

Humid Air Properties
Psychrometrics
Excel® Add-In Library



USER GUIDE

*Windows® Operating System
SI and I-P Units
Version 2.1*

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OVERVIEW

PsychrometricsFLK 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 $T \geq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$)
 - Specific Entropy of Liquid Water
 - Specific Entropy of Saturated Liquid Water
 - Specific Entropy of Saturated Water Vapor (for $T \geq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$)
 - Specific Volume of Liquid Water
 - Specific Volume of Saturated Liquid Water
 - Specific Volume of Saturated Water Vapor (for $T \geq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$)
 - Saturation Pressure of Water
 - Saturation Temperature of Water
 - Specific Enthalpy of Saturated Ice
 - Specific Enthalpy of Saturated Water Vapor (for $T \leq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$)
 - Specific Entropy of Saturated Ice
 - Specific Entropy of Saturated Water Vapor (for $T \leq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$)
 - Specific Volume of Saturated Ice
 - Specific Volume of Saturated Water Vapor (for $T \leq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$)
 - 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 **PsychrometricsFLK**. Please note that if your operating system does not include the corresponding C++ Runtime Library it will be installed by the installation file.

Windows OS	Windows 7 Windows 8 Windows 8.1 Windows 10
Office Excel	Minimum Version : Excel 2010 (32-bit or 64-bit)
C++ Runtime Library	(32-bit): Microsoft Visual C++ 2015-2019 Redistributable (x86) (64-bit) : Microsoft Visual C++ 2015-2019 Redistributable (x64)

PsychrometricsFLK 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.

1.3 Installation

Double-click on the installation file and follow the on-screen instructions. Contact support@fluidika.com if you require assistance.

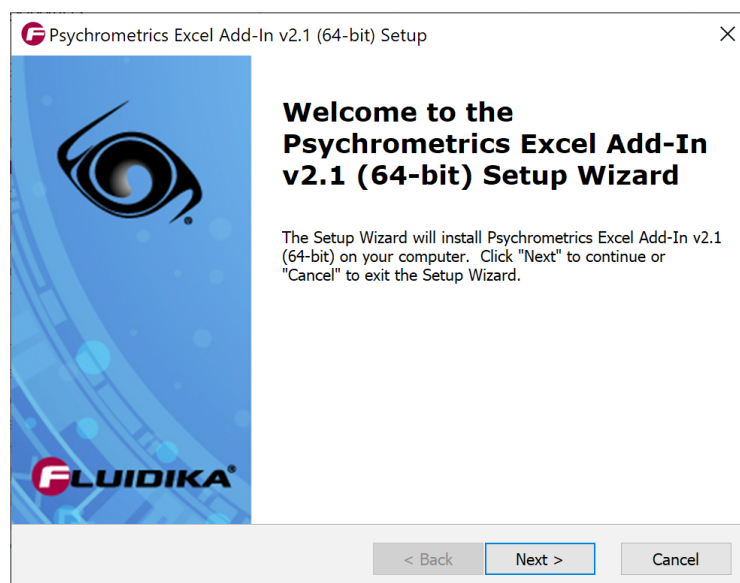


Figure 1. Installation screen of PsychrometricsFLK Add-in.

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

1.4 License

Introduce the **License Key** that you received in order to install the add-In during the installation process.

Contact support@fluidika.com if you require assistance during the activation process.

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*

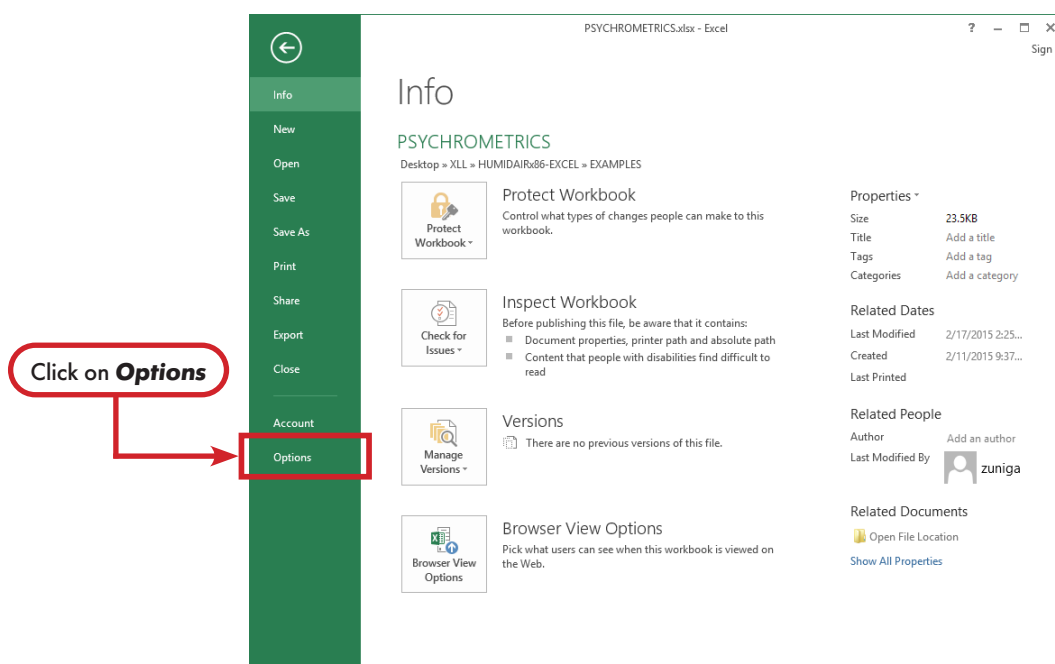


Figure 2. Registration of the add-in in Excel.

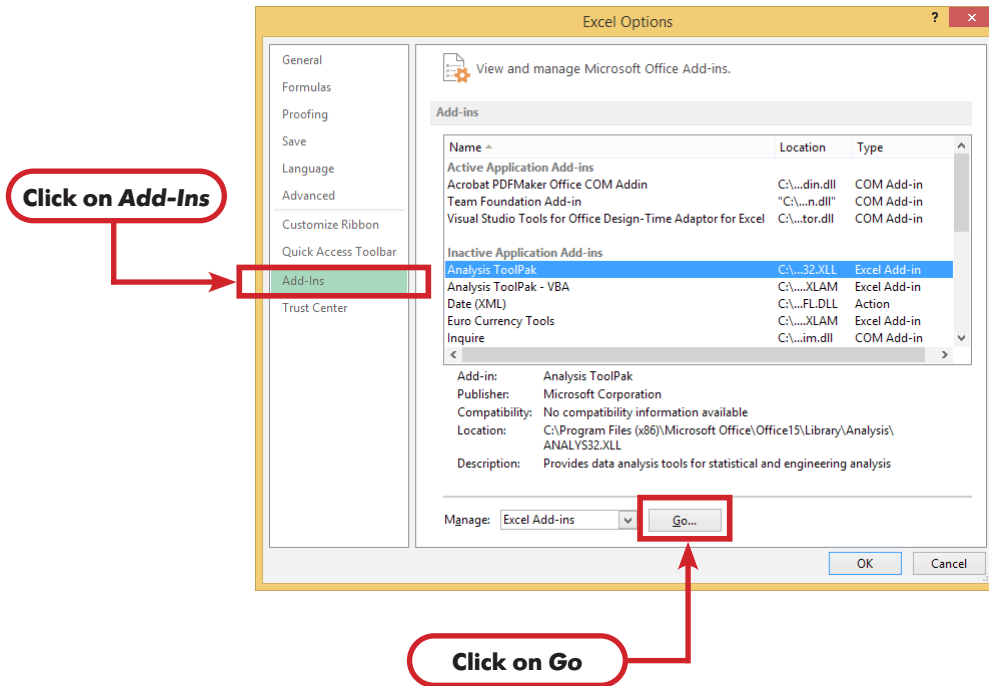


Figure 3. Registration of the add-in in Excel.

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

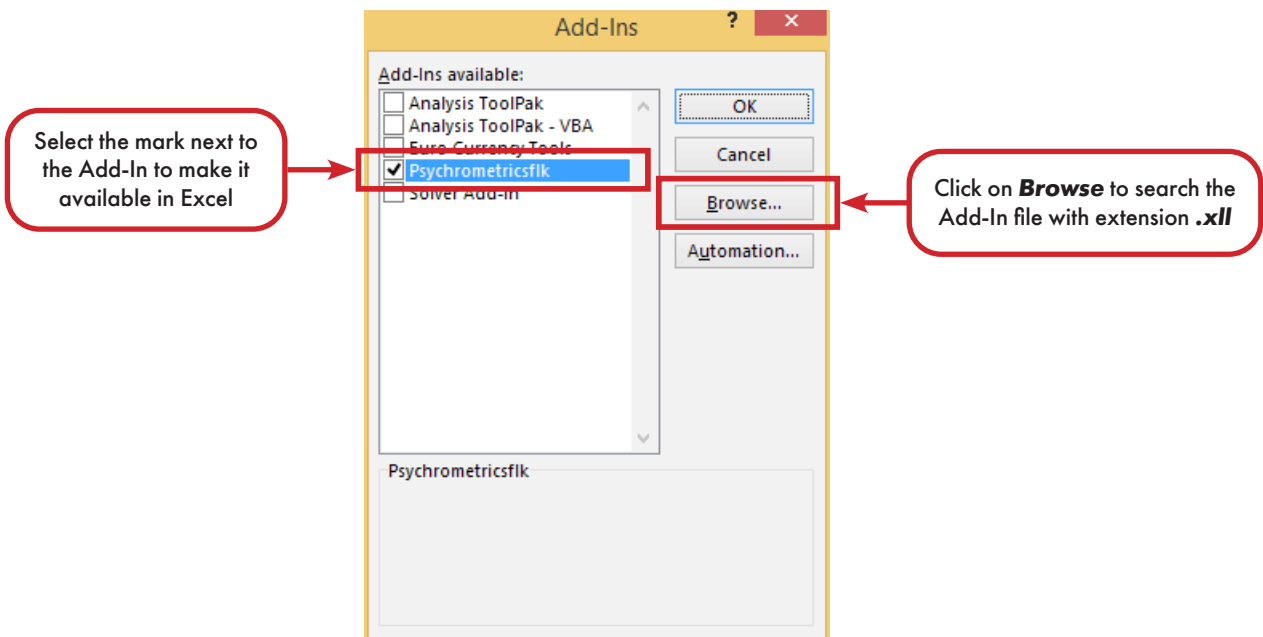


Figure 4. Registration of the add-in in Excel.

The Add-In is now ready for use.

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 5.

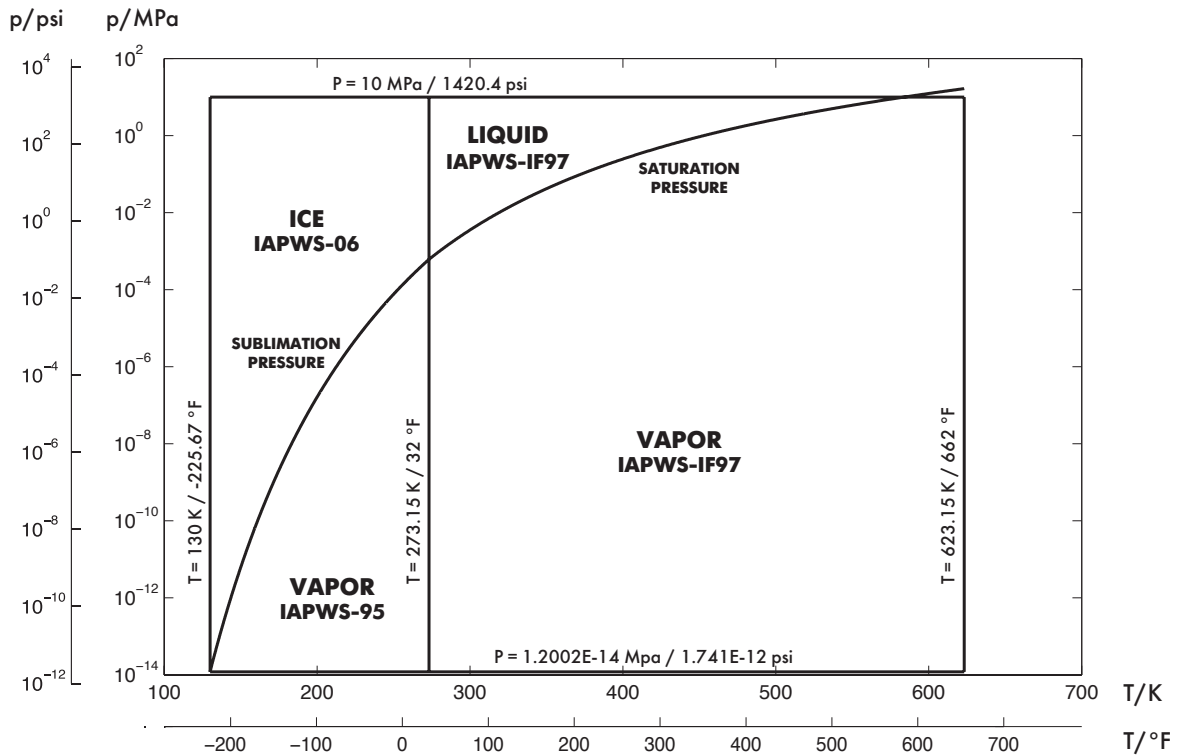


Figure 5. Range of validity of the functions defined in [PsychrometricsFLK](#)

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

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

Table 1. Absolute ranges for input variables used in [PsychrometricsFLK](#)

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 [PsychrometricsFLK](#)

2.2 User Defined Functions (UDF)

PsychrometricsFLK Excel Add-In Library is composed of User Defined Functions (UDF) that take parameters (string and/or double) and return 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

$$T \geq 273.15 \text{ [K]} / 32 \text{ [}^\circ\text{F]}$$

or

$$T \leq 273.15 \text{ [K]} / 32 \text{ [}^\circ\text{F]}$$

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 $T \geq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$

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 $T \leq 273.15 \text{ K} / 32 \text{ }^\circ\text{F}$

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 temperature
SWFLK_SI_W_PSI _{da}	SWFLK_IP_W_PSI _{da}	Mole fraction of dry air
SWFLK_SI_W_PSI _{wv}	SWFLK_IP_W_PSI _{wv}	Mole fraction of water vapor
SWFLK_SI_W_XI _{da}	SWFLK_IP_W_XI _{da}	Mass fraction of dry air
SWFLK_SI_W_XI _{wv}	SWFLK_IP_W_XI _{wv}	Mass fraction of water vapor
SWFLK_SI_Zele_p	SWFLK_IP_Zele_p	Pressure of humid air

Table 6. Additional functions defined in [PsychrometricsFLK](#)

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: $10 \leq p \leq 10.0E6$ [Pa]

Tdb : Dry-bulb temperature in K.
Range: $130.0 \leq Tdb \leq 623.15$ [K]

Twb : Wet-bulb temperature in K.
Range: $130.0 \leq Twb \leq 623.15$ [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: $10 \leq p \leq 10.0E6$ [Pa]

Tdb : Dry-bulb temperature in K.
Range: $130.0 \leq Tdb \leq 623.15$ [K]

Td : Dew point temperature in K.
Range: $130.0 \leq Td \leq 623.15$ [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: $10 \leq p \leq 10.0E6$ [Pa]**Tdb** : Dry-bulb temperature in K.
Range: $130.0 \leq Tdb \leq 623.15$ [K]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: $10 \leq p \leq 10.0E6$ [Pa]**Tdb** : Dry-bulb temperature in K.
Range: $130.0 \leq Tdb \leq 623.15$ [K]**W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [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: $10 \leq p \leq 10.0E6$ [Pa]**Tdb** : Dry-bulb temperature in K.
Range: $130.0 \leq Tdb \leq 623.15$ [K]**h**: Specific enthalpy of humid air in J/kg.
Range: $-311357 \leq h \leq 32135848$ [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: $10 \leq p \leq 10.0E6$ [Pa]**Tdb** : Dry-bulb temperature in K.
Range: $130.0 \leq Tdb \leq 623.15$ [K]**v** : Specific volume of humid air in m³/kg(dry air).
Range: $1.469E-3 \leq v \leq 3.055E5$ [m³/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: $10 \leq p \leq 10.0E6$ [Pa]**W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [kg/kg]**v** : Specific volume of humid air in m³/kg(dry air).
Range: $1.469E-3 \leq v \leq 3.055E5$ [m³/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: $10 \leq p \leq 10.0E6$ [Pa]**W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [kg/kg]**h**: Specific enthalpy of humid air in J/kg.
Range: $-311357 \leq h \leq 32135848$ [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: $10 \leq p \leq 10.0E6$ [Pa]**Twb** : Wet-bulb temperature in K.
Range: $130.0 \leq Twb \leq 623.15$ [K]**W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [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: $10 \leq p \leq 10.0E6$ [Pa]**Twb** : Wet-bulb temperature in K.
Range: $130.0 \leq Twb \leq 623.15$ [K]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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:**HAFK_SI_pTwbTd_prop****EXCEL function usage :** HAFK_SI_pTwbTd_prop(p, Twb, Td, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**Twb** : Wet-bulb temperature in K.
Range: $130.0 \leq Twb \leq 623.15$ [K]**Td** : Dew point temperature in K.
Range: $130.0 \leq Td \leq 623.15$ [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: =HAFK_SI_pTwbTd_prop(101325, 320, 0.208032661, "h").

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

FUNCTION NAME:**HAFK_SI_pTdh_prop****EXCEL function usage :** HAFK_SI_pTdh_prop(p, Td, h, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**Td** : Dew point temperature in K.
Range: $130.0 \leq Td \leq 623.15$ [K]**h**: Specific enthalpy of humid air in J/kg.
Range: $-311357 \leq h \leq 32135848$ [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 specific enthalpy of humid air.

Cell E2 is interpreted as: =HAFK_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	=HAFK_SI_pTdh_prop(A2, B2, C2, D2)

FUNCTION NAME:**HAFK_SI_pTdv_prop****EXCEL function usage :** HAFK_SI_pTdv_prop(p, Td, v, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**Td** : Dew point temperature in K.
Range: $130.0 \leq Td \leq 623.15$ [K]**v** : Specific volume of humid air in m³/kg(dry air).
Range: $1.469E-3 \leq v \leq 3.055E5$ [m³/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 specific volume of humid air.

Cell E2 is interpreted as: =HAFK_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	=HAFK_SI_pTdv_prop(A2, B2, C2, D2)

FUNCTION NAME:**HAFK_SI_pWPHI_prop****EXCEL function usage :** HAFK_SI_pWPHI_prop(p, W, PHI, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [kg/kg]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: =HAFK_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	=HAFK_SI_pWPHI_prop(A2, B2, C2, D2)

FUNCTION NAME:**HAFK_SI_pTdPHI_prop****EXCEL function usage :** HAFK_SI_pTdPHI_prop(p, Td, PHI, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**Td** : Dew point temperature in K.
Range: $130.0 \leq Td \leq 623.15$ [K]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: =HAFK_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	=HAFK_SI_pTdPHI_prop(A2, B2, C2, D2)

FUNCTION NAME:**HAFK_SI_pPHIh_prop****EXCEL function usage :** HAFK_SI_pPHIh_prop(p, PHI, h, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**h**: Specific enthalpy of humid air in J/kg.
Range: $-31\ 1357 \leq h \leq 32\ 135\ 848$ [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: =HAFK_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	=HAFK_SI_pPHIh_prop(A2, B2, C2, D2)

FUNCTION NAME:**HAFLK_SI_pPHlv_prop****EXCEL function usage :** HAFLK_SI_pPHlv_prop(p, PHI, v, prop)**Input values :** **p** : Pressure in Pa.
Range: $10 \leq p \leq 10.0E6$ [Pa]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**v** : Specific volume of humid air in m³/kg(dry air).
Range: $1.469E-3 \leq v \leq 3.055E5$ [m³/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_pPHlv_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_pPHlv_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: $611.2 \leq p \leq 10.0E6$ [Pa]**T** : Temperature in K.
Range: $273.15 \leq T \leq 623.15$ [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: $273.15 \leq T \leq 623.15$ [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: $273.15 \leq T \leq 623.15$ [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: $611.2 \leq p \leq 10.0E6$ [Pa]**T** : Temperature in K.
Range: $273.15 \leq T \leq 623.15$ [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: $273.15 \leq T \leq 623.15$ [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: $273.15 \leq T \leq 623.15$ [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: $611.2 \leq p \leq 10.0E6$ [Pa]**T** : Temperature in K.
Range: $273.15 \leq T \leq 623.15$ [K]**Output Result :** **Specific volume of liquid water in m³/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: $273.15 \leq T \leq 623.15$ [K]**Output Result :** **Specific volume of saturated liquid water in m³/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: $273.15 \leq T \leq 623.15$ [K]**Output Result :** **Specific volume of saturated water vapor in m³/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: $273.15 \leq T \leq 623.15$ [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: $611.2 \leq p \leq 10.0E6$ [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: $130.0 \leq T \leq 273.15$ [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: $130.0 \leq T \leq 273.15$ [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: $130.0 \leq T \leq 273.15$ [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: $130.0 \leq T \leq 273.15$ [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: $130.0 \leq T \leq 273.15$ [K]**Output Result :** **Specific volume of saturated ice in m³/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: $130.0 \leq T \leq 273.15$ [K]**Output Result :** **Specific volume of saturated water vapor in m³/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: $251.165 \leq T \leq 273.15$ [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: $130.0 \leq T \leq 273.15$ [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: $611.2 \leq p \leq 10.0E6$ [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: $1.2002E-8 \leq p \leq 611.2$ [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: $10 \leq p \leq 10.0E6$ [Pa]**T** : Temperature in K.
Range: $130.0 \leq T \leq 623.15$ [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: $10 \leq p \leq 10.0E6$ [Pa]**T** : Temperature in K.
Range: $130.0 \leq T \leq 623.15$ [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: $10 \leq p \leq 10.0E6$ [Pa]**T** : Temperature in K.
Range: $130.0 \leq T \leq 623.15$ [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: $10 \leq p \leq 10.0E6$ [Pa]**W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [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_PSI_{da}****Mole fraction of dry air****EXCEL function usage :** SWFLK_SI_W_PSI_{da}(W)**Input values :** **W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [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_PSI_{da}(0.5).

	A	B
1	W	
2	0.5	=SWFLK_SI_W_PSI _{da} (A2)

FUNCTION NAME:**SWFLK_SI_W_PSI_{wv}****Mole fraction of water vapor****EXCEL function usage :** SWFLK_SI_W_PSI_{wv}(W)**Input values :** **W** : Humidity ratio kg(water)/kg(dry air).
Range: $0 \leq W \leq 10$ [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_PSI_{wv}(0.5).

	A	B
1	W	
2	0.5	=SWFLK_SI_W_PSI _{wv} (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: $0 \leq W \leq 10$ [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: $0 \leq W \leq 10$ [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: $-5000 \leq \text{Zele} \leq 11000$ [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)

2.4 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: $0.00145 \leq p \leq 1450.4$ [psi]

Tdb : Dry-bulb temperature in °F.
Range: $-225.67 \leq Tdb \leq 662$ [°F]

Twb : Wet-bulb temperature in °F.
Range: $-225.67 \leq Twb \leq 662$ [°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: $0.00145 \leq p \leq 1450.4$ [psi]

Tdb : Dry-bulb temperature in °F.
Range: $-225.67 \leq Tdb \leq 662$ [°F]

Td : Dew point temperature in °F.
Range: $-225.67 \leq Td \leq 662$ [°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: $0.00145 \leq p \leq 1450.4$ [psi]**Tdb** : Dry-bulb temperature in °F.
Range: $-225.67 \leq Tdb \leq 662$ [°F]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: $0.00145 \leq p \leq 1450.4$ [psi]**Tdb** : Dry-bulb temperature in °F.
Range: $-225.67 \leq Tdb \leq 662$ [°F]**W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [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: $0.00145 \leq p \leq 1450.4$ [psi]**Tdb** : Dry-bulb temperature in °F.
Range: $-225.67 \leq Tdb \leq 662$ [°F]**h** : Specific enthalpy of humid air in Btu/lb.
Range: $-126.174 \leq h \leq 13823.61$ [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: $0.00145 \leq p \leq 1450.4$ [psi]**Tdb** : Dry-bulb temperature in °F.
Range: $-225.67 \leq Tdb \leq 662$ [°F]**v** : Specific volume of humid air in ft³/lb(dry air).
Range: $2.353E-2 \leq v \leq 4.893E6$ [ft³/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: $0.00145 \leq p \leq 1450.4$ [psi]**W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [lb/lb]**v** : Specific volume of humid air in ft³/lb(dry air).
Range: $2.353E-2 \leq v \leq 4.893E6$ [ft³/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: $0.00145 \leq p \leq 1450.4$ [psi]**W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [lb/lb]**h**: Specific enthalpy of humid air in Btu/lb.
Range: $-126.174 \leq h \leq 13823.61$ [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: $0.00145 \leq p \leq 1450.4$ [psi]**Twb** : Wet-bulb temperature in °F.
Range: $-225.67 \leq Twb \leq 662$ [°F]**W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [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: $0.00145 \leq p \leq 1450.4$ [psi]**Twb** : Wet-bulb temperature in °F.
Range: $-225.67 \leq Twb \leq 662$ [°F]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: $0.00145 \leq p \leq 1450.4$ [psi]**Twb** : Wet-bulb temperature in °F.
Range: $-225.67 \leq Twb \leq 662$ [°F]**Td** : Dew point temperature in °F.
Range: $-225.67 \leq Td \leq 662$ [°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: $0.00145 \leq p \leq 1450.4$ [psi]**Td** : Dew point temperature in °F.
Range: $-225.67 \leq Td \leq 662$ [°F]**h**: Specific enthalpy of humid air in Btu/lb.
Range: $-126.174 \leq h \leq 13823.61$ [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 specific 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: $0.00145 \leq p \leq 1450.4$ [psi]**Td** : Dew point temperature in °F.
Range: $-225.67 \leq Td \leq 662$ [°F]**v** : Specific volume of humid air in ft³/lb(dry air).
Range: $2.353E-2 \leq v \leq 4.893E6$ [ft³/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 specific 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: $0.00145 \leq p \leq 1450.4$ [psi]**W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [lb/lb]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: $0.00145 \leq p \leq 1450.4$ [psi]**Td** : Dew point temperature in °F.
Range: $-225.67 \leq Td \leq 662$ [°F]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**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: $0.00145 \leq p \leq 1450.4$ [psi]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq PHI \leq 1$ [-]**h**: Specific enthalpy of humid air in Btu/lb.
Range: $-126.174 \leq h \leq 13823.61$ [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_pPHlv_prop****EXCEL function usage :** HAFLK_IP_pPHlv_prop(p, PHI, v, prop)**Input values :** **p** : Pressure in psi.
Range: $0.00145 \leq p \leq 1450.4$ [psi]**PHI** : Relative Humidity in (decimal ratio)
Range: $0 \leq \text{PHI} \leq 1$ [-]**v** : Specific volume of humid air in ft³/lb(dry air).
Range: $2.353\text{E-}2 \leq v \leq 4.893\text{E}6$ [ft³/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_pPHlv_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_pPHlv_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: $0.08865 \leq p \leq 1450.4$ [psi]**T** : Temperature in °F.
Range: $32 \leq T \leq 662$ [°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: $32 \leq T \leq 662$ [°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: $32 \leq T \leq 662$ [°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: $0.08865 \leq p \leq 1450.4$ [psi]**T** : Temperature in °F.
Range: $32 \leq T \leq 662$ [°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: $32 \leq T \leq 662$ [°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: $32 \leq T \leq 662$ [°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: $0.08865 \leq p \leq 1450.4$ [psi]**T** : Temperature in °F.
Range: $32 \leq T \leq 662$ [°F]**Output Result :** **Specific volume of liquid water in ft³/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: $32 \leq T \leq 662$ [°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: $32 \leq T \leq 662$ [°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: $32 \leq T \leq 662$ [°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: $0.08865 \leq p \leq 1450.4$ [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: $-225.67 \leq T \leq 32$ [°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: $-225.67 \leq T \leq 32$ [°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: $-225.67 \leq T \leq 32$ [°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: $-225.67 \leq T \leq 32$ [°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: $-225.67 \leq T \leq 32$ [°F]**Output Result :** **Specific volume of saturated ice 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 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: $-225.67 \leq T \leq 32$ [°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_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: $-7.57 \leq T \leq 32$ [°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: $-225.67 \leq T \leq 32$ [°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: $0.08865 \leq p \leq 1450.4$ [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: $1.741E-12 \leq p \leq 0.08865$ [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: $0.00145 \leq p \leq 1450.4$ [psi]**T** : Temperature in °F.
Range: $-225.67 \leq T \leq 662$ [°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: $0.00145 \leq p \leq 1450.4$ [psi]**T** : Temperature in °F.
Range: $-225.67 \leq T \leq 662$ [°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: $0.00145 \leq p \leq 1450.4$ [psi]**T** : Temperature in °F.
Range: $-225.67 \leq T \leq 662$ [°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: $0.00145 \leq p \leq 1450.4$ [psi]**W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [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_PSI_{da}****Mole fraction of dry air****EXCEL function usage :** SWFLK_IP_W_PSI_{da}(W)**Input values :** **W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [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_PSI_{da}(0.5).

	A	B
1	W	
2	0.5	=SWFLK_IP_W_PSI _{da} (A2)

FUNCTION NAME:**SWFLK_IP_W_PSI_{wv}****Mole fraction of water vapor****EXCEL function usage :** SWFLK_IP_W_PSI_{wv}(W)**Input values :** **W** : Humidity ratio lb(water)/lb(dry air).
Range: $0 \leq W \leq 10$ [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_PSI_{wv}(0.5).

	A	B
1	W	
2	0.5	=SWFLK_IP_W_PSI _{wv} (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: $0 \leq W \leq 10$ [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: $0 \leq W \leq 10$ [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: $-16404 \leq \text{Zele} \leq 36089$ [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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