psi.
Range: 0.08865 ⩽ p ⩽ 1450.4 [psi]

T : Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific volume of liquid water in ft^3/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of specific volume of liquid water as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_IP_pT_vlw(14.7, 170.33).

	A	B	C
1	p	T	
2	14.7	170.33	=SWFLK_IP_pT_vlw(A2, B2)

FUNCTION NAME: **SWFLK_IP_T_vlws**

Specific volume of saturated liquid water

EXCEL function usage : SWFLK_IP_T_vlws(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific volume of saturated liquid water in ft³/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated liquid water as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_vlws(170.33).

	A	B
1	T	
2	170.33	=SWFLK_IP_T_vlws(A2)

FUNCTION NAME: **SWFLK_IP_T_vwvs**

Specific volume of saturated water vapor

EXCEL function usage : SWFLK_IP_T_vwvs(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Specific volume of saturated water vapor in ft³/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_vwvs(170,33).

	A	B
1	T	
2	170,33	=SWFLK_IP_T_vwvs(A2)

FUNCTION NAME: **SWFLK_IP_T_Pws**

Saturation pressure of water

EXCEL function usage : SWFLK_IP_T_Pws(T)

Input values : **T :** Temperature in °F.
Range: 32 ⩽ T ⩽ 662 [°F]

Output Result : **Saturation pressure of water in psi.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of saturation pressure of water as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_Pws(170.33).

	A	B
1	T	
2	170.33	=SWFLK_IP_T_Pws(A2)

FUNCTION NAME: **SWFLK_IP_p_Tws**

Saturation temperature of water

EXCEL function usage : SWFLK_IP_p_Tws(p)

Input values : **p :** Pressure in psi.
Range: 0.08865 ⩽ p ⩽ 1450.4 [psi]

Output Result : **Saturation temperature of water in °F.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of saturation temperature of water as function of pressure.
Cell B2 is interpreted as: =SWFLK_IP_p_Tws(14.7).

	A	B
1	p	
2	14.7	=SWFLK_IP_p_Tws(A2)

FUNCTION NAME: **SWFLK_IP_T_hiws**

Specific enthalpy of saturated ice

EXCEL function usage : SWFLK_IP_T_hiws(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Specific enthalpy of saturated ice in Btu/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_hiws(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_hiws(A2)

FUNCTION NAME: **SWFLK_IP_T_hwvs_sub**

Specific enthalpy of saturated water vapor

EXCEL function usage : SWFLK_IP_T_hwvs_sub(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Specific enthalpy of saturated water vapor in Btu/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific enthalpy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_hwvs_sub(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_hwvs_sub(A2)

FUNCTION NAME: **SWFLK_IP_T_siws**

Specific entropy of saturated ice

EXCEL function usage : SWFLK_IP_T_siws(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Specific entropy of saturated ice in Btu/(lb·°R).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_siws(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_siws(A2)

FUNCTION NAME: **SWFLK_IP_T_swvs_sub**

Specific entropy of saturated water vapor

EXCEL function usage : SWFLK_IP_T_swvs_sub(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Specific entropy of saturated water vapor in Btu/(lb·°R).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific entropy of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_swvs_sub(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_swvs_sub(A2)

FUNCTION NAME: **SWFLK_IP_T_viws**

Specific volume of saturated ice

EXCEL function usage : SWFLK_IP_T_viws(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Specific volume of saturated ice in ft^3/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_viws(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_viws(A2)

FUNCTION NAME: **SWFLK_IP_T_vwvs_sub**

Specific volume of saturated water vapor

EXCEL function usage : SWFLK_IP_T_vwvs_sub(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Specific volume of saturated water vapor in ft^3/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of specific volume of saturated water vapor as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_vwvs_sub(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_vwvs_sub(A2)

FUNCTION NAME: **SWFLK_IP_T_Pmel**

Melting pressure of ice

EXCEL function usage : SWFLK_IP_T_Pmel(T)

Input values : **T :** Temperature in °F.
Range: -7.57 ⩽ T ⩽ 32 [°F]

Output Result : **Melting pressure of ice in psi.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of melting pressure of ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_Pmel(-2).

	A	B
1	T	
2	-2	=SWFLK_IP_T_Pmel(A2)

FUNCTION NAME: **SWFLK_IP_T_Psub**

Sublimation pressure of ice

EXCEL function usage : SWFLK_IP_T_Psub(T)

Input values : **T :** Temperature in °F.
Range: -225.67 ⩽ T ⩽ 32 [°F]

Output Result : **Sublimation pressure of ice in psi.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of sublimation pressure of ice as function of temperature.
Cell B2 is interpreted as: =SWFLK_IP_T_Psub(-120).

	A	B
1	T	
2	-120	=SWFLK_IP_T_Psub(A2)

FUNCTION NAME: **SWFLK_IP_p_Tmel**

Melting temperature of ice

EXCEL function usage : SWFLK_IP_p_Tmel(p)

Input values : **p :** Pressure in psi.
Range: 0.08865 ⩽ p ⩽ 1450.4 [psi]

Output Result : **Melting temperature of ice in °F.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of melting temperature of ice as function of pressure.
Cell B2 is interpreted as: =SWFLK_IP_p_Tmel(500).

	A	B
1	p	
2	500	=SWFLK_IP_p_Tmel(A2)

FUNCTION NAME: **SWFLK_IP_p_Tsub**

Sublimation temperature of ice

EXCEL function usage : SWFLK_IP_p_Tsub(p)

Input values : **p :** Pressure in psi.
Range: 1.741E-12 ⩽ p ⩽ 0.08865 [psi]

Output Result : **Sublimation temperature of ice in °F.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of sublimation temperature of ice as function of pressure.
Cell B2 is interpreted as: =SWFLK_IP_p_Tsub(0.5).

	A	B
1	p	
2	0.5	=SWFLK_IP_p_Tsub(A2)

FUNCTION NAME: **SWFLK_IP_pT_Pwvs**

Partial saturation pressure of water vapor

EXCEL function usage : SWFLK_IP_pT_Pwvs(p, T)

Input values : **p :** Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

T : Temperature in °F.
Range: -225.67 ⩽ T ⩽ 662 [°F]

Output Result : **Partial saturation pressure of water vapor in psi.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of the partial saturation pressure of water vapor as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_IP_pT_Pwvs(14.7, 170.33).

	A	B	C
1	p	T	
2	14.7	170.33	=SWFLK_IP_pT_Pwvs(A2, B2)

FUNCTION NAME: **SWFLK_IP_pT_f**

Enhancement factor

EXCEL function usage : SWFLK_IP_pT_f(p, T)

Input values : **p :** Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

T : Temperature in °F.
Range: -225.67 ⩽ T ⩽ 662 [°F]

Output Result : **Enhancement factor in [-].**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of the enhancement factor as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_IP_pT_f(14.7, 170.33).

	A	B	C
1	p	T	
2	14.7	170.33	=SWFLK_IP_pT_f(A2, B2)

FUNCTION NAME: **SWFLK_IP_pT_Ws**

Saturation humidity ratio

EXCEL function usage : SWFLK_IP_pT_Ws(p, T)

Input values : **p :** Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

T : Temperature in °F.
Range: -225.67 ⩽ T ⩽ 662 [°F]

Output Result : **Saturation humidity ratio in lb(water)/lb(dry air).**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of saturation humidity ratio as function of pressure and temperature.
Cell C2 is interpreted as: =SWFLK_IP_pT_Ws(14.7, 170.33).

	A	B	C
1	p	T	
2	14.7	170.33	=SWFLK_IP_pT_Ws(A2, B2)

FUNCTION NAME: **SWFLK_IP_pW_Td**

Dew/frost point temperature

EXCEL function usage : SWFLK_IP_pW_Td(p,W)

Input values : **p :** Pressure in psi.
Range: 0.00145 ⩽ p ⩽ 1450.4 [psi]

W : Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

Output Result : **Dew/frost point temperature in °F.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell C2 returns the value of dew /frost point temperature as function of pressure and humidity ratio.
Cell C2 is interpreted as: =SWFLK_IP_pW_Td(14.7, 0.5).

	A	B	C
1	p	W	
2	14.7	0.5	=SWFLK_IP_pW_Td(A2, B2)

FUNCTION NAME: **SWFLK_IP_W_PSIda**

Mole fraction of dry air

EXCEL function usage : SWFLK_IP_W_PSIda(W)

Input values : **W :** Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

Output Result : **Mole fraction of dry air in mol(dry air)/mol.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mole fraction of dry air in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_IP_W_PSIda(0.5).

	A	B
1	W	
2	0.5	=SWFLK_IP_W_PSIda(A2)

FUNCTION NAME: **SWFLK_IP_W_PSIwv**

Mole fraction of water vapor

EXCEL function usage : SWFLK_IP_W_PSIwv(W)

Input values : **W :** Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

Output Result : **Mole fraction of water vapor in mol(water vapor)/mol.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mole fraction of water vapor in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_IP_W_PSIwv(0.5).

	A	B
1	W	
2	0.5	=SWFLK_IP_W_PSIwv(A2)

FUNCTION NAME: **SWFLK_IP_W_XIda**

Mass fraction of dry air

EXCEL function usage : SWFLK_IP_W_XIda(W)

Input values : **W :** Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

Output Result : **Mass fraction of dry air in lb(dry air)/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mass fraction of dry air in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_IP_W_XIda(0.5).

	A	B
1	W	
2	0.5	=SWFLK_IP_W_XIda(A2)

FUNCTION NAME: **SWFLK_IP_W_XIwv**

Mass fraction of water vapor

EXCEL function usage : SWFLK_IP_W_XIwv(W)

Input values : **W :** Humidity ratio lb(water)/lb(dry air).
Range: 0 ⩽ W ⩽ 10 [lb/lb]

Output Result : **Mass fraction of water vapor in lb(water vapor)/lb.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of mass fraction of water vapor in humid air as function of humidity ratio.
Cell B2 is interpreted as: =SWFLK_IP_W_XIwv(0.5).

	A	B
1	W	
2	0.5	=SWFLK_IP_W_XIwv(A2)

FUNCTION NAME: **SWFLK_IP_Zele_p**

Pressure of humid air as function of elevation

EXCEL function usage : SWFLK_IP_Zele_p(Zele)

Input values : **Zele :** Elevation in ft.
Range: -16404 ⩽ Zele ⩽ 36089 [ft]

Output Result : **Humid air pressure in psi.**

Invalid Output Result : **-9999** For input values outside the valid range or invalid calculation result.

Example : Cell B2 returns the value of pressure of humid air as function of elevation.
Cell B2 is interpreted as: =SWFLK_IP_Zele_p(0).

	A	B
1	Zele	
2	0	=SWFLK_IP_Zele_p(A2)

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